COMMONWEALTH OF MASSACHUSETTS
ENERGY FACILITIES SITING BOARD

Petition of New England Power Company d/b/a National Grid Pursuant to G.L. c. 164, § 69J for Approval to Construct, Operate and Maintain a New Double Circuit Overhead Transmission Line and Two Associated Tap Lines	)	EFSB 23-02

PETITION OF NEW ENGLAND POWER COMPANY d/b/a NATIONAL GRID PURSUANT TO G.L. c. 164, § 69J FOR APPROVAL TO CONSTRUCT, OPERATE AND MAINTAIN A NEW DOUBLE CIRCUIT OVERHEAD TRANSMISSION LINE AND TWO ASSOCIATED TAP LINES

I. INTRODUCTION

Now comes New England Power Company d/b/a National Grid ("NEP" or the "Company") and hereby petitions the Energy Facilities Siting Board (the "Siting Board") pursuant to G.L. c. 164, § 69J for approval to construct, operate and maintain a new double circuit overhead transmission line in Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster and Sterling and two associated tap lines in Athol, Royalston and Gardner (the "Project"). The double circuit transmission line will replace the Company's existing 69 kV A1 and B2 double circuit overhead transmission lines (the "A1/B2 Lines") and the Athol and Crystal Lake Tap Lines (the "Tap Lines") (referred to as the "Existing Lines," the "Existing Tap Lines," the "Rebuilt Lines" and the "Rebuilt Tap Lines"). The Rebuilt Lines and Rebuilt Tap Lines are proposed in the same rights-of-way ("ROWs") as the Existing Lines and Existing Tap Lines. The Project also includes removal of the Existing Lines and Existing Tap Lines, and the construction, reestablishment and improvement of access routes. The Existing Lines and Existing Tap Lines must be rebuilt because they are over 100 years old, have a poor operating history and provide insufficient capacity to interconnect renewables and other green technology to the electric grid. Although NEP will operate the Rebuilt Lines and Tap Lines at 69 kV initially, the Company proposes to construct the transmission structures so that they comply with NEP's 115 kV design standards, which will provide both short- and long-term reliability benefits. All of this work, as more fully described herein, is referred to as the "A1/B2 Asset Condition Refurbishment Project" or the "Project. In support of this Petition, NEP respectfully represents as follows:

1. NEP, a Massachusetts corporation, is an "electric company" as defined by G.L. c. 164, § 69G and is subject to the provisions of G.L. c. 164, §§ 69H-69R. New England Power Company d/b/a National Grid, EFSB 19-04/D.P.U. 19-77/19-78, at 118 (2021) ("NEP Beverly-Salem"); New England Power Company d/b/a National Grid, EFSB 12-1/D.P.U. 12-46/47 (2014) ("NEP IRP"); New England Power Company d/b/a National Grid, EFSB 13-2/D.P.U. 13-151/152 (2014) ("NEP Salem").

2. NEP is represented by David Waterfall, Esq., Senior Counsel, National Grid, 40 Sylvan Road, Waltham, Massachusetts 02451 and Catherine J. Keuthen, Esq. and Cheryl A. Blaine, Esq., both of Keegan Werlin LLP, 99 High Street, Suite 2900, Boston, Massachusetts 02110.

3. Pursuant to G.L. c. 164, § 69J, an electric company seeking to construct a "facility" must obtain approval from the Siting Board. Pursuant to G.L. c. 164, § 69G, a jurisdictional facility is defined as a "a new electric transmission line having a design rating of 115 kilovolts or more which is 10 miles or more in length on an existing transmission corridor except reconductoring or rebuilding of transmission lines at the same voltage". The Rebuilt Lines will extend approximately 54 miles in Massachusetts along an existing transmission

corridor and will have a design rating of 115 kV. Accordingly, the Project is subject to the Siting Board's jurisdiction under Section 69J.

4. Simultaneously herewith, NEP is filing with the Department of Public Utilities (the "Department") a petition requesting approval of the Project in accordance with G.L. c. 164, § 72 (the "Section 72 Petition") (D.P.U. 23-45).

5. The Company is also filing motions with the Department and the Siting Board requesting, respectively, the referral of the Section 72 Petition to the Siting Board and the consolidation of these related petitions into one proceeding for the Siting Board's review. G.L. c. 25, § 4; G.L. c. 164, § 69H; NEP Beverly-Salem at 6; NEP IRP at 3; NEP Salem at 3.

6. The Company incorporates by reference the Section 72 Petition, including all attachments thereto, into this Section 69J Petition.

II. PROJECT DESCRIPTION

7. The A1/B2 Asset Condition Refurbishment Project includes construction of the Rebuilt A1/B2 and Tap Lines and the removal of the Existing A1/B2 and Tap Lines, all located or to be located on existing NEP rights-of-way ("ROW").[1] The A1/B2 Lines extend from the Vernon #13 Substation in Vernon, Vermont and pass through small portions of Vermont and New Hampshire before entering central Massachusetts. The A1/B2 Lines continue through eight Massachusetts municipalities before terminating at Pratts Junction Substation #225 in Sterling, Massachusetts. NEP also proposes to rebuild two of three existing Tap Lines associated with the A1/B2 Lines. The Athol Tap Lines are two parallel tap lines, each approximately six miles long,

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[1] While NEP does not concede that the removal of the Existing A1/B2 and Tap Lines meets the "facility" definition under G.L. c. 164, § 69G(2), the Company wishes to facilitate the Siting Board's review and demonstrate its willingness to undergo a rigorous review of the Project. Accordingly, the Company has prepared this Petition on an integrated and consolidated basis, addressing all related impacts, costs and other topics and requesting all approvals which the Siting Board may view as applicable to the Project.

that pass through Royalston and connect the A1/B2 Lines to the Chestnut Hill Substation #702 in Athol. The Crystal Lake Tap Lines are two parallel tap lines, each approximately 1.2 miles long, that connect the A1/B2 Lines to the Crystal Lake Substation #601 in Gardner.

8. The A1/B2 Asset Condition Refurbishment Project is more specifically described in Section 1.0 of the *A1/B2 Asset Condition Refurbishment Project Application* (the "Application"), provided as Attachment A hereto.

III. STANDARD OF REVIEW

9. In accordance with Section 69J, before approving a petition to construct a proposed energy facility, the Siting Board requires an applicant to justify its proposal in four phases. First, the Siting Board requires the applicant to show that additional energy resources are needed (see Application, Section 2). Second, the Siting Board requires the applicant to establish that, on balance, its proposed project is superior to alternative approaches in terms of reliability, cost and environmental impact, and in its ability to address the identified need (see Application, Section 3). Third, the Siting Board requires the applicant to show that it has considered a reasonable range of practical facility siting alternatives to ensure that no clearly superior route, in terms of cost, environmental impact and reliability, was overlooked (see Application, Sections 4 and 5). Finally, the applicant must show that its plans for construction of new facilities are consistent with the current health, environmental protection and resource use and development policies as developed by the Commonwealth (see Application, Section 6). As demonstrated in the Application, the Project satisfies the Siting Board's standards and relevant precedent for jurisdictional facilities.

A. The Project is Needed.

10. Section 69J provides that the Siting Board should approve a petition to construct if it determines that the plans for the construction of the applicant's facilities are consistent with the policies stated in G.L. c. 164, § 69H to provide a reliable energy supply for the Commonwealth with a minimum impact on the environment at the lowest possible cost. In carrying out its statutory mandate with respect to proposals to construct energy facilities in the Commonwealth, the Siting Board evaluates whether there is a need for additional energy resources to meet: (1) reliability objectives; (2) economic efficiency objectives; or (3) environmental objectives. NEP Beverly at 10; NEP IRP at 4-5; NEP Salem at 5-6. The need for a particular facility can be demonstrated by showing need on any (or all) of those three bases. See NEP IRP at 4-5; NEP Salem at 5-6.

11. To ensure reliability, each transmission and distribution company establishes and applies planning criteria for construction, operation, and maintenance of its transmission and distribution system. NEP Beverly at 10; NEP IRP at 5; NEP Salem at 6. Compliance with the applicable planning criteria can demonstrate a "reliable" system. Id. To determine whether system improvements are needed, the Siting Board: (1) examines the reasonableness of the Company's system reliability planning criteria; (2) determines whether the Company uses reviewable and appropriate methods for assessing system reliability over time based on system modeling analyses or other valid reliability indicators; (3) determines whether the relevant transmission and distribution system meets these reliability criteria over time under normal conditions and under reasonable contingencies, given existing and projected loads.[2] NEP Beverly at 10; NEP IRP at 5; NEP Salem at 6-7.

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[2] Pursuant to c. 249 of the Acts of 2004, applicants proposing a new transmission line are required to provide ". . . (3) a description of alternatives to the facility, such as other methods of transmitting or storing energy .

12. The Company has determined that the Project is needed because the more than a century old Existing A1/B2 and Tap Lines are no longer fit for purpose and must be replaced. The Rebuilt Lines will (1) address the condition of the Existing A1/B2 and Tap Lines in order to improve their performance and increase reliability of service; (2) address existing low voltage conditions under certain contingencies; and (3) provide sufficient capacity to interconnect new distributed energy resources. The need for the Project is more specifically described in Section 2 of the Application.

B. The Company Considered Alternatives to the Project.

13. The Siting Board is required to evaluate proposed projects to ensure a reliable energy supply for the Commonwealth with a minimum impact on the environment at the lowest possible cost. See G.L. c. 164, § 69H. In addition, Section 69J requires a proposed project proponent to present alternatives to the proposed facility, which may include: (a) other methods of transmitting or storing energy; (b) other sources of electrical power or natural gas; or (c) a reduction of requirements through load management. NEP Beverly at 17; NEP IRP at 25-26; NEP Salem at 17-18.

14. In implementing its statutory mandate, the Siting Board requires a petitioner to show that, on balance, its proposed project is superior to alternative approaches in terms of reliability, cost, environmental impact, and ability to meet a previously identified need. NEP Beverly at 17; NEP IRP at 25-26; NEP Salem at 17-18. In addition, the Siting Board requires a petitioner to consider reliability of supply as part of its showing that the proposed project is superior to alternative project approaches. Id.

. . or a reduction of requirements through load management . . ..” In addition, applicants are required to demonstrate that “projections of the demand for electric power . . . include an adequate consideration of conservation and load management.” G.L. c. 164, § 69J.

15. The Company comprehensively identified and analyzed various Project alternatives to address the established need for an additional energy resource, including: (1) a no-build alternative; (2) non-wires alternatives; (3) a critical asset repair alternative; (4) reconductoring and repair of the Existing Lines; and (5) rebuilding the Existing A1/B2 and Tap Lines. The Company's proposed Project, rebuilding the Existing A1/B2 and Tap Lines, best meets the needs identified in Section 2 of the Application while balancing reliability, cost, and environmental considerations.

16. After determining that the Project was the superior alternative for meeting the identified need, NEP considered two transmission structure design alternatives: one that complies with NEP's 115 kV design standards, and a second that complies with NEP's 69 kV design standards. The Company concluded that rebuilding the Existing A1/B2 Lines and Taps in the existing ROW using a 115 kV structure design would best address the identified needs at a low cost while minimizing environmental impacts. It would also allow NEP to adapt its transmission network to future demands without undertaking costly upgrades that result in further impacts at a later date. The Company's analysis of Project alternatives is described in Section 3 of the Application.

C. The Company Properly Evaluated Alternative Routes.

17. The Siting Board has a statutory mandate to implement the policies of G.L. c. 164, §§ 69J-69Q to provide a reliable energy supply for the Commonwealth with a minimum impact on the environment at the lowest possible cost. G.L. c. 164, §§ 69H, 69J. Further, Section 69J requires the Siting Board to review alternatives to planned projects, including "other site locations." In implementing this statutory mandate, the Siting Board requires a petitioner to demonstrate that it has considered a reasonable range of practical siting alternatives and that the

proposed facilities are sited at locations that minimize costs and environmental impacts while ensuring supply reliability. NEP Beverly at 29; NEP IRP at 41-42; NEP Salem at 34-35. To do so, an applicant must satisfy a two-pronged test: (1) the applicant must first establish that it developed and applied a reasonable set of criteria for identifying and evaluating alternative routes in a manner that ensures that it has not overlooked or eliminated any routes that, on balance, are clearly superior to the proposed route; and (2) the applicant must establish that it identified at least two noticed sites or routes with some measure of geographic diversity. Id.

18. The Siting Board has also stated that, while it has required past applicants to provide a noticed alternative route for their proposals, the practice of doing so is not mandated by Section 69J and the Siting Board has accepted that a noticed alternative route may not be warranted in all cases. Colonial Gas Company d/b/a National Grid, EFSB 18-01/D.P.U. 18-30, at 40-41 (2019) ("National Grid Lowell"); Colonial Gas Company d/b/a National Grid, EFSB 16-01, at 28 (2016) ("National Grid Mid Cape").

19. The Company undertook a thorough and objective analysis to determine if the proposed route along the Existing A1/B2 Line corridor best balanced considerations of reliability, and minimization of environmental impacts and costs. The Company's analysis compared potential routing alternatives and demonstrated that the Existing Lines and Tap Line corridors offered clear advantages because of the need to: (1) connect all the substations along the 54-mile length of the A1/B2 Lines; and (2) maintain reliable service to electric customers in twelve Massachusetts cities and towns both during and after construction. Moreover, alternative routes would result in increased costs, schedule delays, and new and/or increased impacts to human and natural environments. Accordingly, the Company determined that specifying a noticed alternative route was not warranted in this instance because all of the alternative routes

considered by the Company were substantially inferior from a cost and environmental impact perspective. Given that rebuilding the Existing Lines and Taps within their existing ROWs would be superior to other alternatives, creating a noticed alternative route would serve little benefit and have the potential to raise concern unnecessarily among certain abutters. As such, the Company is presenting a single route option for the Project. The routing alternatives studied by the Company are more particularly described in Section 4 of the Application.

D. Environmental Impacts, Cost and Reliability of the Project Have Been Appropriately Evaluated.

20. In implementing its statutory mandate under G.L. c. 164, §§ 69H, 69J, the Siting Board requires a petitioner to show that its proposed facility is sited at a location that minimizes costs and environmental impacts while ensuring a reliable energy supply. NEP Beverly at 41; National Grid Lowell at 42; National Grid Mid Cape at 29.

21. An assessment of all impacts of a proposed facility is necessary to determine whether an appropriate balance is achieved both among conflicting environmental concerns as well as among environmental impacts, cost and reliability. NEP Beverly at 41-42. A facility that achieves that appropriate balance meets the Siting Board's statutory requirement to minimize environmental impacts at the lowest possible cost. NEP Beverly at 41-42; NEP IRP at 46-47; NEP Salem at 39.

22. The Siting Board first determines if the petitioner has provided sufficient information regarding environmental impacts and potential mitigation measures to enable the Siting Board to make a determination as to whether a petitioner has achieved the proper balance among various environmental impacts and among environmental impacts, cost and reliability. NEP Beverly at 41-42.

23. The Siting Board then examines the environmental impacts, reliability and cost of the proposed facilities to determine whether: (1) environmental impacts would be minimized; and (2) an appropriate balance would be achieved among conflicting environmental impacts as well as among environmental impacts, cost and reliability. NEP Beverly at 42; NEP IRP at 73; NEP Salem at 89-90.

24. The Company conducted a comprehensive analysis of the environmental impacts of the Project and has appropriately minimized and mitigated the environmental impacts associated with the construction and operation of the Project. The Project will also achieve an appropriate balance among conflicting environmental concerns as well as among environmental impacts, reliability and cost. The cost, reliability and environmental impacts analyses are set forth in Section 5 of the Application.

E. The Project Meets the Siting Board's Consistency Standards in Accordance with Precedent.

25. Section 69J states that the Siting Board shall approve a petition to construct a facility if it determines that "plans for expansion and construction of the applicant's new facilities are consistent with current health, environmental protection, and resource use and development policies as adopted by the commonwealth."

26. The Project is necessary to ensure the reliable supply of electricity to customers in thirteen communities in central Massachusetts. Section 6 of the Application demonstrates that the construction and operation of the Project is consistent with current health, environmental protection and resource use and development policies as adopted by the Commonwealth of Massachusetts.

WHEREFORE, the Petitioner respectfully requests that the Siting Board, pursuant to G.L. c. 164, § 69J, conduct a public hearing on this Petition (and on any matter referred to the

Siting Board from the Department) and take such other action as may be necessary to: (i) grant the authority to construct the Project as more particularly described in the attached Application; (ii) find that the construction of the Project is consistent with current health, environmental, and resource use and development policies as adopted by the Commonwealth of Massachusetts and the policies stated in G.L. c. 164, § 69H; and (iii) find that such construction is required in order to provide a necessary energy supply for the Commonwealth with a minimum impact on the environment at the lowest possible cost.

Respectfully Submitted,

NEW ENGLAND POWER COMPANY
d/b/a NATIONAL GRID

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Dated: April 28, 2023

Inspection Report

A1/B2 Asset Condition Refurbishment

April 2019

Prepared by:	*Caleb Olson* Caleb S. Olson, E.I.T Transmission Line Engineer Commonwealth Associates, Inc.	Date:	4/17/2019
Reviewed by:	*Kenneth Dawe* Kenneth Dawe, Senior Engineer, Options Solutions Engineering NE	Date:	4/19/2019

nationalgrid

Project: A1/B2 Asset Condition Refurbishment
Company: NEP – 5410
Funding Project: C081212, C081211
Work Order: 90000195537

Project Number: TBD
Document Version: 1.0
Date: April 2019

1.0 Inspection Objectives

The purpose of this project is to investigate the 69kV A1/B2 Vernon – Pratts Junction transmission line including taps for conditions that pose a threat to reliability.

2.0 Circuit Information

The 69kV A1/B2 Vernon – Pratts Junction Line originates at the Vernon No. 13 Switchyard in Vernon, VT and terminates at Pratts Junction No. 225 Substation in Sterling, MA. The line is approximately 64.2 miles in length.

The A1/B2 Mainline is designated as follows:

- A1N Vernon No. 13 Switchyard – Royalston No. 701 (Str. #286)
- A1 Royalston No. 701 – Otter River No. 615
- A1S Otter River No. 615 – Pratts Junction No 225
- B2N Vernon No. 13 Switchyard – Gardner Switch (Crystal Lake Tap)
- B2S Gardner Switch (Crystal Lake Tap) – Pratts Junction No. 225

There are also eight (8) taps as follows:

- A1S Tap #1, 135 ft (Str. #534-1 – East Westminster No. 609 Substation);
- B2S Tap #1-1, 115 ft (Str. #534-1 – East Westminster No. 609 Substation);
- A1S/B2S Westminster Tap, 1.2 miles (Str. #497 – Westminster No. 602 Substation);
- B2N Gardner Spur, 1.2 miles (Str. #422 – Park Street No. 601 Substation);
- B2S Gardner Spur, 1.2 miles (Str. #422 – Park Street No. 601 Substation);
- A1S Baldwinville Tap, 1.47 miles (Str. #355 – North Baldwinville No. 682 Substation / Templeton Municipal);
- Athol Tap #1, 5.95 miles (Str. #286 – Chestnut Hill No. 702 Substation); and
- Athol Tap #2, 5.95 miles (Str. #286 – Chestnut Hill No. 702 Substation)

The dual circuit A1/B2 lattice tower Line was originally put into service in 1909 bringing electricity generated at the new Vernon hydro station to the Worcester area. The A1/B2 Mainline generally remains on the original structures. The lines were recoppered ca. 1920. New insulation with a greater BIL was installed in 2004. Bird deterrents were installed in the mid 2000s. The wood pole taps all appear to be newer construction.

Based on visual inspections, the shielding angle on the A1/B2 mainline and all taps appears to be greater than 30 degrees, the recommended shielding angle per RUS Bulletin 1724E-200. This results in a higher probability of flashover of the insulation during lightning strikes and potential reliability issues during storms.

The existing conductor and shieldwire information is summarized below.

Conductor:

A1N, A1, A1S, B2N, B2S:	2/0 Copper
A1S Tap #1 at East Westminster:	1/0 Copper
B2S Tap #1-1 at East Westminster:	1/0 Copper
A1/B2 Westminster Tap:	336.4 ACSR "Linnet"
B2N/B2S Gardner Spur:	2/0 Copper
A1/B2 Baldwinville Tap:	477 ACSR "Hawk"
Athol Tap #1 and Athol Tap #2:	2/0 Copper

Shieldwire:

A1N, A1, A1S, B2N, B2S:	#4 BESG 30% Copper Clad on GW
A1N, B2N (Str. #16 – Str. #14)	3/8" EHS
A1S Tap #1 at East Westminster:	N/A
B2S Tap #1-1 at East Westminster:	N/A
A1/B2 Westminster Tap:	7#9 Alumoweld (A1/B2 to Str. #12 on tap)
A1/B2 Westminster Tap:	3/8" EHS (Str. #12 on tap to Westminster Sub)
B2N/B2S Gardner Spur:	#8 B & S Copper Clad
A1/B2 Baldwinville Tap:	5/16" Galv. Common Steel
Athol Tap #1:	3/8" EHS
Athol Tap #2:	3 - #11 Galv. Steel

3.0 ROW Conditions & Access

The right-of-way appears to be considerably overgrown. While snow cover affected the on-foot inspection, the aerial inspection revealed very dense and tall tree growth.

4.0 Inspection Summary

Two inspections were performed on these lines. A visual inspection of critical structures (see section 4.2) was fielded during the week of March 4, 2019, and drilled pier foundations were picked up on April 4, 2019. Many critical structures were inaccessible due to snowy ROW conditions. A desktop review of aerial photography (see section 4.3) was also performed for the length of the mainline and taps.

Total structure counts are presented below:

Table 1: A1/B2 Mainline Existing Structure Data

Material	Structure Type		Quantity
WOOD	S/C H-FRAME SUSPENSION	HSUSP	2
	D/C H-FRAME SUSPENSION, RESTRAINED	DC HSUSPR	1
	D/C DOUBLE ARM SINGLE INSULATOR SUSPENSION	DC DASI	2
	D/C DOUBLE ARM SINGLE INSULATOR SUSPENSION	DC DASI	34
	D/C POLEARM SUSPENSION	DC PSUSP	2
	D/C SUSPENSION PULLOFF	DC SPO	1
	D/C DEADEND PULLOFF	DC DEPO	5
	D/C DOUBLE ARM DEADEND	DC DADE	5
	S/C H-FRAME DEADEND	HDE	3
	D/C H-FRAME DEADEND	DC HDE	4
SUBTOTAL			59
LATTICE TOWER	D/C BAYONETTE SUSPENSION	BAY-SU	515
	D/C BAYONETTE TRANSPOSITION SUSPENSION	BAY-SU TRANSPOSITION	3
	D/C LARGE ANGLE SUSPENSION	LA-SUSP	5
	D/C BAYONETTE DEADEND	BAY-DE	75
	D/C LARGE ANGLE DEADEND	LA-DE	5
SUBTOTAL			603
STEEL POLE	D/C DAVIT ARM DEADEND	DC DAVIT ARM DE	6
	S/C H-FRAME SWITCH	SWITCH (H-FRAME)	2
SUBTOTAL			8
TOTAL			670

Table 2: Athol Tap #1 and Athol Tap #2 Existing Structure Data

Material	Structure Type		Quantity
WOOD	S/C H-FRAME SUSPENSION	HSUSP	88
	S/C POLEARM SUSPENSION	PSUSP	86
	D/C DOUBLE ARM DOUBLE INSULATOR SUSPENSION	DC DADI	[1]1
	S/C SUSPENSION PULLOFF	SPO	2
	S/C DEADEND PULLOFF	DEPO	4
	S/C POLEARM DEADEND	PDE	9
	S/C H-FRAME DEADEND	HDE	8
TOTAL			198

[1] Str. #98 and Str. #99 are listed as DC DADI structures on T-Sheet T-1700-10. For the quantity listed above, these two poles are considered one (1) double circuit structure (Str. #98/99 Athol Tap #1 and Athol Tap #2).

Table 3: Baldwinville Tap Existing Structure Data

Material	Structure Type		Quantity
WOOD	S/C DAVIT ARM SUSPENSION	SCDSUSP	8
	S/C DAVIT ARM RESTRAINED SUSPENSION	SCDRSUSP	18
	S/C DEADEND PULLOFF	DEPO	1
	S/C H-FRAME DEADEND	HDE	1
	S/C H-FRAME TERMINAL DEADEND	TDE	1
	S/C H-FRAME SWITCH	SWITCH (H-FRAME)	2
TOTAL			31

Table 4: Gardner Spur Existing Structure Data

Material	Structure Type		Quantity
WOOD	S/C DOUBLE ARM DOUBLE INSULATOR SUSPENSION	DADI	6
	S/C DOUBLE ARM SINGLE INSULATOR SUSPENSION	DASI	26
	S/C SUSPENSION PULLOFF	SPO	4
	S/C FLAT CONFIGURATION DOUBLE ARM DEADEND	FDADE	2
	S/C DOUBLE ARM DEADEND	DADE	8
TOTAL			46

Table 5: Westminster Tap Existing Structure Data

Material	Structure Type		Quantity
WOOD	D/C DOUBLE ARM DOUBLE INSULATOR SUSPENSION	DC DADI	1
	D/C DOUBLE ARM SINGLE INSULATOR	DC DASI	11
	D/C SUSPENSION PULLOFF	DC SPO	1
	D/C DOUBLE ARM DEADEND	DC DADE	7
	D/C DEADEND PULLOFF	DC DEPO	1
TOTAL			21

Table 6: East Westminster Tap Existing Structure Data

Material	Structure Type		Quantity
	S/C FLAT CONFIGURATION DOUBLE ARM DEADEND	FDADE	2
TOTAL			2

4.1 Summary

These quantities are based on the visual and desktop inspection to reflect the condition of the entire line as a full line visual inspection was not conducted. See the Appendix for a full structure list with comments associated with each structure.

There do not appear to be any Priority Level 1[2] replacements.

Priority Level 2[3] replacements based on Commonwealth's visual inspection and desktop review are presented below.

- Heavy corrosion and local flange buckling is present at Vernon Substation. There is a separate substation project to relocate the Vernon switchyard and retire this terminal lattice structure.
- Damaged/broken guys were visually seen on two (2) BAY-DE structures.

Priority Level 3[4] replacements based on Commonwealth's visual inspection and desktop review are presented below.

- Member buckling (typically affecting the horizontal diagonals) was observed in every BAY-DE and BAY-SU visually inspected. The desktop review indicates this issue is present or expected to be present along the entire mainline (603 structures).
- Light corrosion was present on every BAY-DE and BAY-SU visually inspected. The desktop review indicates this issue is present or expected to be present along the entire mainline (603 structures).
- Bird deterrents were observed in the desktop review to be either missing or damaged on one-hundred and six (106) out of 603 lattice towers on the mainline, and it is expected that the remaining bird deterrents will need to be replaced within 40 years.
- Damaged/broken guys were visually observed on two (2) BAY-DE structures on the mainline.
- Rusty hardware was observed in the desktop review on forty-seven (47) out of 75 BAY-DE structures on the mainline, one-hundred and twelve (112) out of 515 BAY-SU structures on the mainline, two (2) out of 2 BAY-SU Transposition structures on the mainline, one (1) out of 8 DADE structures on the mainline, and two (2) out of 4 SPO structures on Gardner Spur.

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[2] Priority Level 1 – Reserved for immediate and substantial threats to public safety and/or system reliability. These should generally be very rare

[3] Priority Level 2 – Items which are to be replaced based on current conditions.

[3] Priority Level 3 – Items which are to be replaced as part of a 40-year asset life cycle.

- Rusty davit arm collars were visually observed on one (1) DADE structures on the mainline.
- Woodpecker damage was observed during the desktop review on two (2) out of 59 wood structures on the mainline, eight (8) out of 198 wood structures on Athol #1 and Athol #2 Taps, and one (1) out of 46 wood structures on Gardner Spur.
- Missing/damaged pole caps were observed in the desktop review on one (1) out of 59 wood structures on the mainline, one hundred and sixteen (116) out of 198 wood structures on Athol #1 and Athol #2 taps, ten (10) out of 31 wood structures on Baldwinville Tap, and seven (7) out of 46 wood structures on Gardner Spur.
- Damaged crossarms were found during the desktop review on four (4) out of 59 wood structures on the mainline, one (1) out of 31 wood structures on Baldwinville Tap, and six (6) out of 46 wood structures on Gardner Spur.
- A flashed insulator was observed in the desktop review on a total of one (1) structure on the mainline.
- Damaged or leaning insulators were observed in the desktop review on a total of thirteen (13) structures on the mainline.
- The copper conductor on the mainline is very aged.

4.2 Visual Inspection

Commonwealth performed a visual inspection Mar. 4 – Mar. 8, 2019 with a follow-up on Apr. 4, 2019.

The results of the visual inspection are summarized below.

Table 7: Lattice Structure Visual Inspection Counts

Structure Type	*No. of Str. On Line*	*No. Str. Inspected*	*% Str. Inspected*
LA-DE	5	0	0%
LA-SUSP	5	0	0%
BAY-DE	75	29	39%
BAY-SU	515	45	9%
BAY-SU TRANS.	3	0	9%
Total	603	74	13%

Table 8: Lattice Structure Visual Inspection Findings (Level 1 - 4)

Structure Type	*% of Inspections w/ Member Deflection/Buckling*	*% of Inspections w/ Damaged Bird Deterrents*	*% of Inspections w/ Corrosion*
LA-DE	N/A	N/A	N/A
LA-SU	N/A	N/A	N/A
BAY-DE	21 / 29 = 73%	15 / 29 = 52%	15 / 29 = 52%
BAY-SU	26 / 45 = 58%	31 / 45 = 69%	25 / 45 = 56%
BAY-SU TRANS.	N/A	N/A	N/A

Table 9: Steel Pole Structure Visual Inspection Counts

Structure Type	*No. of Str. On Line*	*No. Str. Inspected*	*% Str. Inspected*
DADE	6	4	67%
SWITCH	2	2	100%
Total	8	6	75%

Steel Pole Structure Visual Inspection Findings (Level 1 - 4)

Steel pole structures appear to be in good condition. The only item observed during the visual inspection was a rusty davit arm collar on Str. #472-1 of the A1/B2 Mainline.

Wood Pole Structure Visual Inspection Counts/Findings (Level 1 – 4)

Wood poles on the mainline and various taps appear to be new construction as part of rebuilds several years ago. As such, lattice towers were the focus of the field inspection with wood poles being primarily evaluated through the Desktop Review presented in Section 4.3.

There do not appear to be any Priority Level 1 replacements.

The Level 2 items resulting from the visual inspection are presented below:

- Heavy corrosion and local flange buckling is present at Vernon Substation.
- Str. #14, BAY-DE, has a guy wire that needs repair/replacement.
- Str. #457, BAY-SU, has a broken guy wire.

The Level 3 items (unless otherwise noted) resulting from the visual inspection are presented below:

- Str #5-1, BAY-DE, has deflection in the horizontal plane on the face of the structure, rusty guy wire, guy not bonded, paint chipping, a warning sign that needs replacing, and step bolts missing.
- Str. #6, BAY-SU, has deflection in the horizontal plane, aerial numbers missing, paint chipping, and bird deterrents damaged.
- Str. #7, BAY-SU, deflecting/bowing in the horizontal plane bracing, has aerial numbers missing, bird deterrents missing, missing structure #, paint chipping, and step bolts missing.
- Str. #13, BAY-SU, has bird deterrents missing.
- Str. #14, BAY-DE, has beam deflection (horizontal diagonals) bracing at all levels, rusty guying, step bolts missing, and chipped paint.
- Str. #15, BAY-DE, has deflecting face bracing/horizontal diagonals, chipped paint, and bird deterrents missing.
- Str. #28, BAY-DE, has deflection/buckling in the horizontal plane, rusty guying, falling bird deterrents, and chipped paint.
- Str. #46, BAY-SU, has deflection in the horizontal diagonals, bird deterrents damaged, danger sign on ground, rusty guy wires, and warning sign missing.
- Str. #47, BAY-SU, has bird deterrents damaged, and rusty guy wire.
- Str. #48, BAY-SU, has aerial numbers missing, missing numbering, rusty hardware, paint chipping, and bird deterrents damaged.
- Str. #79, BAY-SU, has rusty hardware, and missing bird deterrents on the middle phase.
- Str. #80, BAY-DE, has buckling in the diagonal beam on the side of the tower, rusty hardware, bird deterrents damaged, and paint chipping.
- Str. #128, BAY-DE, has buckling in the insulator channel/arm, damaged bird deterrents, and paint chipping.
- Str. #129, BAY-DE, has deflection in the horizontal plane, bird deterrents missing, rusty guys, chipped paint, and rusty hardware.
- Str. #140, BAY-DE, has deflection in the horizontal plane, damaged ground, paint chipping, and rusty hardware.
- Str. #142, BAY-SU, has deflection in the horizontal plane diagonal beams, bird deterrents missing, and paint chipping.
- Str. #218, BAY-SU, has deflection in the horizontal plane.
- Str. #304, BAY-SU, has deflection in the horizontal plane bracing, bird deterrent damage, and paint chipping.
- Str. #305, BAY-DE, has deflection in the horizontal plane, bird deterrent damage, and rusty hardware.

- Str. #354, BAY-DE, has rusty hardware, and needs new paint.
- Str. #356, BAY-SU, has member deflection, paint chipping, and rusty hardware.
- Str. #361, BAY-SU, has member deflection, paint chipping, bird deterrents missing, and missing aerial numbers.
- Str. #365, BAY-SU, needs paint.
- Str. #366, BAY-DE, has slight deflection on the horizontal plane diagonals, rusty guys, paint chipping, and bird deterrent damage.
- Str. #367, BAY-DE, has member deflection.
- Str. #378, BAY-SU, has bird deterrent damage, and needs new paint.
- Str. #392, BAY-SU, has member deflection, missing aerial numbers, and paint chipping.
- Str. #405, BAY-DE, has member deflection, bird deterrent damage, and rusty hardware.
- Str. #406, BAY-SU, has member deflection, rusty guys, missing bird deterrents, and paint chipping.
- Str. #430, BAY-SU, has member deflection, missing aerial numbers, bird deterrent damage, and needs paint.
- Str. #431, BAY-SU, has deflection on the horizontal plane diagonals, missing aerial numbers, bird deterrent damage, and paint chipping.
- Str. #443, BAY-SU, has member deflection, missing aerial numbers, bird deterrent damage, rusty guys, and needs paint.
- Str. #449, BAY-SU, has deflection in the horizontal plane diagonals, missing aerial numbers, bird deterrent damage, and paint chipping.
- Str. #451, BAY-DE, has rusty guys, bird deterrent damage, and rusty hardware.
- Str. #453, BAY-SU, has bird deterrent damage.
- Str. #457, BAY-SU, has bird deterrent damage.
- Str. #462, BAY-SU, has bird deterrent damage, and paint chipping.
- Str. #472-1, DA-DE, has a rusty middle davit arm collar.
- Str. #491, BAY-SU, has bird deterrent damage, and needs paint.
- Str. #492, BAY-SU, has bird deterrent damage, and paint chipping.
- Str. #503, BAY-SU, has member deflection, bird deterrent damage, and paint chipping.
- Str. #505, BAY-SU, has bird deterrent damage, and needs paint.
- Str. #511, BAY-SU, has member deflection.
- Str. #512, BAY-SU, has member deflection, paint chipping.
- Str. #516, BAY-SU, has member deflection, bird deterrent damage, and paint chipping.

- Str. #523, BAY-DE, has member deflection, rusty guys, and bird deterrent damage.
- Str. #526, BAY-DE, has bird deterrent damage.
- Str. #527, BAY-DE, has buckling on the face, paint chipping, rusty guys, and rusty hardware.
- Str. #528, BAY-SU, has member deflection, bird deterrent damage.
- Str. #531, BAY-SU, has member deflection, bird deterrents missing, and paint chipping.
- Str. #534, BAY-SU, has paint chipping and bird deterrent damage.
- Str. #574, BAY-DE, has member deflection, bird deterrent damage, and rusty guys.
- Str. #576, BAY-DE, has member deflection, missing aerial numbers, and rusty guys.
- Str. #600, BAY-SU, has deflection in the horizontal plane diagonals, paint dripping, and bird deterrent damage.
- Str. #624, BAY-DE, has deflection in the horizontal plane diagonals, paint chipping, and rusty hardware.
- Str. #625, BAY-SU, has deflection in the horizontal plane diagonals, bird deterrent damage.
- Str. #626, BAY-DE, has member deflection, rusty guys.
- Str. #629, BAY-DE, has deflection in the horizontal plane diagonals, bird diverter damage, and rusty guys.
- Str. #640, BAY-SU, has deflection in the horizontal plane diagonals, bird deterrent damage.
- Str. #643, BAY-DE, has deflection in the horizontal plane diagonals, paint chipping, and rusty hardware.
- Str. #653, BAY-SU, has buckling in the horizontal face, bird deterrent damage, and paint chipping.

4.3 Desktop Review

Commonwealth performed a desktop review of the line using the Linewise Report. The full Anomaly Report is presented in the Appendix. There does not appear to be any Priority Level 1 or Level 2 items on this line. Priority Level 3 items are further described below.

Linewise Aerial Inspection comments are presented below:

- In general, there is heavy corrosion on hardware attachments and the conductor is very aged.
- All lattice towers show some general rusting on the tower body components.
- A large number of towers have missing or damaged bird deterrents.

- The majority of wood poles have missing pole caps.
- Some crossarm deterioration and pole cracking has been observed on wood poles.
- Woodpecker damage has been observed on some wood poles.
- The entire ROW is characterized by very close and high trees.

Linewise Aerial Inspection results are summarized below:

Table 10: Linewise Aerial Inspection Results Summary

Structure issues			
Level 1	**Level 2**	**Level 3**	**Level 4**
NA	NA	121	2
Insulator issues			
Level 1	**Level 2**	**Level 3**	**Level 4**
NA	NA	14	NA
Signage issues			
Level 1	**Level 2**	**Level 3**	**Level 4**
NA	NA	NA	NA
Conductor issues			
Level 1	**Level 2**	**Level 3**	**Level 4**
NA	NA	NA	1
Hardware issues			
Level 1	**Level 2**	**Level 3**	**Level 4**
NA	NA	196	NA

There do not appear to be any Level 1 items resulting from the desktop review.

There do not appear to be any Level 2 items resulting from the desktop review.

The Level 3 items resulting from the desktop review are summarized below. See Appendix for detailed aerial reports:

- Rusty hardware and damaged bird deterrents on nearly every lattice tower structure.
- Pole caps missing or damaged on nearly every wood pole.

- Deteriorating crossarms on a total of eleven (11) structures (A1/B2 Mainline: 324-1, 325-1, 329-1, 346H; Baldwinville Tap: 4; Gardner Spur: 9, 11, 12, 14, 15, 20).
- Flashed insulator on a total of one (1) structure (A1/B2 Mainline: 236-1).
- Damaged or leaning insulators on a total of thirteen (13) structures (A1/B2 Mainline: 28, 29, 30, 83, 86, 87, 88, 98, 128, 129, 212, 250, 323-1).
- Woodpecker damage on a total of twelve (12) structures (A1/B2 Mainline: 343-1, 346-1; Athol #1 Tap: 60, 63, 64, 91, Athol #2 Tap: 60, 63, 64, 91; Gardner Spur: 10).

4.4 Crossing Details

Crossing inspection details based on the visual inspection and the desktop review (priority level 3 and based on the desktop review unless otherwise noted) are presented below:

Mainline:

Water Crossings:

Connecticut River, Hinsdale, NH (Str #1-1V – Vernon Switchyard)

- Vernon Sub, has level 2 priority maintenance heavy corrosion and local flange buckling.
- Str. #1-1, LA-DE, this structure was not visually inspected, but appears to be intact with rusty diaphragm bracing.

Connecticut River, Hinsdale, NH (Str. #5-1 – Str. #4)

- Str. #4, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware.
- Str. #5-1, BAY-DE, this structure has deflection in the horizontal plane on the face of the structure, has rusty guy wire, guy not bonded, paint chipping, a warning sign that needs replacing, and step bolts missing.

Connecticut River, Hinsdale, NH (Str. #42 – Str. 41)

- Str. #41, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #42, BAY-SU, this structure was not visually inspected, but appears to be intact with damaged bird deterrents.

Miller's River, Winchendon, MA (Str. #346 – Str. #345)

- Str. #345, PA-SU, this structure was not visually inspected, but appears to be intact.
- Str. #346, PA-SU, this structure was not visually inspected, but appears to be intact with woodpecker damage and pole top deteriorating.

Major Road Crossings:

Rte. 63, Winchester, NH (Str. #47 – Str. #46)

- Str. #46, BAY-SU, this structure has deflection in the horizontal diagonals, has bird deterrents damaged, danger sign on ground, rusty guy wires, and warning sign missing.
- Str. #47, BAY-SU, this structure has bird deterrents damaged, and rusty guy wire.

Rte. 10, Winchester, NH (Str. #84 – Str. #83)

- Str. #83, BAY-SU, this structure was not visually inspected, but appears to be intact with a damaged stack insulator cover.
- Str. #84, BAY-SU, this structure was inaccessible, but appears to be intact with a splice in the SW (bk span).

Rte. 78, Warwick, MA (Str. #129 – Str. #128)

- Str. #128, BAY-DE, this structure has buckling in the insulator channel/arm, and has damaged bird deterrents, and paint chipping.
- Str. #129, BAY-DE, this structure has deflection in the horizontal plane, has bird deterrents missing, rusty guys, chipped paint, and rusty hardware.

Rte. 32, Royalston, MA (Str. #218 – Str. #217)

- Str. #217, BAY-SU, this structure was inaccessible, but appears to be intact with heavy rust on attachment hardware.
- Str. #218, BAY-SU, this structure has deflection in the horizontal plane.

Rte. 68, Royalston, MA (Str. #280 – Str. #279)

- Str. #279, BAY-SU, this structure was not visually inspected, but appears to be intact with heavy rust on attachment hardware and damaged/missing bird deterrents.
- Str. #280, BAY-SU, this structure was not visually inspected, but appears to be intact.

Rte. 202, Winchendon, MA (Str. #348 – Str. #347)

- Str. #347, BAY-SU, this structure was not visually inspected, but appears to be intact with heavy rust on attachment hardware.
- Str. #348, BAY-SU, this structure was not visually inspected, but appears to be intact with heavy rust on attachment hardware.

Rte. 101, Gardner, MA (Str. #453 – Str. #452)

- Str. #452, BAY-SU, this structure was not visually inspected, but appears to be intact.

- Str. #453, BAY-SU, this structure has spliced in the ahead and back spans, and has damaged bird deterrents.

Rte. 140, Gardner, MA (Str. #472-1 – Str. #471-1)

- Str. #471-1, DA-DE, this structure was not visually inspected, but appears to be intact.
- Str. #472-1, DA-DE, this structure has a rusty middle davit arm collar.

Rte. 2A, Westminster, MA (Str. #524 – Str. #523)

- Str. #523, BAY-DE, this structure has member deflection, has rusty guys, and bird deterrent damage.
- Str. #524, BAY-SU, this structure was not visually inspected, but appears to be intact.

State Hwy. 2 On-ramp, Westminster, MA (Str. #537-1 – Str. #536)

- Str. #536, BAY-SU, this structure was not visually inspected, but appears to be intact.
- Str. #537-1, BAY-SU, this structure was not visually inspected, but appears to be intact.

State Hwy. 2, Westminster, MA (Str. #538-1 – Str. #537-1)

- Str. #537-1, BAY-SU, this structure was not visually inspected, but appears to be intact.
- Str. #538-1, BAY-DE, this structure was not visually inspected, but appears to be intact.

State Hwy. 2 Off-ramp, Fitchburg, MA (Str. #546 – Str. #545)

- Str. #545, BAY-SU, this structure was not visually inspected, but appears to be intact.
- Str. #546, BAY-SU, this structure was not visually inspected, but appears to be intact.

State Hwy. 2 Off-ramp, Fitchburg, MA (Str. #547 – Str. #546)

- Str. #546, BAY-SU, this structure was not visually inspected, but appears to be intact.
- Str. #547, BAY-DE, this structure was not visually inspected, but appears to be intact.

Rte. 31, Fitchburg, MA (Str. #549-2 – Str. #548-2)

- Str. #548-2, DA-DE, this structure was not visually inspected, but appears to be intact.

- Str. #549-2, DA-DE, this structure was not visually inspected, but appears to be intact.

State Hwy. 2, Fitchburg, MA (Str. #558 – Str. #557)

- Str. #557, BAY-SU, this structure was not visually inspected, but appears to be intact.
- Str. #558, BAY-DE, this structure was not visually inspected, but appears to be intact.

State Hwy. 2, Fitchburg, MA (Str. #563 – Str. #561)

- Str. #561, LA-DE, this structure was not visually inspected, but appears to be intact.
- Str. #563, LA-DE, this structure was not visually inspected, but appears to be intact.

Rte. 12, Leominster, MA (Str. #654 – Str. #653)

- Str. #653, BAY-SU, this structure has buckling in the horizontal face, has bird deterrent damage, and paint chipping.
- Str. #654, BAY-SU, this structure was not visually inspected, but appears to be intact.

Rail Crossings:

Pan Am Railways, (FRAARCID 375067), Gardner, MA (Str. #470 – Str. #469)

- Str. #469, BAY-SU, this structure was not visually inspected, but appears to be intact.
- Str. #470, BAY-DE, this structure was not visually inspected, but appears to be intact.

CSXT, (FRAARCID 374877), Sterling, MA (Str. #665 – Str. #664)

- Str. #664, BAY-SU, this structure was not visually inspected, but appears to be intact.
- Str. #665, BAY-SU, this structure was not visually inspected, but appears to be intact.

Pipeline Crossings:

N/A

<u>Athol Tap:</u>

Water Crossings:

Miller's River, Athol, MA (Athol Tap #1 Str. #97 - #96 and Athol Tap #2 Str. #98 - #97)

- Str. #96 (Athol Tap #1), PDE, this structure was not visually inspected, but appears to be intact.
- Str. #97 (Athol Tap #1), PDE, this structure was not visually inspected, but appears to be intact.
- Str. #97 (Athol Tap #2), HDE, this structure was not visually inspected, but appears to be intact.
- Str. #98 (Athol Tap #2), HDE, this structure was not visually inspected, but appears to be intact.

Major Road Crossings:

State Rte. 68, South Royalston Road, Royalston, MA (Str. #2 – Str. #3)

- Str. #2 (Athol Tap #1), PDE, this structure was not visually inspected, but appears to be intact with missing/damaged pole caps.
- Str. #3 (Athol Tap #1), P-SUSP, this structure was not visually inspected, but appears to be intact with missing/damaged pole caps.
- Str. #2 (Athol Tap #2), HDE, this structure was not visually inspected, but appears to be intact with missing/damaged pole caps.
- Str. #3 (Athol Tap #2), H-SUSP, this structure was not visually inspected, but appears to be intact with missing/damaged pole caps.

Rail Crossings:

Pan Am Railways, (FRAARCID 374677), Athol, MA (Athol Tap #1 Str. #97 - #96 and Athol #2 Str. #98 - #97)

- Str. #96 (Athol Tap #1), PDE, this structure was not visually inspected, but appears to be intact.
- Str. #97 (Athol Tap #1), PDE, this structure was not visually inspected, but appears to be intact.
- Str. #97 (Athol Tap #2), HDE, this structure was not visually inspected, but appears to be intact.
- Str. #98 (Athol Tap #2), HDE, this structure was not visually inspected, but appears to be intact.

Pipeline Crossings:

N/A

<u>N. Baldwinsville Tap:</u>

N/A

<u>Gardner Spur Line:</u>

N/A

Westminster Tap:

State Highway 2, Westminster, MA (Str. #16 – Str. #15)

- Str. #15, DADE, this structure was not visually inspected, but appears to be intact.
- Str. #16, DADE, this structure was not visually inspected, but appears to be intact.

4.5 Deadend Details

Deadend inspection details based on the visual inspection and the desktop review (priority level 3 unless otherwise noted) are presented below:

Wood Pole Structures:

Mainline:

- Str. #219-1, H-DE, this structure was not visually inspected, but appears to be intact.
- Str. #220-1, H-DE, this structure was not visually inspected, but appears to be intact.
- Str. #254A, DADE, this structure was not visually inspected, but appears to be intact.
- Str. #319, DEPO, this structure was not visually inspected, but appears to be intact.
- Str. #331, DEPO, this structure was not visually inspected, but appears to be intact.
- Str. #335, DEPO, this structure was not visually inspected, but appears to be intact.
- Str. #343, DEPO, this structure was not visually inspected, but appears to be intact with minor woodpecker damage.
- Str. #346-E, DEPO, this structure was not visually inspected, but appears to be intact.
- Str. #354E, SWITCH, this structure was not visually inspected, but appears to be intact.
- Str. #483, DADE, this structure was not visually inspected, but appears to be intact.
- Str. #484-1, DADE, this structure was not visually inspected, but appears to be intact.
- Str. #559A, H-DE, this structure was not visually inspected, but appears to be intact.
- Str. #559B, H-DE, this structure was not visually inspected, but appears to be intact.

- Str. #564, H-DE, this structure was not visually inspected, but appears to be intact.
- Str. #566, H-DE, this structure was not visually inspected, but appears to be intact.
- Str. #575, DADE, this structure looks new and appears to be in good condition.

Athol #1 Tap:

- Str. #1, PDE, this structure was not visually inspected, but appears to be intact with missing/damaged pole caps.
- Str. #2, PDE, this structure was not visually inspected, but appears to be intact with missing/damaged pole caps.
- Str. #21, PDE, this structure was not visually inspected, but appears to be intact with missing/damaged pole caps, and rusty guy wires.
- Str. #37, PDE, this structure was not visually inspected, but appears to be intact.
- Str. #58, PDE, this structure was not visually inspected, but appears to be intact with missing/damaged pole caps.
- Str. #72, PDE, this structure was not visually inspected, but appears to be intact.
- Str. #84, DEPO, this structure was not visually inspected, but appears to be intact.
- Str. #91, DEPO, this structure was not visually inspected, but appears to be intact with missing/damaged pole caps, and woodpecker damage.
- Str. #95, PDE, this structure was not visually inspected, but appears to be intact.
- Str. #96, PDE, this structure was not visually inspected, but appears to be intact.
- Str. #97, PDE, this structure was not visually inspected, but appears to be intact.
- Str. #99, DEPO, this structure was not visually inspected, but appears to be intact.

Athol #2 Tap:

- Str. #1, HDE, this structure was no visually inspected, but appears to be intact with missing/damaged pole caps.
- Str. #2, HDE, this structure was not visually inspected, but appears to be intact with missing/damaged pole caps.
- Str. #17, HDE, this structure was not visually inspected, but appears to be intact with missing/damaged pole caps.
- Str. #37, HDE, this structure was not visually inspected, but appears to be intact with missing/damaged pole caps.
- Str. #73, HDE, this structure was not visually inspected, but appears to be intact.
- Str. #96, HDE, this structure was not visually inspected, but appears to be intact with missing/damaged pole caps.
- Str. #97, HDE, this structure was not visually inspected, but appears to be intact.

- Str. #98, HDE, this structure was not visually inspected, but appears to be intact.
- Str. #100, DEPO, this structure was not visually inspected, but appears to be intact.

Baldwinville Tap:

- Str. #L1, TDE, this structure was not visually inspected, but appears to be intact with missing/damaged pole caps.
- Str. #L2, SWITCH, this structure was not visually inspected, but appears to be intact with missing/damaged pole caps.
- Str. #R2, SWITCH, this structure was not visually inspected, but appears to be intact.
- Str. #3, HDE, this structure was not visually inspected, but appears to be intact.
- Str. #30, DEPO, this structure was not visually inspected, but appears to be intact with missing/damaged pole caps.

Gardner Spur:

- Str. #3, DADE, this structure was not visually inspected, but appears to be intact.
- Str. #5, DADE, this structure was not visually inspected, but appears to be intact with missing/damaged pole caps.
- Str. #16, DADE, this structure was not visually inspected, but appears to be intact.
- Str. #23, DADE, this structure was not visually inspected, but appears to be intact.
- Str. #24-1, FDADE, this structure was not visually inspected, but appears to be intact.
- Str. #24-2, FDADE, this structure was not visually inspected, but appears to be intact.

Westminster Tap:

- Str. #1, HDE, this structure was not visually inspected, but appears to be intact.
- Str. #2, DEPO, this structure was not visually inspected, but appears to be intact.
- Str. #6, DADE, this structure was not visually inspected, but appears to be intact.
- Str. #14, DADE, this structure was not visually inspected, but appears to be intact.
- Str. #15, DADE, this structure was not visually inspected, but appears to be intact.
- Str. #16, DADE, this structure was not visually inspected, but appears to be intact.
- Str. #17, DADE, this structure was not visually inspected, but appears to be intact.
- Str. #19, DADE, this structure was not visually inspected, but appears to be intact.
- Str. #21, DADE, this structure was not visually inspected, but appears to be intact.

<u>Lattice Tower Structures:</u>

Mainline:

- Str. #1-1, LA-DE, this structure was not visually inspected, but appears to be intact with rusty diaphragm bracing.

- Str. #1A, LA-DE, this structure was not visually inspected, but appears to be intact.
- Str. #2, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware.
- Str. #4, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware.
- Str. #5-1, BAY-DE, this structure has deflection in the horizontal plane on the face of the structure, has rusty guy wire, guy not bonded, paint chipping, a warning sign that needs replacing, and step bolts missing.
- Str. #11, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware.
- Str. #14, BAY-DE, this structure has both level 2 and level 3 priority maintenance items. This structure has (level 2) a guy wire that needs repair/replace, and (level 3) has beam deflection (horizontal diagonals) bracing at all levels, rusty guying, step bolts missing, and chipped paint.
- Str. #15, BAY-DE, this structure has deflecting face bracing/horizontal diagonals, has chipped paint, and bird deterrents missing.
- Str. #28, BAY-DE, this structure has deflection/buckling in the horizontal plane, rusty guying, falling bird deterrents, and chipped paint.
- Str. #38, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #39, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware.
- Str. #40, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware.
- Str. #41, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #45, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware and missing/damaged bird deterrents.
- Str. #49, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #68, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware.
- Str. #80, BAY-DE, this structure has buckling in the diagonal beam on the side of the tower, rusty hardware, bird deterrents damaged, and paint chipping.
- Str. #88, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware, and stack insulator covers missing.
- Str. #93, BAY-DE, this structure was not visually inspected, but appears to be intact.

- Str. #94, BAY-DE this structure was not visually inspected, but appears to be intact.
- Str. #104, BAY-DE this structure was not visually inspected, but appears to be intact with rusty hardware.
- Str. #116, BAY-DE this structure was not visually inspected, but appears to be intact with rusty hardware, and damaged/missing bird deterrents.
- Str. #128, BAY-DE, this structure has buckling in the insulator channel/arm, damaged bird deterrents, and paint chipping.
- Str. #129, BAY-DE, this structure has deflection in the horizontal plane, bird deterrents missing, rusty guys, chipped paint, and rusty hardware.
- Str. #140, BAY-DE, this structure has deflection in the horizontal plane, damaged ground, paint chipping, and rusty hardware.
- Str. #149, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware, and an inactive birds nest.
- Str. #157, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware.
- Str. #168, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware, and damaged/missing bird deterrents.
- Str. #182, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware.
- Str. #196, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware.
- Str. #209, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware.
- Str. #213, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware.
- Str. #230, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #237-1, LA-DE, this structure was not visually inspected, but appears to be intact.
- Str. #250, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware, damaged/missing bird diverts, and an insulator stack cover out of place.
- Str. #283, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware.
- Str. #286, SWITCH, this structure appears to be intact with SW splices in both the ahead/back spans, and splices in the A1 conductor in the back span.
- Str. #298, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware, and damaged/missing bird deterrents.

- Str. #305, BAY-DE, this structure has deflection in the horizontal plane, bird deterrent damage, and rusty hardware.
- Str. #354, BAY-DE, this structure has rusty hardware, and needs new paint.
- Str. #366, BAY-DE, this structure has slight deflection on the horizontal plane diagonals, rusty guys, paint chipping, and bird deterrent damage.
- Str. #367, BAY-DE, this structure has member deflection, and spliced in the A1 conductor in both the back/ahead spans.
- Str. #384, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware.
- Str. #399, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware.
- Str. #400, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware.
- Str. #404, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware, and damaged/missing bird deterrents.
- Str. #405, BAY-DE, this structure has member deflection, bird deterrent damage, and rusty hardware.
- Str. #413, BAY-DE, this structure was not visually inspected, but appears to be intact with rusty hardware.
- Str. #421, SWITCH, this structure was not visually inspected, but appears to be intact.
- Str. #428, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #429, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #438, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #439, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #440, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #451, BAY-DE, this structure has rusty guys, bird deterrent damage, and rusty hardware.
- Str. #465, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #470, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #478, BAY-DE, this structure was not visually inspected, but appears to be intact.

- Str. #487, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #512, BAY-DE, this structure has member deflection, and has paint chipping.
- Str. #523, BAY-DE, this structure has member deflection, rusty guys, and bird deterrent damage.
- Str. #526, BAY-DE, this structure appears to be intact with bird deterrent damage.
- Str. #527, BAY-DE, this structure has buckling on the face, paint chipping, rusty guys, and rusty hardware.
- Str. #538-1, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #547, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #551-D, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #552, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #558, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #560, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #561, LA-DE, this structure was not visually inspected, but appears to be intact.
- Str. #563, LA-DE, LA-DE, this structure was not visually inspected, but appears to be intact.
- Str. #574, BAY-DE, this structure has member deflection, bird deterrent damage, and rusty guys.
- Str. #576, BAY-DE, this structure has member deflection, missing aerial numbers, and rusty guys,
- Str. #582, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #592, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #605, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #618, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #624, BAY-DE, this structure has deflection in the horizontal plane diagonals, paint chipping, and rusty hardware.
- Str. #626, BAY-DE, this structure has deflection in the horizontal plane diagonals, and has rusty guys.

- Str. #629, BAY-DE, this structure has deflection in the horizontal plane diagonals, has bird diverter damage, and rusty guys.
- Str. #636, BAY-DE, this structure was not visually inspected, but appears to be intact.
- Str. #643, BAY-DE, this structure has deflection in the horizontal plane diagonals, paint chipping, and rusty hardware.

Steel Structures:

Mainline:

- Str. #426, DADE, this structure was inaccessible due to snow, but appears to be intact.
- Str. #471-1, DADE, this structure was not visually inspected, but appears to be intact.
- Str. #472-1, DADE, this structure has a rusty middle davit arm collar.
- Str. #535A, HDE, this structure is intact and appears to be a new structure.
- Str. #535B, HDE, this structure is intact and appears to be a new structure.
- Str. #548-2, DADE, this structure was not visually inspected, but appears to be intact.
- Str. #549-2, DADE, this structure was not visually inspected, but appears to be intact.
- Str. #550-2, DADE, this structure was not visually inspected, but appears to be intact.

5.0 Attachments

- Representative Damage Photos
- T-Sheets
- Structure List

Photographs:
A1/B2 Structure 80 Member deflection/buckling.

A1/B2 Structure 4 Rusty hardware

A1/B2 Structure 42 Damaged/Missing bird deterrents

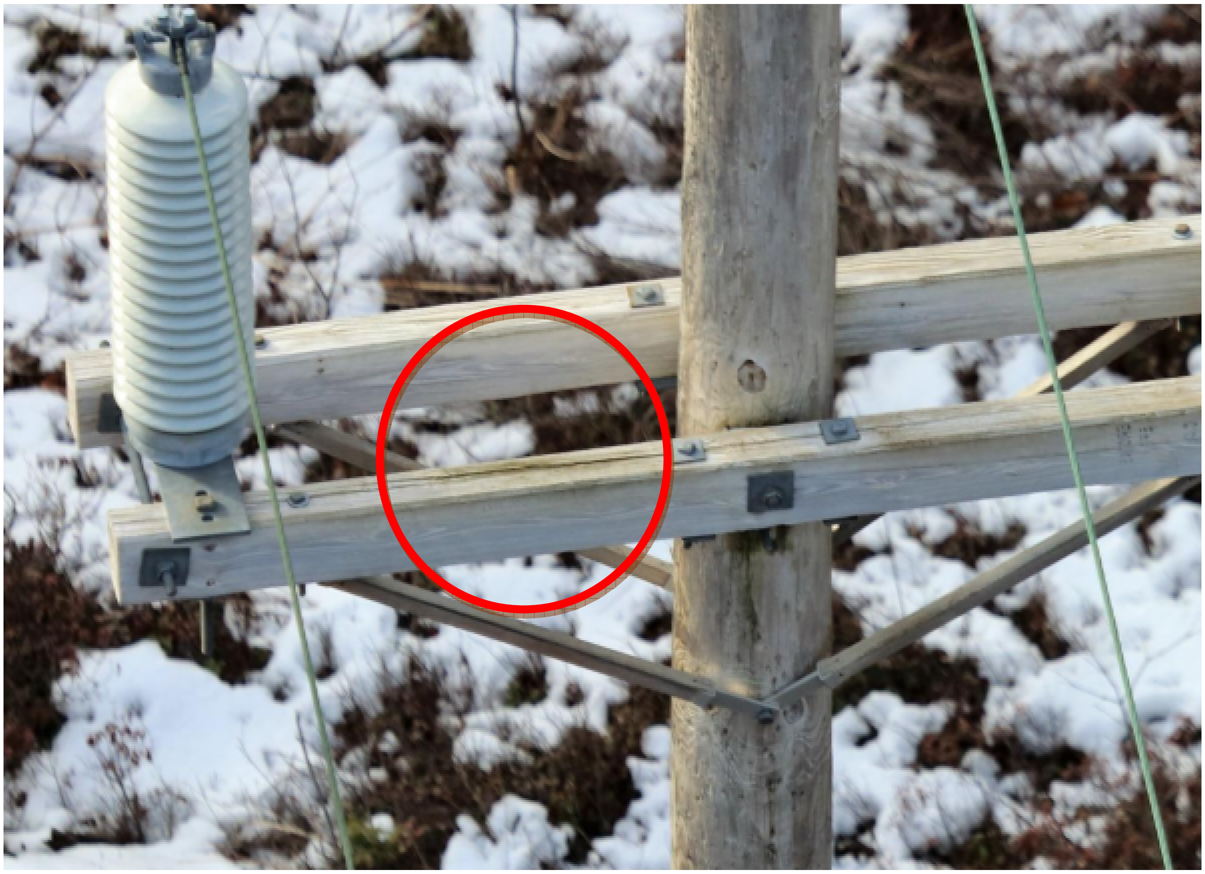
A1/B2 Structure 48 Damaged paint

A1/B2 Structure 472-1 Rusty davit arm collar

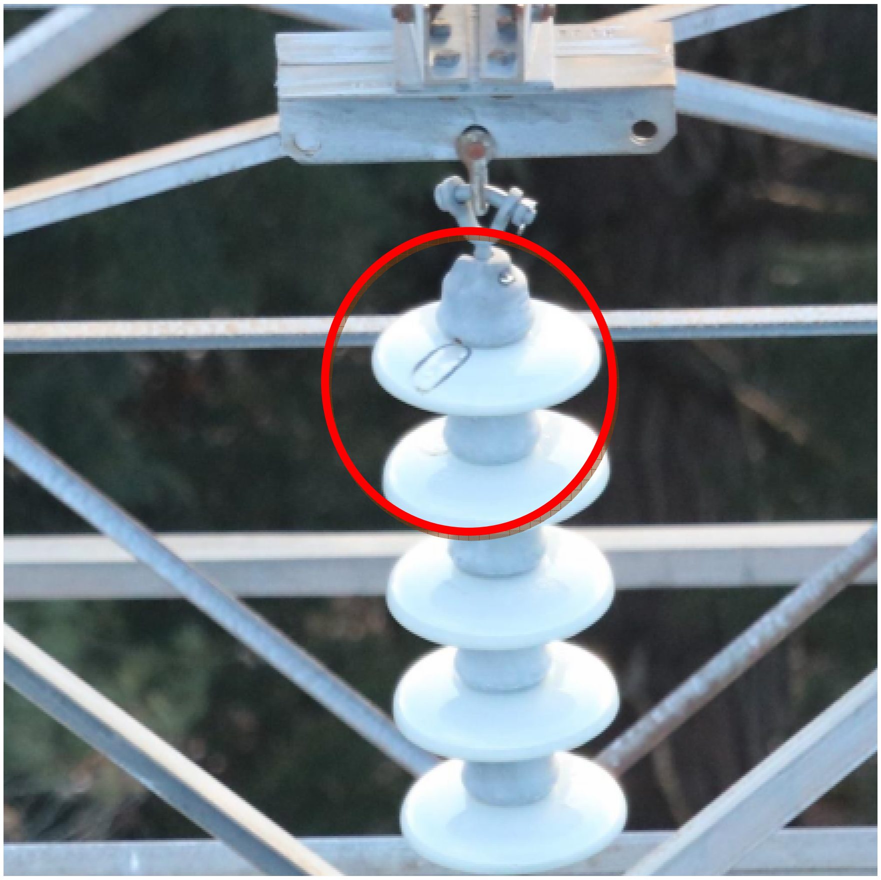
A1/B2 Structure 343-1 Woodpecker damage

A1/B2 Structure 397 Damaged/Missing pole cap

A1/B2 Structure 324-1 Crossbrace defects



A1/B2 Structure 236-1 Flashed insulator



A1/B2 Structure 323-1 Damaged or leaning isulator

ORDER	LINE	EXISTING STR NO.	T-SHEET	STATION (FT)	BACK SPAN (FT)	STR TYPE	MATERIAL	FDN TYPE	UALLY INSPECT	OVERALL	EMBER BUCKLI	HARDWARE	PAINT	RD DETERRENT	HIGHWAY CROSSING	RAILROAD CROSSING	WATER CROSSING	CAI COMMENTS (VISUAL INSPECTION)	LINEWISE COMMENTS (AERIAL INSPECTION)	ROW BACKSPAN COMMENTS	NOTES	TOWN, STATE
0	**Mainline**																					
1	Mainline A1N/B2N	BUS	T-2827	0	0	BUS	LATTICE			2		3	2					STEEL/LATTICE CONDITION: 2, CROSSING AT THE DAM, SHIELD ON A1, NO SHIELD ON B2, EXTENSION BASE ON STR. 1-1 OF A1, (LEVEL 2) HEAVY CORROSION AND LOCAL BEAM BUCKLING, , , , , ,			VERNON SWITCHYARD	VERNON, VT
2	Mainline A1N	1-1	T-800	13+46	1346	LA-DE	LATTICE			3	3	3	3	3			YES					VERNON, VT
3	Mainline B2N	1A	T-800	15+71	1571	LA-DE	LATTICE			3	3	3	3	3								VERNON, VT
4	Mainline A1N/B2N	2	T-800	18+22	476/251	BAY-DE	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			VERNON, VT
5	Mainline A1N/B2N	3	T-800	21+97	375	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
6	Mainline A1N/B2N	4	T-800	25+72	375	BAY-DE	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			VERNON, VT
7	Mainline A1N/B2N	5-1	T-800	34+05	836	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3			YES	STEEL/LATTICE CONDITION: 3, (LEVEL 3) REPAIR/REPLACE GUY WIRE (RUSTY), (LEVEL 3) GUY NOT BONDED, (LEVEL 3) REPLACE WARNING SIGN, (LEVEL 3 - BEAM DEFL/BUCK) HORIZ DEFLECTION ON FACE OF STR., SPLICING IN AHEAD (B2)/BACK SPAN (A1) (BOTH CKTS), (LEVEL 3) PAINT CHIPPING, (LEVEL 3) 2 GUYS RUSTY, (LEVEL 3) STEP BOLTS MISSING, GRILLAGE, ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			VERNON, VT
8	Mainline A1N/B2N	6	T-800	35+86	178	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: 3, (LEVEL 3) AERIAL NUMBERS MISSING, SLEEVE/CONN. SPLICE QTY 1, (LEVEL 3 - BEAM DEFL/BUCK) HORIZ PLANE DEFLECTION, (LEVEL 3) PAINT CHIPPING, (LEVEL 3) BIRD GUARDS DAMAGED, SPLICE IN AHEAD SPAN, GRILLAGE, , , ,				VERNON, VT
9	Mainline A1N/B2N	7	T-800	38+40	254	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: 3, (LEVEL 3) AERIAL NUMBERS MISSING, INSULATOR PLUMB, GRILLAGE FOUNDATION, (LEVEL 3) BIRD PERCHING MISSING, (LEVEL 3) MISSING STR. #, (LEVEL 3) BIRD GUARDS MISSING (HANGING ON TOWER ANGLE BAR), FRESH MASTIC COATING / GRILLAGE FND., (LEVEL 3) PAINT CHIPPING, (LEVEL 3) STEP BOLTS MISSING, (LEVEL 3 - BEAM DEFL/BUCK) HORZ PLANE BRACING IS DEFLECTING/BOWING, SPLICING AHEAD SPAN A1/B2				VERNON, VT
10	Mainline A1N/B2N	8	T-800	42+78	438	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
11	Mainline A1N/B2N	9	T-800	46+98	420	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
12	Mainline A1N/B2N	10	T-800	50+38	340	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
13	Mainline A1N/B2N	11	T-800	54+66	428	BAY-DE	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			VERNON, VT
14	Mainline A1N/B2N	12	T-800	58+31	365	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , , ,			VERNON, VT
15	Mainline A1N/B2N	13	T-800	63+06	475	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: 3, (LEVEL 3) BIRD GUARDS MISSING, , , , , , , , , ,	Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , , ,			VERNON, VT
16	Mainline A1N/B2N	14	T-802	65+86	280	BAY-DE	LATTICE	2 GRILLAGE, 2 CONCRETE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: 3, (LEVEL 3 - GUY) REPAIR/REPLACE GUY WIRE, CONCRETE FOUNDATION, (LEVEL 3) REPLACE WARNING SIGN, CONCRETE FOUNDATION, (LEVEL 3) GUYING (RUSTY), (LEVEL 3) STEP BOLTS?, (LEVEL 3 - BEAM DEFL/BUCK) BEAM DEFLECTION? HORIZ. DIAGONALS (BRACING) AT ALL LEVELS, LOOPED SIDE GUY (DBL STRAND), (LEVEL 3) CHIPPED PAINT, ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			VERNON, VT
17	Mainline A1N/B2N	15	T-802	69+71	385	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: 3, GUYING, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTING FACE BRACING/HORIZ DIAG., NEW DBLE STRAND GUYING, (LEVEL 3) CHIPPED PAINT (3), (LEVEL 3) BIRD GUARDS FALLING, GRILLAGE?, , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			VERNON, VT
18	Mainline A1N/B2N	16	T-802	73+11	340	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
19	Mainline A1N/B2N	17	T-802	77+01	390	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , , ,			VERNON, VT
20	Mainline A1N/B2N	18	T-802	80+41	340	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , , ,			VERNON, VT
21	Mainline A1N/B2N	19	T-802	84+61	420	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , , ,			VERNON, VT
22	Mainline A1N/B2N	20	T-802	89+01	440	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
23	Mainline A1N/B2N	21	T-802	93+41	440	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
24	Mainline A1N/B2N	22	T-802	97+21	380	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
25	Mainline A1N/B2N	23	T-802	101+11	390	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , , ,			VERNON, VT
26	Mainline A1N/B2N	24	T-803	104+91	380	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
27	Mainline A1N/B2N	25	T-803	107+91	300	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
28	Mainline A1N/B2N	26	T-803	110+91	300	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
29	Mainline A1N/B2N	27	T-803	114+44	353	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
30	Mainline A1N/B2N	28	T-803	118+01	357	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: 3, (LEVEL 3 - BEAM DEFL/BUCK) HORIZ. DIAG. DEFLECTION, (LEVEL 3) OLD RUSTY SIDE GUY, (LEVEL 3) FALLING BIRD GUARDS, (LEVEL 3) B2 ROTATED bird GUARD, (LEVEL 3) CHIPPING PAINT, SPLICE IN SHIELD (AH), (LEVEL 3 - BEAM DEFL/BUCK) BUCKLE IN HORIZ PLANE DIAG., GRILLAGE, , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) Insulator stack cover damage, , , , , , , , ,			VERNON, VT
31	Mainline A1N/B2N	29	T-803	121+71	370	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, (LEVEL 3) Leaning stack insulator, , , , , , , , ,			VERNON, VT
32	Mainline A1N/B2N	30	T-803	125+41	370	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, (LEVEL 3) Leaning stack insulator, , , , , , , , ,			VERNON, VT
33	Mainline A1N/B2N	31	T-803	129+16	375	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
34	Mainline A1N/B2N	32	T-803	132+45	329	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
35	Mainline A1N/B2N	33	T-803	138+07	562	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
36	Mainline A1N/B2N	34	T-803	143+67	560	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
37	Mainline A1N/B2N	35	T-803	147+87	420	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
38	Mainline A1N/B2N	36	T-803	149+62	175	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
39	Mainline A1N/B2N	37	T-803	151+37	175	BAY-SU	LATTICE			3	3	3	3	3								VERNON, VT
40	Mainline A1N/B2N	38	T-803	154+77	340	BAY-DE	LATTICE			3	3	3	3	3								VERNON, VT
41	Mainline A1N/B2N	39	T-803	158+07	330	BAY-DE	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			VERNON, VT
42	Mainline A1N/B2N	40	T-803	161+47	340	BAY-DE	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			VERNON, VT
43	Mainline A1N/B2N	41	T-803	164+85	338	BAY-DE	LATTICE			3	3	3	3	3								VERNON, VT
44	Mainline A1N/B2N	42	T-803	171+40	655	BAY-SU	LATTICE			3	3	3	3	3			YES		Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , , ,			HINSDALE, NH
45	Mainline A1N/B2N	43	T-803	174+15	275	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , , ,			HINSDALE, NH
46	Mainline A1N/B2N	44	T-804	176+95	280	BAY-SU	LATTICE			3	3	3	3	3								HINSDALE, NH
47	Mainline A1N/B2N	45	T-804	179+75	280	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				NO FIELD NOTES??, , , , , , , , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			HINSDALE, NH
48	Mainline A1N/B2N	46	T-804	183+75	400	BAY-SU	LATTICE	2 GRILLAGE, 2 CONCRETE (ROCK ANCHORS)	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: 3, (LEVEL 3) INSTALL/REPLACE WARNING SIGN, (LEVEL 3) BIRD GUARDS DAMAGED, 2 GRILLAGE, 2 CONC. FDNS, (LEVEL 3) DANGER SIGN ON GROUND, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTING DIAG/HORZ, (LEVEL 3) RUSTY GUY WIRES, , , , ,	Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , , ,			HINSDALE, NH
49	Mainline A1N/B2N	47	T-804	185+17	142	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3	YES			STEEL/LATTICE CONDITION: 3, (LEVEL 3) BIRD GUARDS DAMAGED, (LEVEL 3) GUY WIRE RUSTY, , , , , , , , ,				HINSDALE, NH

ORDER	LINE	EXISTING STR NO.	T-SHEET	STATION (FT)	BACK SPAN (FT)	STR TYPE	MATERIAL	FDN TYPE	UALLY INSPECT	OVERALL	EMBER BUCKLI	HARDWARE	PAINT	RD DETERRENT	HIGHWAY CROSSING	RAILROAD CROSSING	WATER CROSSING	CAI COMMENTS (VISUAL INSPECTION)	LINEWISE COMMENTS (AERIAL INSPECTION)	ROW BACKSPAN COMMENTS	NOTES	TOWN, STATE
50	Mainline A1N/B2N	48	T-804	186+47	130	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: 3, (LEVEL 3) AERIAL NUMBERS MISSING, (LEVEL 3) MISSING NUMBERING, (LEVEL 3) HARDWARE RUSTY, (LEVEL 3) PAINT CHIPPING/RUSTY, (LEVEL 3) RUSTY SIDE GUYS/OLD ANCHORS, (LEVEL 3) BIRD GUARD DAMAGE, GRILLAGE, , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			HINSDALE, NH
51	Mainline A1N/B2N	49	T-804	189+99	352	BAY-DE	LATTICE			3	3	3	3	3								HINSDALE, NH
52	Mainline A1N/B2N	50	T-804	194+34	435	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			HINSDALE, NH
53	Mainline A1N/B2N	51	T-804	197+14	280	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			HINSDALE, NH
54	Mainline A1N/B2N	52	T-804	199+96	282	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			HINSDALE, NH
55	Mainline A1N/B2N	53	T-804	204+44	448	BAY-SU	LATTICE			3	3	3	3	3								HINSDALE, NH
56	Mainline A1N/B2N	54	T-804	207+99	355	BAY-SU	LATTICE			3	3	3	3	3								HINSDALE, NH
57	Mainline A1N/B2N	55	T-804	211+49	350	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
58	Mainline A1N/B2N	56	T-804	214+96	347	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
59	Mainline A1N/B2N	57	T-804	218+59	363	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			WINCHESTER, NH
60	Mainline A1N/B2N	58	T-804	223+24	465	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			WINCHESTER, NH
61	Mainline A1N/B2N	59	T-804	226+94	370	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			WINCHESTER, NH
62	Mainline A1N/B2N	60	T-804	230+94	400	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
63	Mainline A1N/B2N	61	T-804	237+07	613	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
64	Mainline A1N/B2N	62	T-804	241+47	440	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
65	Mainline A1N/B2N	63	T-804	245+47	400	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
66	Mainline A1N/B2N	64	T-805	249+42	395	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			WINCHESTER, NH
67	Mainline A1N/B2N	65	T-805	252+67	325	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
68	Mainline A1N/B2N	66	T-805	256+27	360	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
69	Mainline A1N/B2N	67	T-805	259+67	340	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			WINCHESTER, NH
70	Mainline A1N/B2N	68	T-805	262+97	330	BAY-DE	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHESTER, NH
71	Mainline A1N/B2N	69	T-805	266+82	385	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			WINCHESTER, NH
72	Mainline A1N/B2N	70	T-805	270+16	334	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
73	Mainline A1N/B2N	71	T-805	274+66	450	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
74	Mainline A1N/B2N	72	T-805	279+94	528	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
75	Mainline A1N/B2N	73	T-805	283+60	366	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
76	Mainline A1N/B2N	74	T-805	286+01	241	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
77	Mainline A1N/B2N	75	T-805	289+01	300	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
78	Mainline A1N/B2N	76	T-805	293+01	400	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
79	Mainline A1N/B2N	77	T-805	296+61	360	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
80	Mainline A1N/B2N	78	T-805	302+51	590	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
81	Mainline A1N/B2N	79	T-805	305+51	300	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: 3, (LEVEL 3) HARDWARE DAM RUSTY, (LEVEL 3) MISSING bird GUARD ON MIDDLE PHASE (A1/B2), , , , , , , ,				WINCHESTER, NH
82	Mainline A1N/B2N	80	T-805	308+56	305	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: 3, (LEVEL 3 - BEAM DEFL/BUCK) STRUCTURE DAMAGE: BUCKLE IN MEMBER, SLEEVE/CONN. AH SPAN, (LEVEL 3) HARDWARE DAM RUSTY, (LEVEL 3) BIRD PERCHINGG GUARD DAMAGE, (LEVEL 3) BIRD GUARD DAMAGE, (LEVEL 3) NO bird GUARDS MID PHASE POSTS (A1/B2), SPLICES IN AH SPAN, (LEVEL 3) PAINT CHIPPING, GRILLAGE, (LEVEL 3 - BEAM DEFL/BUCK) BUCKLE IN DIAG. BEAM ON SIDE OF TOWER, (LEVEL 3) HARDWARE RUSTY	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			WINCHESTER, NH
83	Mainline A1N/B2N	81	T-805	311+81	325	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
84	Mainline A1N/B2N	82	T-805	314+61	280	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
85	Mainline A1N/B2N	83	T-806	317+21	260	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) Stack insulator cover damaged, , , , , , , , ,			WINCHESTER, NH
86	Mainline A1N/B2N	84	T-806	323+56	635	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3	YES			STEEL/LATTICE CONDITION: 3, SLEEVE/CONN. SW BK SPAN, SPLICE IN SW (BK), SIDE GUY, INACCESSIBLE (NEW FROM ROAD), , , , , , ,				WINCHESTER, NH
87	Mainline A1N/B2N	85	T-806	327+84	428	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
88	Mainline A1N/B2N	86	T-806	331+39	355	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, (LEVEL 3) Stack insulator covers missing, , , , , , , , ,			WINCHESTER, NH
89	Mainline A1N/B2N	87	T-806	334+74	335	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, (LEVEL 3) Stack insulator covers missing, , , , , , , , ,			WINCHESTER, NH
90	Mainline A1N/B2N	88	T-806	337+57	283	BAY-DE	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) Stack insulator covers missing, , , , , , , ,			WINCHESTER, NH
91	Mainline A1N/B2N	89	T-806	341+02	345	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
92	Mainline A1N/B2N	90	T-806	344+32	330	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
93	Mainline A1N/B2N	91	T-806	347+77	345	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
94	Mainline A1N/B2N	92	T-806	350+95	318	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
95	Mainline A1N/B2N	93	T-806	354+04	309	BAY-DE	LATTICE			3	3	3	3	3								WINCHESTER, NH
96	Mainline A1N/B2N	94	T-806	357+19	315	BAY-DE	LATTICE			3	3	3	3	3								WINCHESTER, NH
97	Mainline A1N/B2N	95	T-806	360+66	347	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHESTER, NH
98	Mainline A1N/B2N	96	T-806	363+96	330	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			WINCHESTER, NH
99	Mainline A1N/B2N	97	T-806	368+33	437	BAY-SU	LATTICE			3	3	3	3	3								WINCHESTER, NH
100	Mainline A1N/B2N	98	T-806	371+39	306	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) Stack insulator covers missing, , , , , , , , ,			WINCHESTER, NH
101	Mainline A1N/B2N	99	T-807	377+27	588	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			WINCHESTER, NH / W
102	Mainline A1N/B2N	100	T-807	381+79	452	BAY-SU	LATTICE			3	3	3	3	3			YES					WARWICK, MA
103	Mainline A1N/B2N	101	T-807	388+44	665	BAY-SU	LATTICE			3	3	3	3	3								WARWICK, MA
104	Mainline A1N/B2N	102	T-807	390+65	221	BAY-SU	LATTICE			3	3	3	3	3								WARWICK, MA
105	Mainline A1N/B2N	103	T-807	395+89	524	BAY-SU	LATTICE			3	3	3	3	3								WARWICK, MA
106	Mainline A1N/B2N	104	T-807	399+99	410	BAY-DE	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
107	Mainline A1N/B2N	105	T-807	404+19	420	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			WARWICK, MA
108	Mainline A1N/B2N	106	T-807	406+61	242	BAY-SU	LATTICE			3	3	3	3	3								WARWICK, MA
109	Mainline A1N/B2N	107	T-807	412+14	553	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			WARWICK, MA
110	Mainline A1N/B2N	108	T-807	415+69	355	BAY-SU	LATTICE			3	3	3	3	3								WARWICK, MA
111	Mainline A1N/B2N	109	T-807	419+59	390	BAY-SU	LATTICE			3	3	3	3	3								WARWICK, MA
112	Mainline A1N/B2N	110	T-807	423+49	390	BAY-SU	LATTICE			3	3	3	3	3								WARWICK, MA
113	Mainline A1N/B2N	111	T-807	427+49	400	BAY-SU	LATTICE			3	3	3	3	3								WARWICK, MA
114	Mainline A1N/B2N	112	T-807	431+44	395	BAY-SU	LATTICE			3	3	3	3	3								WARWICK, MA
115	Mainline A1N/B2N	113	T-807	435+24	380	BAY-SU	LATTICE			3	3	3	3	3								WARWICK, MA
116	Mainline A1N/B2N	114	T-807	439+64	440	BAY-SU	LATTICE			3	3	3	3	3								WARWICK, MA
117	Mainline A1N/B2N	115	T-807	443+74	410	BAY-SU	LATTICE			3	3	3	3	3								WARWICK, MA
118	Mainline A1N/B2N	116	T-808	447+39	365	BAY-DE	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			WARWICK, MA
119	Mainline A1N/B2N	117	T-808	452+49	510	BAY-SU	LATTICE			3	3	3	3	3								WARWICK, MA
120	Mainline A1N/B2N	118	T-808	456+34	385	BAY-SU	LATTICE			3	3	3	3	3								WARWICK, MA
121	Mainline A1N/B2N	119	T-808	461+09	475	BAY-SU	LATTICE			3	3	3	3	3								WARWICK, MA
122	Mainline A1N/B2N	120	T-808	465+14	405	BAY-SU	LATTICE			3	3	3	3	3								WARWICK, MA
123	Mainline A1N/B2N	121	T-808	468+74	360	BAY-SU	LATTICE			3	3	3	3	3								WARWICK, MA
124	Mainline A1N/B2N	122	T-808	472+04	330	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
125	Mainline A1N/B2N	123	T-808	476+23	422	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
126	Mainline A1N/B2N	124	T-808	478+92	266	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
127	Mainline A1N/B2N	125	T-808	481+62	270	BAY-SU	LATTICE			3	3	3	3	3								WARWICK, MA
128	Mainline A1N/B2N	126	T-808	484+42	280	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			WARWICK, MA

ORDER	LINE	EXISTING STR NO.	T-SHEET	STATION (FT)	BACK SPAN (FT)	STR TYPE	MATERIAL	FDN TYPE	UALLY INSPECT	OVERALL	EMBER BUCKLI	HARDWARE	PAINT	RD DETERRENT	HIGHWAY CROSSING	RAILROAD CROSSING	WATER CROSSING	CAI COMMENTS (VISUAL INSPECTION)	LINEWISE COMMENTS (AERIAL INSPECTION)	ROW BACKSPAN COMMENTS	NOTES	TOWN, STATE
129	Mainline A1N/B2N	127	T-808	488+25	383	BAY-SU	LATTICE			3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
130	Mainline A1N/B2N	128	T-808	493+16	491	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: 3, SLEEVE/CONN. BACK EVERY PHASE, (LEVEL 3) BIRD GUARD DAMAGE, (LEVEL 3) bird GUARDS CROOKED, SPLICES BK EVERY PHASE, SPLICE AH ONE PHASE, (LEVEL 3) PAINT CHIPPING, (LEVEL 3 - BEAM DEFL/BUCK) INSULATOR CHANNEL/ARM IS BUCKLING, , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, (LEVEL 3) Insulator stack cover damage, , , , , , , ,			WARWICK, MA
131	Mainline A1N/B2N	129	T-808	496+05	266	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3	YES			STEEL/LATTICE CONDITION: 3, (LEVEL 3) bird GUARDS ON INSULATORS ARE CROOKED (MISSING ON MID PHASES), (LEVEL 3) 2 RUSTY SIDE GUYS (VEG ON GUYS), (LEVEL 3) CHIPPED PAINT, (LEVEL 3 - BEAM DEFL/BUCK) HORIZ PLANE DEFLECTION, GRILLAGE, (LEVEL 3) HARDWARE RUSTY, (LEVEL 3) OBJECT ON A1 PHASE, , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) Insulator stack cover damage, , , , , , , , ,			WARWICK, MA
132	Mainline A1N/B2N	130	T-808	500+10	405	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
133	Mainline A1N/B2N	131	T-808	503+65	355	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
134	Mainline A1N/B2N	132	T-808	506+97	332	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
135	Mainline A1N/B2N	133	T-808	510+29	332	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
136	Mainline A1N/B2N	134	T-809	514+96	467	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
137	Mainline A1N/B2N	135	T-809	517+16	220	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
138	Mainline A1N/B2N	136	T-809	522+16	502	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
139	Mainline A1N/B2N	137	T-809	526+21	403	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
140	Mainline A1N/B2N	138	T-809	530+41	420	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
141	Mainline A1N/B2N	139	T-809	533+03	262	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
142	Mainline A1N/B2N	140	T-809	536+74	371	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: 3, SLEEVE/CONN., (LEVEL 3) DAMAGED GROUND, SPLICE AH (B2 CENTER PHASE), (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION HORIZ PLANE, (LEVEL 3) PAINT CHIPPING, (LEVEL 3) STRAND ON GROUND BROKEN, (LEVEL 3) HARDWARE RUSTY, , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
143	Mainline A1N/B2N	141	T-809	540+76	404	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
144	Mainline A1N/B2N	142	T-809	543+42	264	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: 3, SLEEVE/CONN. AH SPAN, SPLICES IN AH SPAN B2, (LEVEL 3) bird GUARDS MISSING MID PHASES, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION IN HORIZ PLAN DIAG BEAMS, (LEVEL 3) PAINT CHIPPING, , , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
145	Mainline A1N/B2N	143	T-809	547+46	404	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
146	Mainline A1N/B2N	144	T-809	551+45	399	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
147	Mainline A1N/B2N	145	T-809	556+92	547	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
148	Mainline A1N/B2N	146	T-809	559+20	228	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
149	Mainline A1N/B2N	147	T-809	562+27	307	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
150	Mainline A1N/B2N	148	T-809	566+61	434	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
151	Mainline A1N/B2N	149	T-809	569+57	296	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 4) birds nest / not active, , , , , , , ,			WARWICK, MA
152	Mainline A1N/B2N	150	T-809	573+10	353	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
153	Mainline A1N/B2N	151	T-809	577+07	397	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
154	Mainline A1N/B2N	152	T-809	580+93	386	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
155	Mainline A1N/B2N	153	T-809	584+85	392	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
156	Mainline A1N/B2N	154	T-810	589+08	423	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
157	Mainline A1N/B2N	155	T-810	593+13	405	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
158	Mainline A1N/B2N	156	T-810	598+82	569	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
159	Mainline A1N/B2N	157	T-810	603+29	447	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
160	Mainline A1N/B2N	158	T-810	606+61	332	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
161	Mainline A1N/B2N	159	T-810	613+71	710	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
162	Mainline A1N/B2N	160	T-810	917+26	355	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
163	Mainline A1N/B2N	161	T-810	621+06	380	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
164	Mainline A1N/B2N	162	T-810	625+24	418	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
165	Mainline A1N/B2N	163	T-810	627+58	234	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
166	Mainline A1N/B2N	164	T-810	630+46	288	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
167	Mainline A1N/B2N	165	T-810	634+41	395	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
168	Mainline A1N/B2N	166	T-810	637+84	343	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
169	Mainline A1N/B2N	167	T-810	640+03	219	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
170	Mainline A1N/B2N	168	T-810	642+56	253	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , ,			WARWICK, MA
171	Mainline A1N/B2N	169	T-810	645+61	305	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
172	Mainline A1N/B2N	170	T-810	649+69	408	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
173	Mainline A1N/B2N	171	T-810	653+74	405	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
174	Mainline A1N/B2N	172	T-811	656+40	466	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
175	Mainline A1N/B2N	173	T-811	660+06	166	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
176	Mainline A1N/B2N	174	T-811	663+64	358	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
177	Mainline A1N/B2N	175	T-811	666+07	243	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
178	Mainline A1N/B2N	176	T-811	668+64	257	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
179	Mainline A1N/B2N	177	T-811	673+43	479	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
180	Mainline A1N/B2N	178	T-811	676+18	275	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
181	Mainline A1N/B2N	179	T-811	679+12	294	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
182	Mainline A1N/B2N	180	T-811	684+58	546	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
183	Mainline A1N/B2N	181	T-811	686+58	400	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
184	Mainline A1N/B2N	182	T-811	689+48	90	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WARWICK, MA
185	Mainline A1N/B2N	183	T-811	692+13	265	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
186	Mainline A1N/B2N	184	T-811	696+29	416	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
187	Mainline A1N/B2N	185	T-811	700+60	431	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
188	Mainline A1N/B2N	186	T-811	703+29	269	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
189	Mainline A1N/B2N	187	T-811	706+68	339	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
190	Mainline A1N/B2N	188	T-811	710+78	410	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
191	Mainline A1N/B2N	189	T-811	714+92	414	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
192	Mainline A1N/B2N	190	T-811	718+63	371	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			WARWICK, MA
193	Mainline A1N/B2N	191	T-812	722+88	425	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WARWICK, MA
194	Mainline A1N/B2N	192	T-812	725+83	295	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
195	Mainline A1N/B2N	193	T-812	729+08	325	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
196	Mainline A1N/B2N	194	T-812	732+58	350	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , ,			ROYALSTON, MA
197	Mainline A1N/B2N	195	T-812	735+88	330	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
198	Mainline A1N/B2N	196	T-812	739+58	370	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			ROYALSTON, MA
199	Mainline A1N/B2N	197	T-812	743+21	363	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , ,			ROYALSTON, MA

ORDER	LINE	EXISTING STR NO.	T-SHEET	STATION (FT)	BACK SPAN (FT)	STR TYPE	MATERIAL	FDN TYPE	UALLY INSPECT	OVERALL	MBER BUCKLI	HARDWARE	PAINT	RD DETERRENT	HIGHWAY CROSSING	RAILROAD CROSSING	WATER CROSSING	CAI COMMENTS (VISUAL INSPECTION)	LINEWISE COMMENTS (AERIAL INSPECTION)	ROW BACKSPAN COMMENTS	NOTES	TOWN, STATE
200	Mainline A1N/B2N	198	T-812	746+91	370	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
201	Mainline A1N/B2N	199	T-812	751+03	412	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
202	Mainline A1N/B2N	200	T-812	754+73	370	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , ,			ROYALSTON, MA
203	Mainline A1N/B2N	201	T-812	757+45	272	BAY-SU TRANSPOSITION	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , ,			ROYALSTON, MA
204	Mainline A1N/B2N	202	T-812	760+23	278	DC DASI	WOOD	GRILLAGE		3		3										ROYALSTON, MA
205	Mainline A1N/B2N	203	T-812	764+38	415	DC DASI	WOOD	GRILLAGE		3		3										ROYALSTON, MA
206	Mainline A1N/B2N	204	T-812	769+28	490	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
207	Mainline A1N/B2N	205	T-812	773+28	400	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
208	Mainline A1N/B2N	206	T-812	777+03	375	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , ,			ROYALSTON, MA
209	Mainline A1N/B2N	207	T-812	780+28	325	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , ,			ROYALSTON, MA
210	Mainline A1N/B2N	208	T-812	783+76	348	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
211	Mainline A1N/B2N	209	T-812	787+26	350	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , ,			ROYALSTON, MA
212	Mainline A1N/B2N	210	T-813	790+92	366	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
213	Mainline A1N/B2N	211	T-813	794+46	354	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , ,			ROYALSTON, MA
214	Mainline A1N/B2N	212	T-813	799+16	470	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Insulator stack cover damaged, , , , , , , , ,			ROYALSTON, MA
215	Mainline A1N/B2N	213	T-813	803+69	453	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				NO FIELD NOTES??, , , , , , , , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , ,			ROYALSTON, MA
216	Mainline A1N/B2N	214	T-813	805+74	205	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
217	Mainline A1N/B2N	215	T-813	807+73	199	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
218	Mainline A1N/B2N	216	T-813	813+96	623	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				NO FIELD NOTES??, , , , , , , , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , ,			ROYALSTON, MA
219	Mainline A1N/B2N	217	T-813	817+18	322	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				FIELD NOTE FORM NOT FILLED OUT??, , , , , , , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , ,			ROYALSTON, MA
220	Mainline A1N/B2N	218	T-813	820+62	344	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3	YES			STEEL/LATTICE CONDITION: 3, SLEEVE/CONN. SW (BK), SPLICE IN SW, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION HORIZ. PLANE, , , , , , ,				ROYALSTON, MA
221	Mainline A1N/B2N	219-1	T-813	821+78	116	DC HDE	WOOD	GRILLAGE		3		3										ROYALSTON, MA
222	Mainline A1N/B2N	220-1	T-813	829+16	740	DC HDE	WOOD	GRILLAGE		3		3										ROYALSTON, MA
223	Mainline A1N/B2N	221	T-813	830+98	180	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
224	Mainline A1N/B2N	222	T-813	834+08	310	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , ,			ROYALSTON, MA
225	Mainline A1N/B2N	223	T-813	837+18	310	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
226	Mainline A1N/B2N	224	T-813	840+58	340	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
227	Mainline A1N/B2N	225	T-813	844+21	363	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
228	Mainline A1N/B2N	226	T-813	847+88	367	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
229	Mainline A1N/B2N	227	T-813	851+66	378	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
230	Mainline A1N/B2N	228	T-813	856+00	434	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
231	Mainline A1N/B2N	229	T-814	858+95	295	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
232	Mainline A1N/B2N	230	T-814	862+04	309	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
233	Mainline A1N/B2N	231	T-814	866+30	426	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
234	Mainline A1N/B2N	232	T-814	869+48 = 0+00	318	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
235	Mainline A1N/B2N	233-1	T-814	4+11	411	LA-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
236	Mainline A1N/B2N	234-1	T-814	8+64	453	LA-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
237	Mainline A1N/B2N	235-1	T-814	22+15	1351	LA-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
238	Mainline A1N/B2N	236-1	T-814	35+08	1293	LA-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Flashed insulator, , , , , , , , ,			ROYALSTON, MA
239	Mainline A1N/B2N	237-1	T-814	48+15	1307	LA-DE	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
240	Mainline A1N/B2N	238-1	T-814	52+98	483	LA-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
241	Mainline A1N/B2N	247	T-814	56+19 = 925+78	321	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , ,			ROYALSTON, MA
242	Mainline A1N/B2N	248	T-815	929+57	379	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
243	Mainline A1N/B2N	249	T-815	934+75	518	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
244	Mainline A1N/B2N	250	T-815	937+85	310	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, (LEVEL 3) Insulator stack cover out of place, , , , , , , ,			ROYALSTON, MA
245	Mainline A1N/B2N	251	T-815	940+94	309	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
246	Mainline A1N/B2N	252	T-815	944+80	386	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
247	Mainline A1N/B2N	253	T-815	949+55	475	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
248	Mainline A1N/B2N	254	T-815	955+15	560	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
249	Mainline A1N/B2N	254A	T-815	956+62	147	DC DADE	WOOD	GRILLAGE		3		3										ROYALSTON, MA
250	Mainline A1N/B2N	255-1	T-815	690+93	430	DC DADE	WOOD	GRILLAGE		3		3										ROYALSTON, MA
251	Mainline A1N/B2N	256	T-815	962+66	173	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
252	Mainline A1N/B2N	257	T-815	967+03	437	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
253	Mainline A1N/B2N	258	T-815	970+84	381	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
254	Mainline A1N/B2N	259	T-815	975+26	442	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
255	Mainline A1N/B2N	260	T-815	979+03	377	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
256	Mainline A1N/B2N	261	T-815	982+00	297	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
257	Mainline A1N/B2N	262	T-815	985+20	320	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
258	Mainline A1N/B2N	263	T-815	988+54	334	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
259	Mainline A1N/B2N	264	T-815	992+86	432	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , ,			ROYALSTON, MA
260	Mainline A1N/B2N	265	T-816	996+39	353	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
261	Mainline A1N/B2N	266	T-816	1001+08	469	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
262	Mainline A1N/B2N	267	T-816	1004+48	340	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
263	Mainline A1N/B2N	268	T-816	1008+46	398	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
264	Mainline A1N/B2N	269	T-816	1012+28	382	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
265	Mainline A1N/B2N	270	T-816	1015+63	355	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
266	Mainline A1N/B2N	271	T-816	1019+36	373	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
267	Mainline A1N/B2N	272	T-816	1024+06	470	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
268	Mainline A1N/B2N	273	T-816	1027+68	382	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
269	Mainline A1N/B2N	274	T-816	1030+74	286	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
270	Mainline A1N/B2N	275	T-816	1035+77	503	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
271	Mainline A1N/B2N	276	T-816	1038+78	301	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
272	Mainline A1N/B2N	277	T-816	1041+83	305	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
273	Mainline A1N/B2N	278	T-816	1046+18	435	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
274	Mainline A1N/B2N	279	T-816	1049+28	310	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
275	Mainline A1N/B2N	280	T-816	-	-	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
276	Mainline A1N/B2N	281	T-816	1055+80	382	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
277	Mainline A1N/B2N	282	T-816	1058+12	232	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
278	Mainline A1N/B2N	283	T-817	1061+75	363	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				INACCESSIBLE DUE TO SNOW, , , , , , , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , ,			ROYALSTON, MA
279	Mainline A1N/B2N	284	T-817	1066+01	426	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
280	Mainline A1N/B2N	285	T-817	1071+44	543	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , ,			ROYALSTON, MA
281	Mainline A1N/B2N	286	T-817	1074+54	310	BUS	STEEL	CONCRETE	YES	4		3						STEEL/LATTICE CONDITION: ?, DEADEND CLAMP MID SPAN (BK) & (AH) IN SW, SPLICES IN BK SPAN (A1), , , , , , , , ,				ROYALSTON, MA
283	Mainline A1/B2N	287	T-817	1077+84	330	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , ,			ROYALSTON, MA
284	Mainline A1/B2N	288	T-817	1081+15	331	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
285	Mainline A1/B2N	289	T-817	1084+44	329	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
286	Mainline A1/B2N	290	T-817	1087+76	332	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
287	Mainline A1/B2N	291	T-817	1092+85	509	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , ,			ROYALSTON, MA
288	Mainline A1/B2N	292	T-817	1095+84	299	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
289	Mainline A1/B2N	293	T-817	1099+04	320	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA

ORDER	LINE	EXISTING STR NO.	T-SHEET	STATION (FT)	BACK SPAN (FT)	STR TYPE	MATERIAL	FDN TYPE	UALLY INSPECT	OVERALL	EMBER BUCKLI	HARDWARE	PAINT	RD DETERRENT	HIGHWAY CROSSING	RAILROAD CROSSING	WATER CROSSING	CAI COMMENTS (VISUAL INSPECTION)	LINEWISE COMMENTS (AERIAL INSPECTION)	ROW BACKSPAN COMMENTS	NOTES	TOWN, STATE
290	Mainline A1/B2N	294	T-817	1102+82	378	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			ROYALSTON, MA
291	Mainline A1/B2N	295	T-817	1107+05	423	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
292	Mainline A1/B2N	296	T-817	1110+83	378	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
293	Mainline A1/B2N	297	T-817	1114+25	342	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
294	Mainline A1/B2N	298	T-817	118+13	388	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
295	Mainline A1/B2N	299	T-817	1121+46	333	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
296	Mainline A1/B2N	300	T-817	1125+06	360	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
297	Mainline A1/B2N	301	T-818	1128+44	338	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			ROYALSTON, MA
298	Mainline A1/B2N	302	T-818	1131+81	337	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			ROYALSTON, MA
299	Mainline A1/B2N	303	T-818	1136+46	465	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			ROYALSTON, MA
300	Mainline A1/B2N	304	T-818	1140+32	386	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) BIRD GUARD DAMAGE, (LEVEL 3 - BEAM DEFL/BUCK) HORIZ PLANE BRACING DEFLECTION, (LEVEL 3) PAINT CHIPPING, , , , , , , ,	Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
301	Mainline A1/B2N	305	T-818	1143+51	319	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				(AH), (LEVEL 3 - BEAM DEFL/BUCK) HORIZ PLANE DEFLECTION, (LEVEL 3) PAINT CHIPPING, (LEVEL 3) BIRD GUARD DAMAGE, (LEVEL 3) HARDWARE RUSTY, , , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
302	Mainline A1/B2N	306	T-818	1146+57	306	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				NO FIELD NOTES??, , , , , , , , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			ROYALSTON, MA
303	Mainline A1/B2N	307	T-818	1150+16	359	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			ROYALSTON, MA
304	Mainline A1/B2N	308	T-818	1154+47	431	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			ROYALSTON, MA
305	Mainline A1/B2N	309	T-818	1159+00	453	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			ROYALSTON, MA
306	Mainline A1/B2N	310	T-818	1163+72	472	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
307	Mainline A1/B2N	311	T-818	1168+93	521	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
308	Mainline A1/B2N	312	T-818	1172+32	339	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, ALL FOUNDATIONS GRILLAGE UNLESS OTHERWISE NOTED, DIDN'T INSPECT, , , , , , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			ROYALSTON, MA
309	Mainline A1/B2N	313	T-818	1175+38	306	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
310	Mainline A1/B2N	314	T-818	1178+61	323	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			ROYALSTON, MA
311	Mainline A1/B2N	315	T-818	1181+88	327	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			ROYALSTON, MA
312	Mainline A1/B2N	316	T-818	1185+07	319	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			ROYALSTON, MA
313	Mainline A1/B2N	317	T-818	1188+93	386	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			ROYALSTON, MA
314	Mainline A1/B2N	318	T-2225	1192+54	361	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								ROYALSTON, MA
315	Mainline A1/B2N	319	T-2225	2+92	292	DEPO	WOOD	GRILLAGE		3		3										ROYALSTON, MA
316	Mainline A1/B2N	320	T-2225	5+30	238	DC DASI	WOOD	GRILLAGE		3		3										ROYALSTON, MA
317	Mainline A1/B2N	321	T-2225	7+70	240	DC DASI	WOOD	GRILLAGE		3		3										ROYALSTON, MA
318	Mainline A1/B2N	322	T-2225	11+42	372	DC DASI	WOOD	GRILLAGE		3		3							Level 3, (LEVEL 3) Previous/old hardware ground attachment remaining on the line, , , , , , , , , ,			WINCHENDON, MA
319	Mainline A1/B2N	323	T-2225	14+39	297	DC DASI	WOOD	GRILLAGE		3		3							Level 3, (LEVEL 3) Leaning stack insulator, , , , , , , , , ,			WINCHENDON, MA
320	Mainline A1/B2N	324	T-2225	17+47	308	DC DASI	WOOD	GRILLAGE		3		3							Level 3, (LEVEL 3) Crossarm deteriorating, , , , , , , , , ,			WINCHENDON, MA
321	Mainline A1/B2N	325	T-2225	20+48	301	DC DASI	WOOD	GRILLAGE		3		3							Level 3, (LEVEL 3) Crossarm deteriorating, , , , , , , , , ,			WINCHENDON, MA
322	Mainline A1/B2N	326	T-2225	24+41	393	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
323	Mainline A1/B2N	327	T-2225	26+39	198	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
324	Mainline A1/B2N	328	T-2225	29+80	341	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
325	Mainline A1/B2N	329	T-2225	33+16	336	DC DASI	WOOD	GRILLAGE		3		3							Level 3, (LEVEL 3) Crossarm deteriorating, , , , , , , , , ,			WINCHENDON, MA
326	Mainline A1/B2N	330	T-2225	35+75	259	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
327	Mainline A1/B2N	331	T-2225	39+30	355	DEPO	WOOD	GRILLAGE		3		3										WINCHENDON, MA
328	Mainline A1/B2N	332	T-2225	42+65	335	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
329	Mainline A1/B2N	333	T-2225	45+75	310	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
330	Mainline A1/B2N	334	T-2225	47+63	188	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
331	Mainline A1/B2N	335	T-2225	53+63	600	DEPO	WOOD	GRILLAGE		3		3										WINCHENDON, MA
332	Mainline A1/B2N	336	T-2225	57+03	340	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
333	Mainline A1/B2N	337	T-2225	62+05	502	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
334	Mainline A1/B2N	338	T-2225	64+53	248	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
335	Mainline A1/B2N	339	T-2225	68+60	407	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
336	Mainline A1/B2N	340	T-2226	70+95	242	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
337	Mainline A1/B2N	341	T-2226	74+55	367	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
338	Mainline A1/B2N	342	T-2226	76+85	230	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
339	Mainline A1/B2N	343	T-2226	79+19	234	DEPO	WOOD	GRILLAGE		3		3							Level 3, (LEVEL 3) woodpecker damage, , , , , , , , , ,			WINCHENDON, MA
340	Mainline A1/B2N	344	T-2226	82+45	326	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
341	Mainline A1/B2N	345	T-2226	85+00	255	DC PSUSP	WOOD	GRILLAGE		3		3										WINCHENDON, MA
342	Mainline A1/B2N	346	T-2226	92+80	780	DC PSUSP	WOOD	GRILLAGE		3		3					YES		Level 3, (LEVEL 3) woodpecker damage, (LEVEL 3) Pole top deteriorating, , , , , , , , ,			WINCHENDON, MA
343	Mainline A1/B2N	346-A	T-2226	96+35	355	DC DASI	WOOD	GRILLAGE		3		3							Level 3, (LEVEL 3) Pole top deteriorating, , , , , , , , , ,			WINCHENDON, MA
344	Mainline A1/B2N	346-B	T-2226	100+45	410	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
345	Mainline A1/B2N	346-C	T-2226	104+80	435	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
346	Mainline A1/B2N	346-D	T-2226	108+95	415	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
347	Mainline A1/B2N	346-E	T-2226	112+81	386	DEPO	WOOD	GRILLAGE		3		3										WINCHENDON, MA
348	Mainline A1/B2N	346-F	T-2226	116+05	324	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
349	Mainline A1/B2N	346-G	T-2226	117+80	180	DC DASI	WOOD	GRILLAGE		3		3										WINCHENDON, MA
350	Mainline A1/B2N	346-H	T-2226	121+35	355	DC DASI	WOOD	GRILLAGE		3		3							Level 3, (LEVEL 3) Crossarm deteriorating, , , , , , , , , ,			WINCHENDON, MA
351	Mainline A1/B2N	346-I	T-2226	124+90	355	DC SPO	WOOD	GRILLAGE		3		3										WINCHENDON, MA
352	Mainline A1/B2N	347	T-2226	127+89.6=1301+	299	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
353	Mainline A1/B2N	348	T-2226	1305+88	405	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3	YES				Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
354	Mainline A1/B2N	349	T-2226	1309+57	369	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
355	Mainline A1/B2N	350	T-2226	1313+16	359	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
356	Mainline A1/B2N	351	T-2226	1316+82	366	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WINCHENDON, MA
357	Mainline A1/B2N	352	T-820	1320+82	400	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WINCHENDON, MA
358	Mainline A1/B2N	353	T-820	1324+24	342	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WINCHENDON, MA
359	Mainline A1/B2N	354	T-820	1327+59	335	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, 2 NEW SIDE GUYS, (LEVEL 3) NEEDS NEW PAINT, (LEVEL 3) HARDWARE RUSTY, , , , , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
360	Mainline A1/B2N	SUB	T-820			BUS	LATTICE	GRILLAGE		4		3						STEEL/LATTICE CONDITION: ?, TAP STRS LOOK NEWER, (LEVEL 3) STR. 3 HAD 1 WOODPECKER HOLE BENEATH GUY PLATE ATTACHMENT, (LEVEL 3) STR. 2 HAS A SLACK GUY, , , , , , , ,				WINCHENDON, MA
361	Mainline A1S/B2N	356	T-820	1331+52	99	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) PAINT CHIPPING, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, 2 SIDE GUYS (LOOK NEWER), (LEVEL 3) HARDWARE RUSTY, , , , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
362	Mainline A1S/B2N	357	T-820	1335+19	367	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
363	Mainline A1S/B2N	358	T-820	1339+43	424	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WINCHENDON, MA
364	Mainline A1S	354C	T-820	1330+53	130	HSUSP	WOOD	GRILLAGE		3		3										WINCHENDON, MA
365	Mainline B2N	354E	T-820	1329+55	138	HDE	WOOD	GRILLAGE		3		3										WINCHENDON, MA
366	Mainline B2N	354D	T-820	1325+55	116	HSUSP	WOOD	GRILLAGE		3		3										WINCHENDON, MA
367	Mainline A1S/B2N	359	T-821	1342+69	-	BAY-SU TRANSPOSITION	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
368	Mainline A1S/B2N	360	T-821	1346+04	335	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
369	Mainline A1S/B2N	361	T-821	1349+51	347	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				CHIPPING, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, (LEVEL 3) BIRD GUARD DAMAGE, SPLICES IN AH & BK SPANS, (LEVEL 3) MISSING PARTS OF AERIAL #'S, , , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			WINCHENDON, MA
370	Mainline A1S/B2N	362	T-821	1352+62	311	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WINCHENDON, MA

ORDER	LINE	EXISTING STR NO.	T-SHEET	STATION (FT)	BACK SPAN (FT)	STR TYPE	MATERIAL	FDN TYPE	UALLY INSPECT	OVERALL	EMBER BUCKLII	HARDWARE	PAINT	RD DETERRENT	HIGHWAY CROSSING	RAILROAD CROSSING	WATER CROSSING	CAI COMMENTS (VISUAL INSPECTION)	LINEWISE COMMENTS (AERIAL INSPECTION)	ROW BACKSPAN COMMENTS	NOTES	TOWN, STATE
371	Mainline A1S/B2N	363	T-821	1356+01	339	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
372	Mainline A1S/B2N	364	T-821	1359+97	396	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
373	Mainline A1S/B2N	365	T-821	1364+37	440	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3			YES	STEEL/LATTICE CONDITION: ?, (LEVEL 3) NEEDS PAINT, MEMBERS LOOK GOOD, , , , , , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
374	Mainline A1S/B2N	366	T-821	1367+97	360	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				RUSTY SIDE GUYS, (LEVEL 3) PAINT CHIPPING, (LEVEL 3) BIRD GUARD DAMAGE, (LEVEL 3) HARDWARE RUSTY, (LEVEL 3 - BEAM DEFL/BUCK) SLIGHT DEFLECTION ON HORIZ PLANE DIAG., , , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
375	Mainline A1S/B2N	367	T-821	1371+17	320	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, 2 SIDE GUYS, SPLICES IN BK SPAN (A1) / AH SPAN (A1), (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, (LEVEL 3 - GUY) SECONDARY POLE W/ SLACK DOWN GUY TOWARDS TOWER BASE (WIRES ON THE GROUND), NECO POLE 65-1, 30'/6 OR 35'-6, 12-11, , , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
376	Mainline A1S/B2N	368	T-821	1375+25	408	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WINCHENDON, MA
377	Mainline A1S/B2N	369	T-821	1378+50	325	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WINCHENDON, MA
378	Mainline A1S/B2N	370	T-821	1382+32	382	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
379	Mainline A1S/B2N	371	T-821	1386+00	368	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
380	Mainline A1S/B2N	372	T-821	1390+46	446	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
381	Mainline A1S/B2N	373	T-821	1393+10	264	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
382	Mainline A1S/B2N	374	T-821	1397+53	443	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
383	Mainline A1S/B2N	375	T-821	1401+00	347	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			WINCHENDON, MA
384	Mainline A1S/B2N	376	T-822	1405+80	480	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
385	Mainline A1S/B2N	377	T-822	1408+80	300	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
386	Mainline A1S/B2N	378	T-822	1412+31	351	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, SLEEVE/CONN. SPLICES, (LEVEL 3) BIRD GUARD DAMAGE, (LEVEL 3) DEFLECTION, (LEVEL 3) NEEDS PAINT, SPLICES IN BOTH CKTS AH SPAN, , , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
387	Mainline A1S/B2N	379	T-822	1415+38	307	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
388	Mainline A1S/B2N	380	T-822	1418+58	320	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
389	Mainline A1S/B2N	381	T-822	1421+82	324	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
390	Mainline A1S/B2N	382	T-822	1425+02	320	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
391	Mainline A1S/B2N	383	T-822	1428+22	320	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WINCHENDON, MA
392	Mainline A1S/B2N	384	T-822	1431+75	353	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
393	Mainline A1S/B2N	385	T-822	1435+75	400	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
394	Mainline A1S/B2N	386	T-822	1438+60	285	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
395	Mainline A1S/B2N	387	T-822	1441+95	335	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
396	Mainline A1S/B2N	388	T-822	1445+75	380	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WINCHENDON, MA
397	Mainline A1S/B2N	389	T-822	1449+40	365	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WINCHENDON, MA
398	Mainline A1S/B2N	390	T-822	1452+83	343	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
399	Mainline A1S/B2N	391	T-822	1456+60	377	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
400	Mainline A1S/B2N	392	T-822	1460+69	409	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) MISSING SOME AERIAL #'S, (LEVEL 3) PAINT CHIPPING, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, SPLICES IN AH SPAN, , , , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
401	Mainline A1S/B2N	393	T-822	1464+68	399	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WINCHENDON, MA
402	Mainline A1S/B2N	394	T-822	1468+65	397	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			WINCHENDON, MA
403	Mainline A1S/B2N	395	T-822	1472+38	373	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			WINCHENDON, MA
404	Mainline A1S/B2N	396	T-823	1475+82	344	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			GARDNER, MA
405	Mainline A1S/B2N	397	T-823	1480+53	471	DC DASI	WOOD	GRILLAGE		3		3							Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			GARDNER, MA
406	Mainline A1S/B2N	398	T-823	1484+95	442	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			GARDNER, MA
407	Mainline A1S/B2N	399	T-823	1489+22	427	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			GARDNER, MA
408	Mainline A1S/B2N	400	T-823	1494+64	542	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			GARDNER, MA
409	Mainline A1S/B2N	401	T-823	1498+94	430	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			GARDNER, MA
410	Mainline A1S/B2N	402	T-823	1503+02	408	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			GARDNER, MA
411	Mainline A1S/B2N	403	T-823	1507+18	416	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			GARDNER, MA
412	Mainline A1S/B2N	404	T-823	1510+52	334	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			GARDNER, MA
413	Mainline A1S/B2N	405	T-823	1514+22	370	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, 2 SIDE GUYS, (LEVEL 3) BIRD GUARD DAMAGE, (LEVEL 3) RUSTY HARDWARE, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, , , , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			GARDNER, MA
414	Mainline A1S/B2N	406	T-823	1517+04	282	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) RUSTY SIDE GUY, (LEVEL 3) BIRD GUARDS MISSING ON 1/2 STR., (LEVEL 3) PAINT CHIPPING, SPLICE IN SW (AH), (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, (LEVEL 3) MISSING SOME NUMBERING, , , , ,	Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			GARDNER, MA
415	Mainline A1S/B2N	407	T-823	1520+86	382	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , , ,			GARDNER, MA
416	Mainline A1S/B2N	408	T-823	1524+43	357	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			GARDNER, MA
417	Mainline A1S/B2N	409	T-823	1528+36	393	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			GARDNER, MA
418	Mainline A1S/B2N	410	T-823	1532+35	399	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			GARDNER, MA
419	Mainline A1S/B2N	411	T-823	1535+44	309	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
420	Mainline A1S/B2N	412	T-823	1539+06	362	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
421	Mainline A1S/B2N	413	T-823	1543+00	394	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			GARDNER, MA
422	Mainline A1S/B2N	414	T-824	1545+69	269	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			GARDNER, MA
423	Mainline A1S/B2N	415	T-824	1548+65	296	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			GARDNER, MA
424	Mainline A1S/B2N	416	T-824	1552+16	351	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
425	Mainline A1S/B2N	417	T-824	1555+92	376	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
426	Mainline A1S/B2N	418	T-824	1559+60	368	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			GARDNER, MA
427	Mainline A1S/B2N	419	T-824	1563+30	370	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, , , , , , , , , ,			GARDNER, MA

ORDER	LINE	EXISTING STR NO.	T-SHEET	STATION (FT)	BACK SPAN (FT)	STR TYPE	MATERIAL	FDN TYPE	UALLY INSPECT	OVERALL	EMBER BUCKLI	HARDWARE	PAINT	RD DETERRENT	HIGHWAY CROSSING	RAILROAD CROSSING	WATER CROSSING	CAI COMMENTS (VISUAL INSPECTION)	LINEWISE COMMENTS (AERIAL INSPECTION)	ROW BACKSPAN COMMENTS	NOTES	TOWN, STATE
428	Mainline A1S/B2N	420	T-824	1568+03	473	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3					Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) bird diverters failing/damaged/missing, , , , , , , , ,			GARDNER, MA
429	Mainline A1S/B2N	421	T-824	1569+63	160	BUS	STEEL	CONCRETE		4		3										GARDNER, MA
431	Mainline A1S/B2S	422	T-824	1572+63	300	DC DASI	WOOD	GRILLAGE		3		3										GARDNER, MA
432	Mainline A1S/B2S	423	T-824	1574+72	243	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
433	Mainline A1S/B2S	424	T-824	1578+52	378	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
434	Mainline A1S/B2S	425	T-824	1582+88	465	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
435	Mainline A1S/B2S	426	T-824	1586+62	374	DC DADE	STEEL	CONCRETE	YES	3		3						INACCESSIBLE DUE TO SNOW, , , , , , , , , , ,				GARDNER, MA
436	Mainline A1S/B2S	428	T-824	1596+24	962	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3								GARDNER, MA
437	Mainline A1S/B2S	429	T-824	1596+24	0	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3								GARDNER, MA
438	Mainline A1S/B2S	430	T-824	1599+83	359	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, STR. #429 SHOWN ON SW MEMBER, SHOULD BE #430 PER T-SHEET, (LEVEL 3) AERIAL NUMBERS DON'T MATCH, (LEVEL 3) BIRD GUARD DAMAGE, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, (LEVEL 3) NEEDS PAINT, , , , , ,				GARDNER, MA
439	Mainline A1S/B2S	431	T-824	1603+16	333	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				SHOWN ON SW MEMBER, SHOULD BE #431 PER T-SHEET, (LEVEL 3) AERIAL NUMBERS DON'T MATCH, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION ON HORIZ PLANE DIAG., (LEVEL 3) BIRD GUARD DAMAGE (B2), SPLICE (AH) A1, (LEVEL 3) RUSTY SIDE GUY, (LEVEL 3) PAINT CHIPPING, , , ,				GARDNER, MA
440	Mainline A1S/B2S	432	T-824	1606+84	368	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
441	Mainline A1S/B2S	433	T-824	1610+42	358	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
442	Mainline A1S/B2S	434	T-824	1614+15	373	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
443	Mainline A1S/B2S	435	T-825	1617+99	384	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
444	Mainline A1S/B2S	436	T-825	1621+48	349	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
445	Mainline A1S/B2S	437	T-825	1625+19	371	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
446	Mainline A1S/B2S	438	T-825	1628+39	320	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
447	Mainline A1S/B2S	439	T-825	1630+64	225	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
448	Mainline A1S/B2S	440	T-825	1633+91	327	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
449	Mainline A1S/B2S	441	T-825	1637+28	337	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
450	Mainline A1S/B2S	442	T-825	1640+50	322	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
451	Mainline A1S/B2S	443	T-825	1643+48	298	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) MISSING AERIAL # ON SW MEMBER, (LEVEL 3) BIRD GURAD DAMAGE, (LEVEL 3) RUSTY SIDE GUY, (LEVEL 3) NEEDS PAINT, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, , , , , ,				GARDNER, MA
452	Mainline A1S/B2S	444	T-825	1646+60	312	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
453	Mainline A1S/B2S	445	T-825	1650+83	423	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
454	Mainline A1S/B2S	446	T-825	1653+83	300	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
455	Mainline A1S/B2S	447	T-825	1657+63	380	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
456	Mainline A1S/B2S	448	T-825	1662+05	442	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
457	Mainline A1S/B2S	449	T-825	1666+72	467	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) MISSING SOME AERIAL #'S, (LEVEL 3) BIRD GUARD DAMAGE, (LEVEL 3) PAINT CHIPPING, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION IN HORIZ PLANE DIAG., , , , , , ,				GARDNER, MA
458	Mainline A1S/B2S	450	T-825	1670+18	346	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
459	Mainline A1S/B2S	451	T-825	1673+26	308	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) 2 RUSTY SIDE GUYS, (LEVEL 3) BIRD GUARD DAMAGE, (LEVEL 3) HARDWARE RUSTY, SPLICES IN AH SPAN, , , , , , ,				GARDNER, MA
460	Mainline A1S/B2S	452	T-825	1676+13	287	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
461	Mainline A1S/B2S	453	T-825	1679+04	291	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) BIRD GUARD DAMAGE, SPLICES IN AH & BK, , , , , , , , ,				GARDNER, MA
462	Mainline A1S/B2S	454	T-825	1682+82	378	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
463	Mainline A1S/B2S	455	T-825	1686+50	368	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
464	Mainline A1S/B2S	456	T-826	1690+13	363	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
465	Mainline A1S/B2S	457	T-826	1693+60	347	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, SPLICES IN AH, (LEVEL 3 - BEAM DEFL/BUCK) BROKEN GUY, (LEVEL 3) BIRD GUARD DAMAGE, , , , , , , ,				GARDNER, MA
466	Mainline A1S/B2S	458	T-826	1697+45	385	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
467	Mainline A1S/B2S	459	T-826	1701+07	362	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
468	Mainline A1S/B2S	460	T-826	1704+66	359	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
469	Mainline A1S/B2S	461	T-826	1708+30	364	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
470	Mainline A1S/B2S	462	T-826	1711+96	366	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) BIRD GUARDS MISSING/DAMAGED, (LEVEL 3) PAINT CHIPPING, SPLICES IN BK SPAN, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, , , , , , ,				GARDNER, MA
471	Mainline A1S/B2S	463	T-826	1715+99	403	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
472	Mainline A1S/B2S	464	T-826	1719+56	357	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
473	Mainline A1S/B2S	465	T-826	1723+09	353	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
474	Mainline A1S/B2S	466	T-826	1726+62	353	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
475	Mainline A1S/B2S	467	T-826	1730+06	344	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								GARDNER, MA
476	Mainline A1S/B2S	468	T-826	1733+31	325	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
477	Mainline A1S/B2S	469	T-826	1737+39	408	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
478	Mainline A1S/B2S	470	T-826	1739+91	252	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3		YES (FRAARCID 375067; OWNER: PAS)						WESTMINSTER, MA
479	Mainline A1S/B2S	471-1	T-826	1744+84	493	DC DAVIT ARM DE	STEEL	CONCRETE		3		3										WESTMINSTER, MA
480	Mainline A1S/B2S	472-1	T-826	1747+96	312	DC DADE	STEEL	CONCRETE	YES	3		3			YES			STEEL/LATTICE CONDITION: ?, (LEVEL 3) MIDDLE POLE BAND RUSTY LOOKING, ON FDN CAISSON / SELF SUPPORTING, , , , , , , , ,				WESTMINSTER, MA
481	Mainline A1S/B2S	473	T-826	1749+88=1750+	192	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
482	Mainline A1S/B2S	474	T-826	1754+63	370	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
483	Mainline A1S/B2S	475	T-827	1758+16	353	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
484	Mainline A1S/B2S	476	T-827	1762+56	440	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
485	Mainline A1S/B2S	477	T-827	1766+81	425	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
486	Mainline A1S/B2S	478	T-827	1770+34	353	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
487	Mainline A1S/B2S	479	T-827	1773+86	352	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
488	Mainline A1S/B2S	480	T-827	1777+89	403	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
489	Mainline A1S/B2S	481	T-827	1782+50	461	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
490	Mainline A1S/B2S	482	T-827	1787+16	466	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
491	Mainline A1S/B2S	483	T-827	1793+51	635	DC DADE	WOOD	GRILLAGE		3		3										WESTMINSTER, MA
492	Mainline A1S/B2S	484-1	T-827	1799+55	604	DC DADE	WOOD	GRILLAGE		3		3										WESTMINSTER, MA
493	Mainline A1S/B2S	485	T-827	1801+40	185	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
494	Mainline A1S/B2S	486	T-827	1804+10	270	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
495	Mainline A1S/B2S	487	T-827	1806+79	269	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
496	Mainline A1S/B2S	488	T-827	1809+87	308	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
497	Mainline A1S/B2S	489	T-827	1813+30	343	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
498	Mainline A1S/B2S	490	T-827	1817+19	389	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
499	Mainline A1S/B2S	491	T-827	1820+75	356	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) BIRD GUARD MISSING/DAMAGED, DID NOT WALK TO STR., (LEVEL 3) NEEDS PAINT, , , , , , , ,				WESTMINSTER, MA
500	Mainline A1S/B2S	492	T-828	1824+35	360	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) BIRD GUARD DAMAGE, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, (LEVEL 3) PAINT CHIPPING, SPLICES AH (SW), , , , , , ,				WESTMINSTER, MA
501	Mainline A1S/B2S	493	T-828	1827+02	267	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
502	Mainline A1S/B2S	494	T-828	1830+24	322	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
503	Mainline A1S/B2S	495	T-828	1834+30	406	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
504	Mainline A1S/B2S	496	T-828	1839+34	504	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
505	Mainline A1S/B2S	497/496	T-828			BUS	WOOD	DIRECT-BURIED		3		3									WESTMINSTER TAP. BETWEEN STR #497 & #496	WESTMINSTER, MA
506	Mainline A1S/B2S	497	T-828	1843+84		BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
507	Mainline A1S/B2S	498	T-828	1848+65	481	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
508	Mainline A1S/B2S	499	T-828	1852+80	415	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
509	Mainline A1S/B2S	500	T-828	1856+11	331	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
510	Mainline A1S/B2S	501	T-828	1859+65	354	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
511	Mainline A1S/B2S	502	T-828	1864+93	528	DC DASI	WOOD	GRILLAGE	YES	3		3						STEEL/LATTICE CONDITION: ?, DBL POST INSULATORS, , , , , , , , , ,				WESTMINSTER, MA

ORDER	LINE	EXISTING STR NO.	T-SHEET	STATION (FT)	BACK SPAN (FT)	STR TYPE	MATERIAL	FDN TYPE	UALLY INSPECT	OVERALL	EMBER BUCKLI	HARDWARE	PAINT	RD DETERRENT	HIGHWAY CROSSING	RAILROAD CROSSING	WATER CROSSING	CAI COMMENTS (VISUAL INSPECTION)	LINEWISE COMMENTS (AERIAL INSPECTION)	ROW BACKSPAN COMMENTS	NOTES	TOWN, STATE
512	Mainline A1S/B2S	503	T-828	1868+76	383	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) BIRD GUARD DAMAGE/MISSING, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, (LEVEL 3) PAINT CHIPPING, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, , , , , , ,				WESTMINSTER, MA
513	Mainline A1S/B2S	504	T-828	1873+38	462	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
514	Mainline A1S/B2S	505	T-828	1876+87	349	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, SLEEVE/CONN. SPLICE, (LEVEL 3) BIRD GUARD DAMAGE, (LEVEL 3) NEEDS PAINT, SPLICE ON A1 (BK SPAN), , , , , , ,				WESTMINSTER, MA
515	Mainline A1S/B2S	506	T-828	1881+14	427	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
516	Mainline A1S/B2S	507	T-828	1885+48	434	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
517	Mainline A1S/B2S	508	T-828	1888+78	330	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
518	Mainline A1S/B2S	509	T-829	1892+86	408	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
519	Mainline A1S/B2S	510	T-829	1896+73	387	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
520	Mainline A1S/B2S	511	T-829	1900+54	381	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, , , , , , , , , ,				WESTMINSTER, MA
521	Mainline A1S/B2S	512	T-829	1904+93	439	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				CHIPPING, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, SPLICE IN SW, (LEVEL 3 - BEAM DEFL/BUCK) DIAG BOWED/BUCKLED ON FACE, , , , , , ,				WESTMINSTER, MA
522	Mainline A1S/B2S	513	T-829	1907+15	222	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				NO FIELD NOTES??, , , , , , , , , , ,				WESTMINSTER, MA
523	Mainline A1S/B2S	514	T-829	1910+22	307	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
524	Mainline A1S/B2S	515	T-829	1914+12	390	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
525	Mainline A1S/B2S	516	T-829	1917+78	366	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				GUARD DAMAGE, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, (LEVEL 3) PAINT CHIPPING, , , , , , ,				WESTMINSTER, MA
526	Mainline A1S/B2S	517	T-829	1919+57	179	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
527	Mainline A1S/B2S	518	T-829	1925+57	600	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
528	Mainline A1S/B2S	519	T-829	1930+32	475	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
529	Mainline A1S/B2S	520	T-829	1933+77	345	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
530	Mainline A1S/B2S	521	T-829	1937+16	339	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
531	Mainline A1S/B2S	522	T-829	1940+16	300	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
532	Mainline A1S/B2S	523	T-829	1942+54	238	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, (LEVEL 3) BROKEN SIDE GUY (RUSTY), (LEVEL 3) BIRD GUARD DAMAGE, , , , , , , ,				WESTMINSTER, MA
533	Mainline A1S/B2S	524	T-829	1947+69	515	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
534	Mainline A1S/B2S	525	T-829	1951+69	400	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
535	Mainline A1S/B2S	526	T-829	1955+57	388	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) BIRD GUARD DAMAGE, , , , , , , , , ,				WESTMINSTER, MA
536	Mainline A1S/B2S	527	T-2731	1960+04	447	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) PAINT CHIPPING/RUSTY, (LEVEL 3 - BEAM DEFL/BUCK) BUCKLE ON FACE DIAG/SPLICED DIAG, (LEVEL 3) RUSTY GUYS (2 SIDE), (LEVEL 3) HARDWARE RUSTY, SPLICES IN BK SPAN (B2), , , , , ,				WESTMINSTER, MA
537	Mainline A1S/B2S	528	T-2731	1962+74	270	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) BIRD GUARDS DAMAGED/MISSING, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, , , , , , , , ,				WESTMINSTER, MA
538	Mainline A1S/B2S	529	T-2731	1965+42	268	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
539	Mainline A1S/B2S	530	T-2731	1968+48	306	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
540	Mainline A1S/B2S	531	T-2731	1973+45	497	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) BIRD GUARDS MISSING (B2 SIDE)/DAMAGED (A1 SIDE), (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, (LEVEL 3) PAINT CHIPPING, , , , , , ,				WESTMINSTER, MA
541	Mainline A1S/B2S	532	T-2731	1977+51	406	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
542	Mainline A1S/B2S	533-1	T-2731	1982+59	508	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				NO FIELD NOTES??, , , , , , , , , , ,				WESTMINSTER, MA
543	Mainline A1S/B2S	534	T-2731	1985+20	314	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, SLEEVE/CONN. SPLICES, EXTENSION ON BASE (IN POOR CONDITION, TWISTED?), (LEVEL 3) PAINT CHIPPING, SPLICES (BK) B2, (LEVEL 3) BIRD GUARD DAMAGE, , , , , ,				WESTMINSTER, MA
544	Mainline A1S/B2S	534-1	T-2731	1986+46	73	DC HSUSPR	WOOD	GRILLAGE		3		3						STEEL/LATTICE CONDITION: ?, 5 POLE (2 H-FRAME, 1 SW POLE), NEW STRUCTURES, , , , , , , , ,				WESTMINSTER, MA
546	Mainline A1S	535A	T-2731	1988+38	192	SWITCH (H-DE)	STEEL	CONCRETE	YES	3		3						STEEL/LATTICE CONDITION: ?, SW POLE (535), NEW A&B POLE, SW ON WOOD POLE (NEW POLE), NEW STEEL POLE STRUCTURES, , , , , , ,				WESTMINSTER, MA
547	Mainline B2S	535B	T-2731	1988+38	192	SWITCH (H-DE)	STEEL	CONCRETE	YES	3		3						STEEL/LATTICE CONDITION: ?, SW POLE (535), NEW A&B POLE, SW ON WOOD POLE (NEW POLE), NEW STEEL POLE STRUCTURES, , , , , , ,				WESTMINSTER, MA
550	Mainline A1S/B2S	536	T-2731	1991+15	277	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
551	Mainline A1S/B2S	537-1	T-2731	1994+22	307	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								WESTMINSTER, MA
552	Mainline A1S/B2S	538-1	T-2731	1999+88	555	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3	YES							FITCHBURG, MA
553	Mainline A1S/B2S	540	T-2731	2004+55=2004+	467	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								FITCHBURG, MA
554	Mainline A1S/B2S	541	T-2731	2008+31	374	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								FITCHBURG, MA
555	Mainline A1S/B2S	542	T-2731	2012+16	385	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								FITCHBURG, MA
556	Mainline A1S/B2S	543	T-2731	2016+82	366	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								FITCHBURG, MA
557	Mainline A1S/B2S	544	T-2731	2019+60	378	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								FITCHBURG, MA
558	Mainline A1S/B2S	545	T-2731	2022+96	336	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								FITCHBURG, MA
559	Mainline A1S/B2S	546	T-2732			BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								FITCHBURG, MA
560	Mainline A1S/B2S	547	T-2732	2029+64	280	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3								FITCHBURG, MA
561	Mainline A1S/B2S	548-2	T-2732	2034+64	500	DC DADE	STEEL	CONCRETE	YES	3		3										FITCHBURG, MA
562	Mainline A1S/B2S	549-2	T-2732	2043+14	850	DC DAVIT ARM DE	STEEL	CONCRETE		3		3										FITCHBURG, MA
563	Mainline A1S/B2S	550-2	T-2732	2049+64	650	DC DAVIT ARM DE	STEEL	CONCRETE		3		3										FITCHBURG, MA
564	Mainline A1S/B2S	551-B	T-2732	2052+34	300	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								FITCHBURG, MA
565	Mainline A1S/B2S	551-C	T-2732	2057+96	562	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								FITCHBURG, MA
566	Mainline A1S/B2S	551-D	T-2732	2061+04	308	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3								FITCHBURG, MA
567	Mainline A1S/B2S	552	T-2732	2064+74=2064+	370	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3								FITCHBURG, MA
568	Mainline A1S/B2S	553	T-2732	2067+98	326	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
569	Mainline A1S/B2S	554	T-2732	2071+73	375	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
570	Mainline A1S/B2S	555	T-1218	2075+32	359	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
571	Mainline A1S/B2S	555A	T-1218			BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
572	Mainline A1S/B2S	556	T-1218	2079+66	434	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
573	Mainline A1S/B2S	557	T-1218	2083+54	378	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
574	Mainline A1S/B2S	558	T-1218	2087+47	393	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
575	Mainline A1S	559A	T-1218	2090+17	270	HDE	WOOD	GRILLAGE		3		3										LEOMINSTER, MA
576	Mainline B2S	559B	T-1218	2090+17	270	HDE	WOOD	GRILLAGE		3		3										LEOMINSTER, MA
577	Mainline A1S/B2S	560	T-1218	2093+17	300	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
578	Mainline A1S/B2S	561	T-1218	2096+63	345	LA-DE	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
579	Mainline A1S/B2S	563	T-1218	2104+72	810	LA-DE	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
580	Mainline A1S/B2S	564	T-1218	2108+02	330	DC HDE	WOOD	GRILLAGE		3		3										LEOMINSTER, MA
581	Mainline A1S/B2S	566	T-1218	2116+22	820	DC HDE	WOOD	GRILLAGE		3		3										LEOMINSTER, MA
582	Mainline A1S/B2S	567	T-1218	2119+67	345	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
583	Mainline A1S/B2S	568	T-1218	2122+22	310	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
584	Mainline A1S/B2S	569	T-1219	2125+85	308	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
585	Mainline A1S/B2S	570	T-1219	2130+04	419	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
586	Mainline A1S/B2S	571	T-1219	2133+17	313	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
587	Mainline A1S/B2S	572	T-1219	2137+03	386	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
588	Mainline A1S/B2S	573	T-1219	2140+73	370	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
589	Mainline A1S/B2S	574	T-1219	2144+43	370	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				GUARD DAMAGE, (LEVEL 3) 2 SIDE GUYS (RUSTY), (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, , , , , , , ,				LEOMINSTER, MA
590	Mainline A1S/B2S	575	T-1219	2147+89	346	DC DADE	WOOD	GRILLAGE	YES	3		3						STEEL/LATTICE CONDITION: ?, SLEEVE/CONN. SPLICES, LOOKS NEW (3 AH GUYS, 3 BK, 1 SIDE) (DBL STRAND), SPLICES, , , , , , , ,				LEOMINSTER, MA
591	Mainline A1S/B2S	576	T-1219	2151+30	351	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) MISSING AERIAL #'S, (LEVEL 3) 2 RUSTY SIDE GUYS, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION, , , , , , , ,				LEOMINSTER, MA
592	Mainline A1S/B2S	577	T-1219	2155+80	388	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
593	Mainline A1S/B2S	578	T-1219	2158+98	380	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
594	Mainline A1S/B2S	579	T-1219	2162+83	385	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
595	Mainline A1S/B2S	580	T-1219	2166+12	329	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
596	Mainline A1S/B2S	581	T-1219	2169+68	356	DC DASI	WOOD	GRILLAGE		3		3										LEOMINSTER, MA
597	Mainline A1S/B2S	582	T-1220	2172+89	331	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
598	Mainline A1S/B2S	583	T-1220	2179+64	375	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA

ORDER	LINE	EXISTING STR NO.	T-SHEET	STATION (FT)	BACK SPAN (FT)	STR TYPE	MATERIAL	FDN TYPE	UALLY INSPECT	OVERALL	EMBER BUCKLI	HARDWARE	PAINT	RD DETERRENT	HIGHWAY CROSSING	RAILROAD CROSSING	WATER CROSSING	CAI COMMENTS (VISUAL INSPECTION)	LINEWISE COMMENTS (AERIAL INSPECTION)	ROW BACKSPAN COMMENTS	NOTES	TOWN, STATE
599	Mainline A1S/B2S	584	T-1220	2179+88	324	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
600	Mainline A1S/B2S	585	T-1220	2184+55	467	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
601	Mainline A1S/B2S	586	T-1220	2188+09	354	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
602	Mainline A1S/B2S	587	T-1220	2192+18	409	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
603	Mainline A1S/B2S	588	T-1220	2195+88	370	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
604	Mainline A1S/B2S	589	T-1220	2199+48	360	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
605	Mainline A1S/B2S	590	T-1220	2202+88	340	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
606	Mainline A1S/B2S	591	T-1220	2205+98	310	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
607	Mainline A1S/B2S	592	T-1220	2208+89	288	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
608	Mainline A1S/B2S	593	T-1220	2212+38	352	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
609	Mainline A1S/B2S	594	T-1220	2215+63	325	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
610	Mainline A1S/B2S	595	T-1220	2218+83	320	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
611	Mainline A1S/B2S	596	T-1220	2223+01	418	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
612	Mainline A1S/B2S	597	T-1220	2226+46	345	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
613	Mainline A1S/B2S	598	T-1220	2230+42	396	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
614	Mainline A1S/B2S	599	T-1220	2234+14	372	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
615	Mainline A1S/B2S	600	T-1220	2237+38	324	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) PAINT DRIPPING, (LEVEL 3) BIRD GUARD DAMAGE, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION HORIZ PLANE DIAG, , , , , , , ,				LEOMINSTER, MA
616	Mainline A1S/B2S	601	T-1221	2241+56	418	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
617	Mainline A1S/B2S	602	T-1221	2245+71	415	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
618	Mainline A1S/B2S	603	T-1221	2249+37	366	DC DASI	WOOD	GRILLAGE		3		3										LEOMINSTER, MA
619	Mainline A1S/B2S	604	T-1221	2251+68	231	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
620	Mainline A1S/B2S	605	T-1221	2254+90	322	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
621	Mainline A1S/B2S	606	T-1221	2258+82	392	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
622	Mainline A1S/B2S	607	T-1221	2262+45	363	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
623	Mainline A1S/B2S	608	T-1221	2266+03	358	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
624	Mainline A1S/B2S	609	T-1221	2269+39	336	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
625	Mainline A1S/B2S	610	T-1221	2272+22	283	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
626	Mainline A1S/B2S	611	T-1221	2275+52	330	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
627	Mainline A1S/B2S	612	T-1221	2279+55	403	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
628	Mainline A1S/B2S	613	T-1221	2282+83	328	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
629	Mainline A1S/B2S	614	T-1221	2285+62	279	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
630	Mainline A1S/B2S	615	T-1221	2287+90	228	BAY-SU TRANSPOSITION	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
631	Mainline A1S/B2S	616	T-1221	2289+91	201	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
632	Mainline A1S/B2S	617	T-1222	2293+40	349	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
633	Mainline A1S/B2S	618	T-1222	2297+60	420	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
634	Mainline A1S/B2S	619	T-1222	2300+83	323	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
635	Mainline A1S/B2S	620	T-1222	2303+89	306	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
636	Mainline A1S/B2S	621	T-1222	2307+88	399	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
637	Mainline A1S/B2S	622	T-1222	2311+58	370	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
638	Mainline A1S/B2S	623	T-1222	2315+44	386	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
639	Mainline A1S/B2S	624	T-1222	2318+20	276	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				SPLICES (BK), ANCHOR IN WATER? (DBL GUY STRAND), SPLICES IN BK SPAN (BOTH CKTS), (LEVEL 3) PAINT CHIPPING, (LEVEL 3) HARDWARE RUSTY, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION HORIZ PLANE DIAG, STRUCTURE NEAR CITY OF LEOMISTER RESERVOIR WATERSHED, , , ,				LEOMINSTER, MA
640	Mainline A1S/B2S	625	T-1222	2322+99	479	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) BIRD GUARD DAMAGE, (LEVEL 3 - BEAM DEFL/BUCK) HORIZ PLANE DIAG DEFLECTION, , , , , , , , ,				LEOMINSTER, MA
641	Mainline A1S/B2S	626	T-1222	2327+02	403	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) 2 RUSTY SIDE GUYS, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION HORIZ PLANE DIAG, , , , , , , , ,				LEOMINSTER, MA
642	Mainline A1S/B2S	627	T-1222	2329+72	270	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
643	Mainline A1S/B2S	628	T-1222	2333+51	379	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
644	Mainline A1S/B2S	629	T-1222	2337+71	420	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				DEFL/BUCK) DEFLECTION HORIZ PLANE DIAG, 3 SIDE GUYS, SPLICE ON B2 COND. (BK), VEGETATION ON 1 TOWER LEG & 1 GUY, (LEVEL 3) BIRD GUARD DAMAGE, (LEVEL 3) HARDWARE RUSTY, , , , ,				LEOMINSTER, MA
645	Mainline A1S/B2S	630	T-1222	2342+14	443	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
646	Mainline A1S/B2S	631	T-1222	2345+88	374	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
647	Mainline A1S/B2S	632	T-1222	2348+93	305	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
648	Mainline A1S/B2S	633	T-1222	2352+87	394	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
649	Mainline A1S/B2S	634	T-1222	2356+18	331	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
650	Mainline A1S/B2S	635	T-1222	2360+43	425	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
651	Mainline A1S/B2S	636	T-1222	2363+33	290	BAY-DE	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
652	Mainline A1S/B2S	637	T-1223	2366+31	298	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
653	Mainline A1S/B2S	638	T-1223	2372+41	610	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
654	Mainline A1S/B2S	639	T-1223	2377+21	480	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
655	Mainline A1S/B2S	640	T-1223	2381+54	433	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: ?, (LEVEL 3) BIRD GUARDS MISSING ON ONE SIDE OF TOWER, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION HORIZ PLANE DIAGONALS, , , , , , , , ,				LEOMINSTER, MA
656	Mainline A1S/B2S	641	T-1223	2385+26	372	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
657	Mainline A1S/B2S	642	T-1223	2390+65	539	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
658	Mainline A1S/B2S	643	T-1223	2394+60	395	BAY-DE	LATTICE	GRILLAGE	YES	3	3	3	3	3				SPLICES BK SPAN, SPLICES IN BK SPAN BOTH CIRCUITS, (LEVEL 3) PAINT CHIPPING, (LEVEL 3 - BEAM DEFL/BUCK) DEFLECTION IN HORIZ. PLANE DIAGONALS, (LEVEL 3) HARDWARE RUSTY, , , , , ,				LEOMINSTER, MA
659	Mainline A1S/B2S	644	T-1223	2397+93	333	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
660	Mainline A1S/B2S	645	T-1223	2402+05	412	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
661	Mainline A1S/B2S	646	T-1223	2405+49	344	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
662	Mainline A1S/B2S	647	T-1223	2409+11	362	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
663	Mainline A1S/B2S	648	T-1223	2413+30	419	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
664	Mainline A1S/B2S	649	T-1223	2416+85	355	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
665	Mainline A1S/B2S	650	T-1223	2420+41	356	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
666	Mainline A1S/B2S	651	T-1223	2424+09	368	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
667	Mainline A1S/B2S	652	T-1223	2427+91	382	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
668	Mainline A1S/B2S	653	T-3474	2431+41	350	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				STEEL/LATTICE CONDITION: 3, SPLICES BK, (LEVEL 3) BIRD GUARD DAMAGE, SPLICES (BK SPAN), (LEVEL 3) PAINT CHIPPING, (LEVEL 3 -				LEOMINSTER, MA
669	Mainline A1S/B2S	654	T-3474	2434+51	310	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								LEOMINSTER, MA
670	Mainline A1S/B2S	655	T-3474	2437+71	320	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				DID NOT INSPECT, DBL POST INSULATORS, , , , , , , , ,				STERLING, MA
671	Mainline A1S/B2S	656	T-3474	2441+71	400	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								STERLING, MA
672	Mainline A1S/B2S	657	T-3474	2445+71	400	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								STERLING, MA
673	Mainline A1S/B2S	658	T-3474	2449+90	419	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								STERLING, MA
674	Mainline A1S/B2S	659	T-3474	2453+68	378	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								STERLING, MA
675	Mainline A1S/B2S	660	T-3474	2457+28	360	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								STERLING, MA
676	Mainline A1S/B2S	661	T-3474	2461+78	450	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								STERLING, MA
677	Mainline A1S/B2S	662	T-3474	2465+07	329	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								STERLING, MA
678	Mainline A1S/B2S	663	T-3474	2468+43	336	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3								STERLING, MA
679	Mainline A1S/B2S	664	T-3474	2471+47	304	BAY-SU	LATTICE	GRILLAGE	YES	3	3	3	3	3				DID NOT INSPECT, DBL POST INSULATORS, , , , , , , , ,				STERLING, MA
680	Mainline A1S/B2S	665	T-3474	2473+40	193	BAY-SU	LATTICE	GRILLAGE		3	3	3	3	3		YES (FRAARCID 374877; OWNER: CSXT)						STERLING, MA
681	Mainline A1S/B2S	SUB	T-3474			BUS	LATTICE	DIRECT-BURIED		4		3	3	3				NO FIELD NOTES??, , , , , , , , , , ,				STERLING, MA
682.5	ATHOL TAP																					
683	ATHOL #1	BUS	T-817	0+00		BUS	WOOD	DIRECT-BURIED		3		3			-	-	-					ROYALSTON, MA
684	ATHOL #1	1	T-817	1+97	197	PDE	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
685	ATHOL #1	2	T-817	4+62 = 4+50	265	PDE	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
686	ATHOL #1	3	T-1696	9+52	505	PSUSP	WOOD	DIRECT-BURIED		3		3			STATE RTE. 68 (SOUTH ROYALSTON ROAD)	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
687	ATHOL #1	4	T-1696	12+70	318	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
688	ATHOL #1	5	T-1696	17+76	506	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
689	ATHOL #1	6	T-1696	19+59	183	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
690	ATHOL #1	7	T-1696	22+58	299	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
691	ATHOL #1	8	T-1696	24+91	233	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ROYALSTON, MA
692	ATHOL #1	9	T-1696	27+58	267	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
693	ATHOL #1	10	T-1696	31+10	352	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA

ORDER	LINE	EXISTING STR NO.	T-SHEET	STATION (FT)	BACK SPAN (FT)	STR TYPE	MATERIAL	FDN TYPE	UALLY INSPECT	OVERALL	EMBER BUCKLI	HARDWARE	PAINT	RD DETERRENT	HIGHWAY CROSSING	RAILROAD CROSSING	WATER CROSSING	CAI COMMENTS (VISUAL INSPECTION)	LINEWISE COMMENTS (AERIAL INSPECTION)	ROW BACKSPAN COMMENTS	NOTES	TOWN, STATE
694	ATHOL #1	11	T-1696	33+38	226	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
695	ATHOL #1	12	T-1696	38+80	542	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
696	ATHOL #1	13	T-1696	43+36	445	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
697	ATHOL #1	14	T-1696	47+72	436	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
698	ATHOL #1	15	T-1696	49+80	208	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
699	ATHOL #1	16	T-1696	52+98	318	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
700	ATHOL #1	17	T-1696	56+85	387	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
701	ATHOL #1	18	T-1696	59+48	263	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
702	ATHOL #1	19	T-1696	61+90	242	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
703	ATHOL #1	20	T-1696	65+38	348	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
704	ATHOL #1	21	T-1697	70+50	512	PDE	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, (LEVEL 3) Guy wire heavily corroded, , , , , , , , ,			ROYALSTON, MA
705	ATHOL #1	22	T-1697	74+54	404	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
706	ATHOL #1	23	T-1697	77+00	246	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
707	ATHOL #1	24	T-1697	80+73	373	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
708	ATHOL #1	25	T-1697	84+78	405	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
709	ATHOL #1	26	T-1697	87+17	239	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
710	ATHOL #1	27	T-1697	89+61	244	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
711	ATHOL #1	28	T-1697	91+82	221	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
712	ATHOL #1	29	T-1697	94+85	303	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ROYALSTON, MA
713	ATHOL #1	30	T-1697	100+59	574	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
714	ATHOL #1	31	T-1697	103+40	281	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
715	ATHOL #1	32	T-1697	106+90	350	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
716	ATHOL #1	33	T-1697	110+40	350	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
717	ATHOL #1	34	T-1697	113+18	278	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
718	ATHOL #1	35	T-1697	118+26	508	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
719	ATHOL #1	36	T-1697	120+34	208	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
720	ATHOL #1	37	T-1697	123+04	270	PDE	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
721	ATHOL #1	38	T-1697	126+38	334	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
722	ATHOL #1	39	T-1697	129+03	265	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
723	ATHOL #1	40	T-1697	131+82	279	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
724	ATHOL #1	41	T-1697	134+28	246	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
725	ATHOL #1	42	T-1697	137+98	370	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
726	ATHOL #1	43	T-1698	141+21	323	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
727	ATHOL #1	44	T-1698	144+02	281	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) East pole deteriorating, , , , , , , , , ,			ATHOL, MA
728	ATHOL #1	45	T-1698	146+83	391	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
729	ATHOL #1	46	T-1698	150+87	387	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
730	ATHOL #1	47	T-1698	153+42	255	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
731	ATHOL #1	48	T-1698	155+65	225	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
732	ATHOL #1	49	T-1698	158+15	250	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
733	ATHOL #1	50	T-1698	160+54	239	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
734	ATHOL #1	51	T-1698	165+72	518	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
735	ATHOL #1	52	T-1698	167+59	187	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
736	ATHOL #1	53	T-1698	169+45	188	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
737	ATHOL #1	54	T-1698	172+98	355	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
738	ATHOL #1	55	T-1698	175+91	293	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
739	ATHOL #1	56	T-1698	178+60	269	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
740	ATHOL #1	57	T-1698	180+57	197	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
741	ATHOL #1	58	T-1698	183+38	281	PDE	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
742	ATHOL #1	59	T-1698	188+00	462	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
743	ATHOL #1	60	T-1698	190+43	243	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) woodpecker damage, , , , , , , , , ,			ATHOL, MA
744	ATHOL #1	61	T-1698	193+30	287	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
745	ATHOL #1	62	T-1698	196+04	274	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
746	ATHOL #1	63	T-1698	199+07	303	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) woodpecker damage, , , , , , , , , ,			ATHOL, MA
747	ATHOL #1	64	T-1698	202+04	297	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) woodpecker damage, , , , , , , , , ,			ATHOL, MA
748	ATHOL #1	65	T-1698	204+51	248	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
749	ATHOL #1	66	T-1699	207+20	269	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
750	ATHOL #1	67	T-1699	210+31	311	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
751	ATHOL #1	68	T-1699	213+25	294	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
752	ATHOL #1	69	T-1699	216+03	278	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
753	ATHOL #1	70	T-1699	218+65	262	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
754	ATHOL #1	71	T-1699	221+60	295	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 4, (LEVEL 4) Baloon tangled in static attachment and ground, , , , , , , , , ,			ATHOL, MA
755	ATHOL #1	72	T-1699	224+90	330	PDE	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
756	ATHOL #1	73	T-1699	228+54	364	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
757	ATHOL #1	74	T-1699	231+82	328	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
758	ATHOL #1	75	T-1699	234+80	298	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
759	ATHOL #1	76	T-1699	237+47	267	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
760	ATHOL #1	77	T-1699	240+18	271	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) West pole deteriorating, , , , , , , , , ,			ATHOL, MA
761	ATHOL #1	78	T-1699	244+62	444	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
762	ATHOL #1	79	T-1699	246+46	184	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
763	ATHOL #1	80	T-1699	249+62	316	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
764	ATHOL #1	81	T-1699	251+55	193	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
765	ATHOL #1	82	T-1699	255+27	372	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
766	ATHOL #1	83	T-1699	259+98	471	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
767	ATHOL #1	84	T-1699	263+28	330	DEPO	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
768	ATHOL #1	85	T-1699	268+01	473	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
769	ATHOL #1	86	T-1700	269-93	499	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
770	ATHOL #1	87	T-1700			PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
771	ATHOL #1	88	T-1700	277+53	499	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
772	ATHOL #1	89	T-1700	281+50	397	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
773	ATHOL #1	90	T-1700	283+45	195	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
774	ATHOL #1	91	T-1700	285+00	155	DEPO	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) West pole deteriorating, (LEVEL 3) woodpecker damage, , , , , , , , ,			ATHOL, MA
775	ATHOL #1	92	T-1700	288+77	380	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, (LEVEL 4) Large wasp nest, , , , , , , , ,			ATHOL, MA
776	ATHOL #1	93	T-1700	291+72	292	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
777	ATHOL #1	94	T-1700	293+60	188	PSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
778	ATHOL #1	95	T-1700	298+92	290	PDE	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA

ORDER	LINE	EXISTING STR NO.	T-SHEET	STATION (FT)	BACK SPAN (FT)	STR TYPE	MATERIAL	FDN TYPE	UALLY INSPECT	OVERALL	MBER BUCKLII	HARDWARE	PAINT	RD DETERRENT	HIGHWAY CROSSING	RAILROAD CROSSING	WATER CROSSING	CAI COMMENTS (VISUAL INSPECTION)	LINEWISE COMMENTS (AERIAL INSPECTION)	ROW BACKSPAN COMMENTS	NOTES	TOWN, STATE
779	ATHOL #1	96	T-1700	301+82	142	PDE	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
780	ATHOL #1	97	T-1700	303+24	635	PDE	WOOD	DIRECT-BURIED		3		3			-	PAN AM RAILWAY (FRAARCID 374677)	MILLER'S RIVER					ATHOL, MA
781	ATHOL #1/ATHOL TAP #2	98/99	T-1700	309+59	235	DC DADI	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
782	ATHOL #1	99	T-2093	313+89	195	DEPO	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
783	ATHOL #1	100	T-2093	315+06	117	BUS	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
784	ATHOL #2	SUB	T-817	0+00		BUS	WOOD	DIRECT-BURIED		3		3			-	-	-					ROYALSTON, MA
785	ATHOL #2	1	T-817	0+99	99	HDE	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
786	ATHOL #2	2	T-817	4+65 = 4+90	364	HDE	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
787	ATHOL #2	3	T-1696	10+04	514	HSUSP	WOOD	DIRECT-BURIED		3		3			STATE RTE. 68 (SOUTH ROYALSTON ROAD)	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
788	ATHOL #2	4	T-1696	12+90	286	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
789	ATHOL #2	5	T-1696	18+00	510	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
790	ATHOL #2	6	T-1696	20+40	240	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
791	ATHOL #2	7	T-1696	23+00	260	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
792	ATHOL #2	8	T-1696	25+40	240	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ROYALSTON, MA
793	ATHOL #2	9	T-1696	28+00	260	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
794	ATHOL #2	10	T-1696	31+60	360	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
795	ATHOL #2	11	T-1696	33+75	215	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
796	ATHOL #2	12	T-1696	39+15	540	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
797	ATHOL #2	13	T-1696	43+60	445	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
798	ATHOL #2	14	T-1696	48+15	455	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
799	ATHOL #2	15	T-1696	50+20	205	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
800	ATHOL #2	16	T-1696	53+40	320	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
801	ATHOL #2	17	T-1696	56+90	350	HDE	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
802	ATHOL #2	18	T-1696	59+60	270	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
803	ATHOL #2	19	T-1696	62+20	260	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
804	ATHOL #2	20	T-1696	65+60	340	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
805	ATHOL #2	21	T-1697	71+00	540	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, (LEVEL 3) Guy wire heavily corroded, , , , , , , ,			ROYALSTON, MA
806	ATHOL #2	22	T-1697	75+00	400	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
807	ATHOL #2	23	T-1697	77+55	255	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
808	ATHOL #2	24	T-1697	81+00	345	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
809	ATHOL #2	25	T-1697	5+40	440	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
810	ATHOL #2	26	T-1697	87+60	220	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
811	ATHOL #2	27	T-1697	90+153	255	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
812	ATHOL #2	28	T-1697	92+25	210	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
813	ATHOL #2	29	T-1697	95+40	315	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ROYALSTON, MA
814	ATHOL #2	30	T-1697	101+00	560	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
815	ATHOL #2	31	T-1697	103+90	290	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
816	ATHOL #2	32	T-1697	107+35	345	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
817	ATHOL #2	33	T-1697	111+00	365	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
818	ATHOL #2	34	T-1697	113+45	245	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
819	ATHOL #2	35	T-1697	118+63	518	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
820	ATHOL #2	36	T-1697	120+60	197	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
821	ATHOL #2	37	T-1697	123+55.4	295	HDE	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
822	ATHOL #2	38	T-1697	127+00	345	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
823	ATHOL #2	39	T-1697	129+50	250	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
824	ATHOL #2	40	T-1697	132+25	275	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
825	ATHOL #2	41	T-1697	134+70	245	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
826	ATHOL #2	42	T-1697	138+50	380	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
827	ATHOL #2	43	T-1698	141+75	325	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
828	ATHOL #2	44	T-1698	144+60	285	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) East pole deteriorating, , , , , , , , ,			ATHOL, MA
829	ATHOL #2	45	T-1698	147+30	270	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
830	ATHOL #2	46	T-1698	151+30	400	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
831	ATHOL #2	47	T-1698	153+75	245	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
832	ATHOL #2	48	T-1698	156+20	245	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
833	ATHOL #2	49	T-1698	158+95	275	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
834	ATHOL #2	50	T-1698	161+20	225	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
835	ATHOL #2	51	T-1698	166+10	490	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
836	ATHOL #2	52	T-1698	167+88	178	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
837	ATHOL #2	53	T-1698	170+20	232	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
838	ATHOL #2	54	T-1698	173+46	326	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
839	ATHOL #2	55	T-1698	176+50	304	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
840	ATHOL #2	56	T-1698	179+15	265	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
841	ATHOL #2	57	T-1698	181+65	250	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
842	ATHOL #2	58	T-1698	183+80	215	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
843	ATHOL #2	59	T-1698	188+40	460	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
844	ATHOL #2	60	T-1698	191+20	280	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) woodpecker damage, , , , , , , , ,			ATHOL, MA
845	ATHOL #2	61	T-1698	194+05	285	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
846	ATHOL #2	62	T-1698	196+80	175	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
847	ATHOL #2	63	T-1698	199+60	280	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) woodpecker damage, , , , , , , , ,			ATHOL, MA
848	ATHOL #2	64	T-1698	202+55	295	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) woodpecker damage, , , , , , , , ,			ATHOL, MA
849	ATHOL #2	65	T-1698	205+00	245	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
850	ATHOL #2	66	T-1698	207+70	270	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
851	ATHOL #2	67	T-1699	210+85	315	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
852	ATHOL #2	68	T-1699	213+75	290	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
853	ATHOL #2	69	T-1699	216+55	280	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
854	ATHOL #2	70	T-1699	219+15	260	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
855	ATHOL #2	71	T-1699	222+05	290	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 4, (LEVEL 4) Baloon tangled in static attachment and ground, , , , , , , , ,			ATHOL, MA
856	ATHOL #2	72	T-1699	225+30	325	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
857	ATHOL #2	73	T-1699	228+97	367	HDE	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
858	ATHOL #2	74	T-1699	232+20	323	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
859	ATHOL #2	75	T-1699	235+20	300	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
860	ATHOL #2	76	T-1699	237+85	265	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
861	ATHOL #2	77	T-1699	240+5	270	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) West pole deteriorating, , , , , , , , ,			ATHOL, MA
862	ATHOL #2	78	T-1699	245+00	445	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
863	ATHOL #2	79	T-1699	246+80	180	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA
864	ATHOL #2	80	T-1699	249+96	316	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , ,			ATHOL, MA

ORDER	LINE	EXISTING STR NO.	T-SHEET	STATION (FT)	BACK SPAN (FT)	STR TYPE	MATERIAL	FDN TYPE	UALLY INSPECT	OVERALL	EMBER BUCKLI	HARDWARE	PAINT	RD DETERRENT	HIGHWAY CROSSING	RAILROAD CROSSING	WATER CROSSING	CAI COMMENTS (VISUAL INSPECTION)	LINEWISE COMMENTS (AERIAL INSPECTION)	ROW BACKSPAN COMMENTS	NOTES	TOWN, STATE
865	ATHOL #2	81	T-1699	251+65	169	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
866	ATHOL #2	82	T-1699	255+15	350	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
867	ATHOL #2	83	T-1699	259+80	465	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
868	ATHOL #2	84	T-1699	263+40	360	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
869	ATHOL #2	85	T-1699	268+38.3	498	SPO	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
870	ATHOL #2	86	T-1699	270+25	187	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
871	ATHOL #2	87	T-1700	273+40	315	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
872	ATHOL #2	88	T-1700	277+85	445	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
873	ATHOL #2	89	T-1700	281+90	405	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
874	ATHOL #2	90	T-1700	284+20	230	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
875	ATHOL #2	91	T-1700	285+45	125	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) West pole deteriorating, (LEVEL 3) woodpecker damage, , , , , , , , ,			ATHOL, MA
876	ATHOL #2	92	T-1700	289+06.7	362	SPO	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, (LEVEL 4) Large wasp nest, , , , , , , , ,			ATHOL, MA
877	ATHOL #2	93	T-1700	291+80	273	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
878	ATHOL #2	94	T-1700	293+75	195	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
879	ATHOL #2	95	T-1700	299+00	525	HSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
880	ATHOL #2	96	T-1700	301+90	290	HDE	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			ATHOL, MA
881	ATHOL #2	97	T-1700	303+68	178	HDE	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
882	ATHOL #2	98	T-1700	309+58	590	HDE	WOOD	DIRECT-BURIED		3		3			-	PAN AM RAILWAY (FRAARCID 374677)	MILLER'S RIVER					ATHOL, MA
883	ATHOL #2/ATHOL TAP #1	99/98	T-1700	311+94	236	DC DADI	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
884	ATHOL #2	100	T-2093	313+89	195	DEPO	WOOD	DIRECT-BURIED		3		3			-	-	-					ATHOL, MA
885	ATHOL #2	SUB	T-2093	315+06	117	BUS	WOOD			3		3			-	-	-					ATHOL, MA
885.5	BALDWINSVILLE TAP																					
886	A1S N. BALDWINSVILLE	L1	T-820	1+68		TDE	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			WINCHENDON, MA
887	A1S N. BALDWINSVILLE	L2	T-820	3+18	150	SWITCH (H-FRAME)	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			WINCHENDON, MA
888	B2N N. BALDWINSVILLE	R1	T-820	1+58		BUS	LATTICE	CONCRETE		4		3	3	3	-	-	-				OTTER RIVER NO. 615 SUBSTATION	WINCHENDON, MA
889	B2N N. BALDWINSVILLE	R2	T-820	3+8	150	SWITCH (H-FRAME)	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
891	A1S/B2N N. BALDWINSVILLE	3	T-4273	4+63	155	HDE	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
892	A1S/B2N N. BALDWINSVILLE	4	T-4273	6+45	182	SCDRSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, (LEVEL 3) Crossarm deteriorating, , , , , , , , ,			WINCHENDON, MA
893	A1S/B2N N. BALDWINSVILLE	5	T-4273	8+78	233	SCDRSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
894	A1S/B2N N. BALDWINSVILLE	6	T-4273	11+28	250	SCDRSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
895	A1S/B2N N. BALDWINSVILLE	7	T-4273	13+78	250	SCDRSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
896	A1S/B2N N. BALDWINSVILLE	8	T-4273	16+28	250	SCDRSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
897	A1S/B2N N. BALDWINSVILLE	9	T-4273	19+28	300	SCDRSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
898	A1S/B2N N. BALDWINSVILLE	10	T-4273	22+28	300	SCDSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
899	A1S/B2N N. BALDWINSVILLE	11	T-4273	25+30	302	SCDSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
900	A1S/B2N N. BALDWINSVILLE	12	T-4273	28+30	300	SCDRSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
901	A1S/B2N N. BALDWINSVILLE	13	T-4274	31+30	275	SCDRSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
902	A1S/B2N N. BALDWINSVILLE	14	T-4274	33+80	250	SCDRSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			WINCHENDON, MA
903	A1S/B2N N. BALDWINSVILLE	15	T-4274	36+30	250	SCDRSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
904	A1S/B2N N. BALDWINSVILLE	16	T-4274	38+80	250	SCDRSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
905	A1S/B2N N. BALDWINSVILLE	17	T-4274	41+30	250	SCDRSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
906	A1S/B2N N. BALDWINSVILLE	18	T-4274	44+30	300	SCDRSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
907	A1S/B2N N. BALDWINSVILLE	19	T-4274	47+30	300	SCDSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
908	A1S/B2N N. BALDWINSVILLE	20	T-4274	50+30	300	SCDSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
909	A1S/B2N N. BALDWINSVILLE	21	T-4274	53+30	300	SCDSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
910	A1S/B2N N. BALDWINSVILLE	22	T-4275	56+30	300	SCDRSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					WINCHENDON, MA
911	A1S/B2N N. BALDWINSVILLE	23	T-4275	59+30	300	SCDRSUSP	WOOD	DIRECT-BURIED		3		3										TEMPLETON, MA
912	A1S/B2N N. BALDWINSVILLE	24	T-4275	61+80	250	SCDRSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, (LEVEL 3) Crack in pole body, , , , , , , , ,			TEMPLETON, MA
913	A1S/B2N N. BALDWINSVILLE	25	T-4275	64+30	250	SCDRSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			TEMPLETON, MA
914	A1S/B2N N. BALDWINSVILLE	26	T-4275	66+80	250	SCDRSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			TEMPLETON, MA
915	A1S/B2N N. BALDWINSVILLE	27	T-4275	69+80	300	SCDSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			TEMPLETON, MA
916	A1S/B2N N. BALDWINSVILLE	28	T-4275	72+80	300	SCDSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-					TEMPLETON, MA
917	A1S/B2N N. BALDWINSVILLE	29	T-4275	75+30	250	SCDSUSP	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			TEMPLETON, MA
918	A1S/B2N N. BALDWINSVILLE	30	T-4275	77+30	200	DEPO	WOOD	DIRECT-BURIED		3		3			-	-	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			TEMPLETON, MA
918.5	A1S/B2N N. BALDWINSVILLE	BUS	T-4275	78+30	111	BUS	STEEL	CONCRETE							-	-	-				NORTH BALDWINVILLE NO. 606 SUBSTATION (TEMPLETON	TEMPLETON, MA
918.5	GARDNER SPUR														-	-	-					
920	B2N TAP (GARDNER SPUR)	1	T-824	0+00	0	BUS	ENGINEERED STEEL POLE	CONCRETE		4		3			-	-	-					GARDNER, MA
921	B2N TAP (GARDNER SPUR)	2	T-824	1+95	195	DADI	WOOD	DIRECT-BURIED		3		3			-	-						GARDNER, MA
922	B2N TAP (GARDNER SPUR)	3	T-2627	6+39	437	DADE	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
923	B2N TAP (GARDNER SPUR)	4	T-2627	8+75	236	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
924	B2N TAP (GARDNER SPUR)	5	T-2627	11+14	239	DADE	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			GARDNER, MA
925	B2N TAP (GARDNER SPUR)	6	T-2627	14+61	286	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
926	B2N TAP (GARDNER SPUR)	7	T-2627	17+50	289	SPO	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-		Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) Pole cap damaged / missing, , , , , , , ,			GARDNER, MA
927	B2N TAP (GARDNER SPUR)	8	T-2627	20+51	301	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			GARDNER, MA
928	B2N TAP (GARDNER SPUR)	9	T-2627	23+45	294	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-		Level 3, (LEVEL 3) Pole cap damaged / missing, (LEVEL 3) Crossarm deteriorating, , , , , , , , ,			GARDNER, MA
929	B2N TAP (GARDNER SPUR)	10	T-2627	26+39	294	SPO	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-		Level 3, (LEVEL 3) Heavy Rust on Wire Attachment Hardware, (LEVEL 3) Pole cap damaged / missing, (LEVEL 3) woodpecker damage, , , , , , , ,			GARDNER, MA
930	B2N TAP (GARDNER SPUR)	11	T-2627	29+64	325	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-		Level 3, (LEVEL 3) Crossarm deteriorating, , , , , , , , , ,			GARDNER, MA
931	B2N TAP (GARDNER SPUR)	12	T-2627	32+82	318	DADI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-		Level 3, (LEVEL 3) Crossarm deteriorating, , , , , , , , , ,			GARDNER, MA
932	B2N TAP (GARDNER SPUR)	13	T-2627	35+45	263	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
933	B2N TAP (GARDNER SPUR)	14	T-2627	37+83	238	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-		Level 3, (LEVEL 3) Crossarm deteriorating, , , , , , , , , ,			GARDNER, MA
934	B2N TAP (GARDNER SPUR)	15	T-2627	39+84	201	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-		Level 3, (LEVEL 3) Crossarm deteriorating, , , , , , , , , ,			GARDNER, MA
935	B2N TAP (GARDNER SPUR)	16	T-2627	42+24	240	DADE	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
936	B2N TAP (GARDNER SPUR)	17	T-2627	45+37	313	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			GARDNER, MA
937	B2N TAP (GARDNER SPUR)	18	T-2627	48+58	321	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
938	B2N TAP (GARDNER SPUR)	19	T-2627	51+18	260	DADI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-		Level 3, (LEVEL 3) Pole cap damaged / missing, , , , , , , , , ,			GARDNER, MA
939	B2N TAP (GARDNER SPUR)	20	T-2627	53+16	198	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-		Level 3, (LEVEL 3) Crossarm deteriorating, , , , , , , , , ,			GARDNER, MA
940	B2N TAP (GARDNER SPUR)	21	T-2627	55+600	244	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
941	B2N TAP (GARDNER SPUR)	22	T-2627	58+57	297	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
942	B2N TAP (GARDNER SPUR)	23	T-2627	61+38	281	DADE	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
943	B2N TAP (GARDNER SPUR)	24-2	T-2627	62+89	151	FDADE	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
944	B2N TAP (GARDNER SPUR)	BUS	T-2627	64+13	124	BUS	STEEL	CONCRETE		4		3			-	-	-					GARDNER, MA
946	B2S TAP (GARDNER SPUR)	1	T-824	0+00		BUS	ENGINEERED STEEL POLE	CONCRETE		4		3			-	-	-					GARDNER, MA
947	B2S TAP (GARDNER SPUR)	2	T-824	2+02	202	DADI	WOOD	DIRECT-BURIED		3		3			-	-	-					GARDNER, MA
948	B2S TAP (GARDNER SPUR)	3	T-2627	6+39	442	DADE	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
949	B2S TAP (GARDNER SPUR)	4	T-2627	8+78	237	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
950	B2S TAP (GARDNER SPUR)	5	T-2627	11+13	236	DADE	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
951	B2S TAP (GARDNER SPUR)	6	T-2627	14+61	286	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
952	B2S TAP (GARDNER SPUR)	7	T-2627	17+50	289	SPO	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
953	B2S TAP (GARDNER SPUR)	8	T-2627	20+51	301	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
954	B2S TAP (GARDNER SPUR)	9	T-2627	23+45	294	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
955	B2S TAP (GARDNER SPUR)	10	T-2627	26+39	294	SPO	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
956	B2S TAP (GARDNER SPUR)	11	T-2627	29+64	325	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
957	B2S TAP (GARDNER SPUR)	12	T-2627	32+82	318	DADI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
958	B2S TAP (GARDNER SPUR)	13	T-2627	35+45	263	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
959	B2S TAP (GARDNER SPUR)	14	T-2627	37+83	238	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
960	B2S TAP (GARDNER SPUR)	15	T-2627	39+84	201	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
961	B2S TAP (GARDNER SPUR)	16	T-2627	42+24	240	DADE	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
962	B2S TAP (GARDNER SPUR)	17	T-2627	45+37	313	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
963	B2S TAP (GARDNER SPUR)	18	T-2627	48+58	321	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
964	B2S TAP (GARDNER SPUR)	19	T-2627	51+18	260	DADI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
965	B2S TAP (GARDNER SPUR)	20	T-2627	53+16	198	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
966	B2S TAP (GARDNER SPUR)	21	T-2627	55+60	244	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA

ORDER	LINE	EXISTING STR NO.	T-SHEET	STATION (FT)	BACK SPAN (FT)	STR TYPE	MATERIAL	FDN TYPE	UALLY INSPECT	OVERALL	EMBER BUCKLI	HARDWARE	PAINT	RD DETERRENT	HIGHWAY CROSSING	RAILROAD CROSSING	WATER CROSSING	CAI COMMENTS (VISUAL INSPECTION)	LINEWISE COMMENTS (AERIAL INSPECTION)	ROW BACKSPAN COMMENTS	NOTES	TOWN, STATE
967	B2S TAP (GARDNER SPUR)	22	T-2627	58+57	297	DASI	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
968	B2S TAP (GARDNER SPUR)	23	T-2627	61+38	281	DADE	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
969	B2S TAP (GARDNER SPUR)	24-1	T-2627	62+59	121	FDADE	WOOD	DIRECT-BURIED		3		3			-	PARALLEL TO ABANDONED RR	-					GARDNER, MA
970	B2S TAP (GARDNER SPUR)	BUS	T-2627	63+58	99	BUS	STEEL	CONCRETE		4		3			-	-	-					GARDNER, MA
970.5	WESTMINSTER TAP																					
971	A1S/B2S TAP WESTMINSTER	496/497	T-828	0	0	BUS	WOOD	DIRECT-BURIED		3		3			-	-	-				WESTMINSTER SWITCHING STATION.	WESTMINSTER, MA
972	A1S TAP WESTMINSTER	496/497	T-1975	0	0	BUS	WOOD	DIRECT-BURIED		3		3			-	-	-				WESTMINSTER SWITCHING STATION. NO SHIELDWIRE	WESTMINSTER, MA
973	A1S/B2S TAP WESTMINSTER	1	T-1975	2+73	273	DC DEPO	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
974	A1S/B2S TAP WESTMINSTER	2	T-1975	5+68	295	DC DADI	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
975	A1S/B2S TAP WESTMINSTER	3	T-1975	7+73	205	DC DASI	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
976	A1S/B2S TAP WESTMINSTER	4	T-1975	11+98	425	DC DASI	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
977	A1S/B2S TAP WESTMINSTER	5	T-1975	14+98	300	DC DASI	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
978	A1S/B2S TAP WESTMINSTER	6	T-1975	18+04	306	DC DADE	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
979	A1S/B2S TAP WESTMINSTER	7	T-1975	21+45	341	DC DASI	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
980	A1S/B2S TAP WESTMINSTER	8	T-1975	24+17	272	DC DASI	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
981	A1S/B2S TAP WESTMINSTER	9	T-1975	26+23	206	DC SPO	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
982	A1S/B2S TAP WESTMINSTER	10	T-1975	29+19	296	DC DASI	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
983	A1S/B2S TAP WESTMINSTER	11	T-1975	31+72	253	DC DASI	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
984	A1S/B2S TAP WESTMINSTER	12	T-1975	34+30	258	DC DASI	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
985	A1S/B2S TAP WESTMINSTER	13	T-1975	36+83	253	DC DASI	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
986	A1S/B2S TAP WESTMINSTER	14	T-1975	39+47	264	DC DADE	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
987	A1S/B2S TAP WESTMINSTER	15	T-1975	42+77	330	DC DADE	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
988	A1S/B2S TAP WESTMINSTER	16	T-1975	46+07	330	DC DADE	WOOD	DIRECT-BURIED		3		3			RTE. 2	-	-					WESTMINSTER, MA
989	A1S/B2S TAP WESTMINSTER	17	T-1975	48+72B = 48+87	265	DC DADE	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
990	A1S/B2S TAP WESTMINSTER	18	T-1975	51+63	276	DC DASI	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
991	A1S/B2S TAP WESTMINSTER	19	T-1975	55+65	402	DC DADE	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
992	A1S/B2S TAP WESTMINSTER	20	T-1975	58+87	322	DC DASI	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
992.5	A1S/B2S TAP WESTMINSTER	21	T-1975	61+45	258	DC DADE	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
992.6	A1S/B2S TAP WESTMINSTER	BUS	T-1975	64+92	347	BUS	WOOD	DIRECT-BURIED		3		3			-	-	-				WESTMINSTER NO. 602 SUBSTATION	WESTMINSTER, MA
993	EAST WESTMINSTER TAP																					
994	A1S EAST WESTMINSTER TAP	A1S-TAP #1	T-2731	1+35	135	FDADE	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
995	A1S EAST WESTMINSTER TAP	BUS	T-2731	-		BUS	ENGINEERED STEEL POLE	CONCRETE		4		3			-	-	-					WESTMINSTER, MA
996	B2S EAST WESTMINSTER TAP	B2S TAP #1-1	T-2731	1+15	115	FDADE	WOOD	DIRECT-BURIED		3		3			-	-	-					WESTMINSTER, MA
997	B2S EAST WESTMINSTER TAP	BUS	T-2731	-		BUS	ENGINEERED STEEL POLE	CONCRETE		4		3			-	-	-					WESTMINSTER, MA
	Total				**64.22 mi**	**990**	**990**	**874**	**82**	**989**	**603**	**989**	**606**	**605**								**990**

REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
1		ORIGINAL-ISSUE 1			
2	04/13/36	TOWER #5 MOVED 105'± EASTERLY DUE TO SPRING FLOOD	CEB		
3	10/14/66	TOWER #1A RELOCATED A/C BANK EROSION	DEM		
4	05/22/41	CORRECTED A/O FIELD CHECK APR. 1941 R.W.B. & H.C.	CMB		
5	07/14/67	TITLE CHANGE	DEM		
6	04/08/97	Digitized & Added Match Line to T-2827.	BMR		
7	07/17/03	Added Access, Wetlands & Wetland, Access Text.	JFH		
8	05/12/11	RENAME A1/B2 LINES TO AIN/B2N	TEC		

ORIGINAL	DATE
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

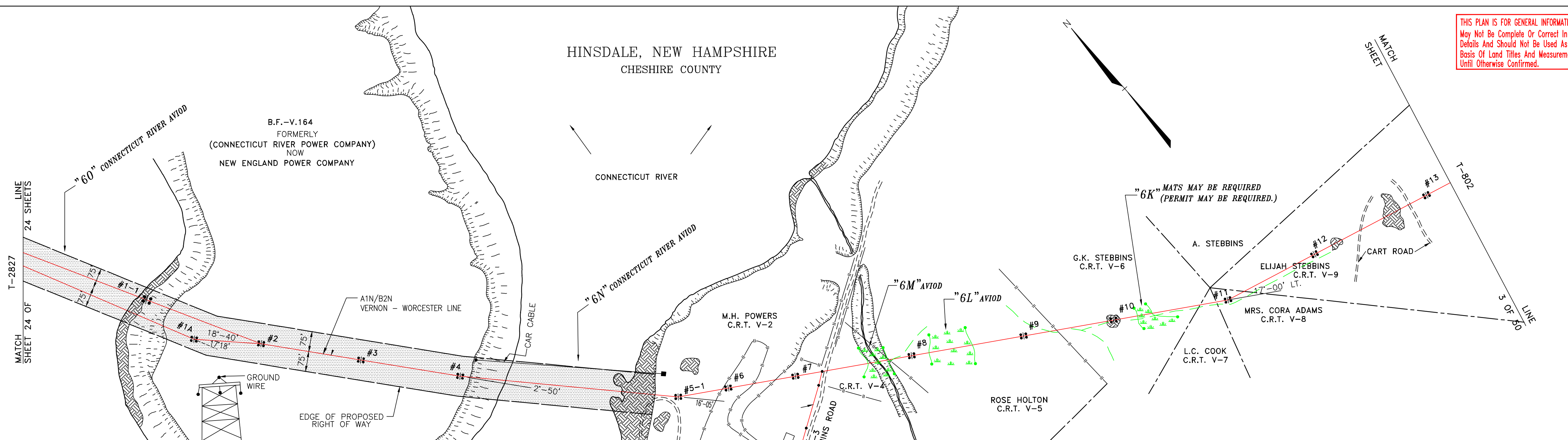
T-800-8

N.E.P.CO. 69kV CONSTRUCTION DATA					VERNON – WORCESTER		A1N
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#1-1	13+46	1346	60	LA-DE			STEEL

N.E.P.CO. 69kV CONSTRUCTION DATA					VERNON – WORCESTER		B2N
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#1A	15+71	1571	60	LA-DE	017 18 00 L		STEEL

N.E.P.CO. 69kV CONSTRUCTION DATA					VERNON – WORCESTER		A1N/B2N
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#2	18+22	476/251	40	BAY-DE	004 51 00 R		STEEL
#3	21+97	375	40	BAY-DE			STEEL
#4	25+72	375	40	BAY-DE		4H+1 R	STEEL
#5-1	34+08	836	41.5	BAY-DE	016 05 00	2 R	STEEL
#6	35+86	178	40	BAY-SU			STEEL
#7	38+40	254	40	BAY-SU			STEEL
#8	42+78	438	40	BAY-SU			STEEL
#9	46+98	420	40	BAY-SU			STEEL
#10	50+38	340	40	BAY-SU			STEEL
#11	54+66	428	40	BAY-DE	017 00 00 L	2 R	STEEL
#12	58+31	365	40	BAY-SU			STEEL
#13	63+06	475	40	BAY-SU			STEEL

NOTE:
STRUCTURES #1-1 & #1A SET ON 4 CONCRETE FILLED STEEL TUBES 24" O.D. VARYING IN HEIGHT FROM 19' TO 27'.



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MAP OF
#1 & #2 LINES
VERNON – WORCESTER
SHEET 1 OF 50 SHEETS

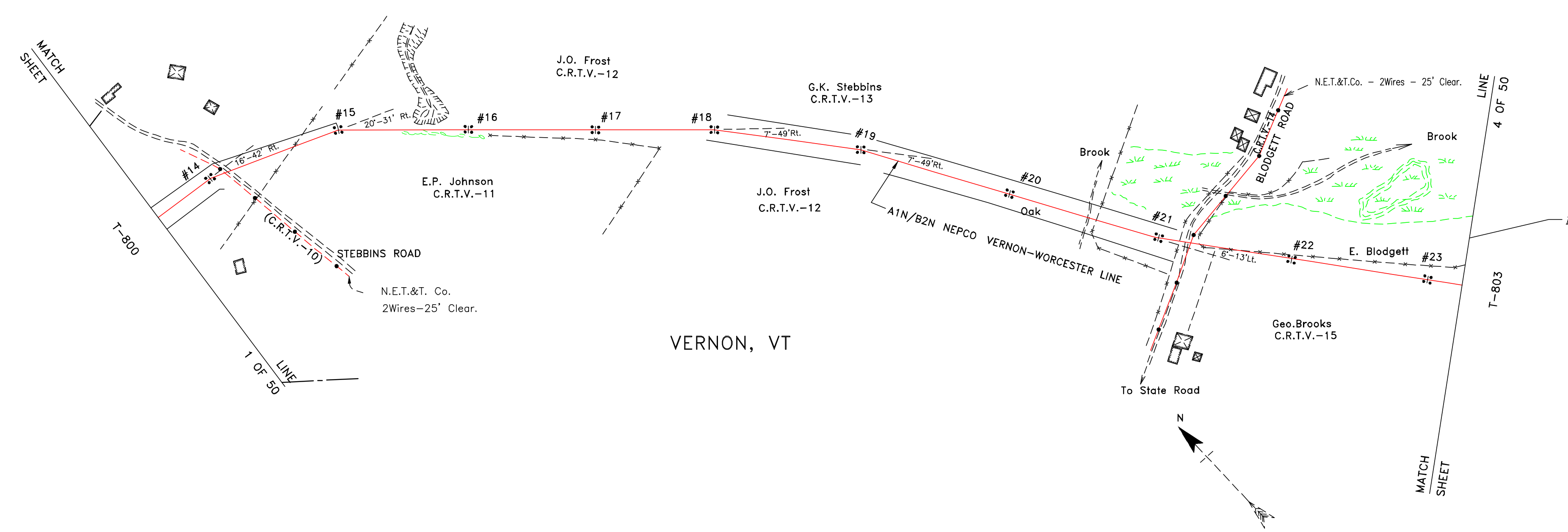
SCALE: 1"=200' DATE:

INCHES ON ORIGINAL

T-800-8

T-802-4

NEPCo 69kV CONSTRUCTION DATA					VERNON – WORCESTER		A1N/B2N
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#14	65+86	280	40	BAY–DE	016 42 00 R	2 L	STEEL
#15	69+71	385	40	BAY–DE	020 31 00 R	2 L	STEEL
#16	73+11	340	40	BAY–SU			STEEL
#17	77+01	390	40	BAY–SU			STEEL
#18	80+41	340	40	BAY–SU	007 49 00 R	1 L	STEEL
#19	84+61	420	40	BAY–SU	007 23 00 R	1 L	STEEL
#20	89+01	440	40	BAY–SU			STEEL
#21	93+41	440	40	BAY–SU	006 13 00 L	1 R	STEEL
#22	97+21	380	40	BAY–SU			STEEL
#23	101+11	390	40	BAY–SU			STEEL



NO WETLANDS ON THIS T-SHEET.

THIS PLAN IS FOR GENERAL INFORMATION. May Not Be Complete Or Correct In All Details And Should Not Be Used As A Basis Of Land Titles And Measurements Until Otherwise Confirmed.

REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	APP'D.
1	05/22/41	Corrected a/o Field Check R.W.B.& H.C.(Apr. 1941)	C.M.B.		
2		Title Change			
3	09/25/97	Digitized on AutoCad Release 12 by Infotech.	W.F.D.		
4	05/12/11	RENAMED A1/B2 TO A1N/B2N	TEC		
5					
6					
7					
8					

ORIGINAL

DATE
DESIGNED
CHECKED
SUPERVISOR
INSPECTED
REVIEWED
REVIEWED
APPROVED
APPROVED

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MAP OF
#1 & #2 LINES
VERNON – WORCESTER

SHEET 3 OF 50

SCALE: 1"=200'
DATE:

INCHES ON ORIGINAL

T-802-4

REVISIONS

REV	DATE	DESCRIPTION	MADE	CHK'D.	APP'D.
1		ORIGINAL–ISSUE 1			
2	05/22/41	Revised a/o Field Check R.W.B.&H.C.Apr.1941	CMB		
3	09/22/41	Revised as per Field Check by S.W.S.	A.L.P.		
4	07/14/67	Title Charge	DEM		
5	07/17/03	Added Access, Wetlands & Wetland, Access Text.	JFH		
6	05/13/11	CHANGED A1/B2 TO A1N/B2N	TEC		
7					
8					

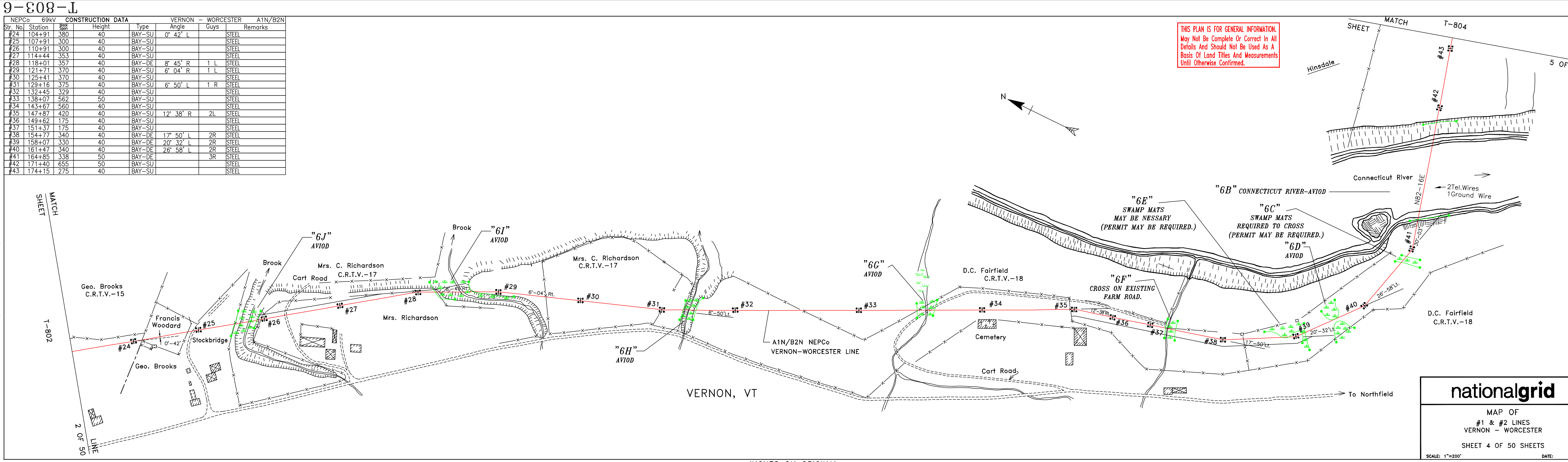
ORIGINAL

DATE	
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

T-803-6

NEPCo 69kV **CONSTRUCTION DATA** VERNON – WORCESTER A1N/B2N

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#24	104+91	380	40	BAY–SU	0° 42' L		STEEL
#25	107+91	300	40	BAY–SU			STEEL
#26	110+91	300	40	BAY–SU			STEEL
#27	114+44	353	40	BAY–SU			STEEL
#28	118+01	357	40	BAY–DE	8° 45' R	1 L	STEEL
#29	121+71	370	40	BAY–SU	6° 04' R	1 L	STEEL
#30	125+41	370	40	BAY–SU			STEEL
#31	129+16	375	40	BAY–SU	6° 50' L	1 R	STEEL
#32	132+45	329	40	BAY–SU			STEEL
#33	138+07	562	50	BAY–SU			STEEL
#34	143+67	560	40	BAY–SU			STEEL
#35	147+87	420	40	BAY–SU	12° 38' R	2L	STEEL
#36	149+62	175	40	BAY–SU			STEEL
#37	151+37	175	40	BAY–SU			STEEL
#38	154+77	340	40	BAY–DE	17° 50' L	2R	STEEL
#39	158+07	330	40	BAY–DE	20° 32' L	2R	STEEL
#40	161+47	340	40	BAY–DE	26° 58' L	2R	STEEL
#41	164+85	338	50	BAY–DE		3R	STEEL
#42	171+40	655	50	BAY–SU			STEEL
#43	174+15	275	40	BAY–SU			STEEL



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MAP OF
#1 & #2 LINES
VERNON – WORCESTER

SHEET 4 OF 50 SHEETS

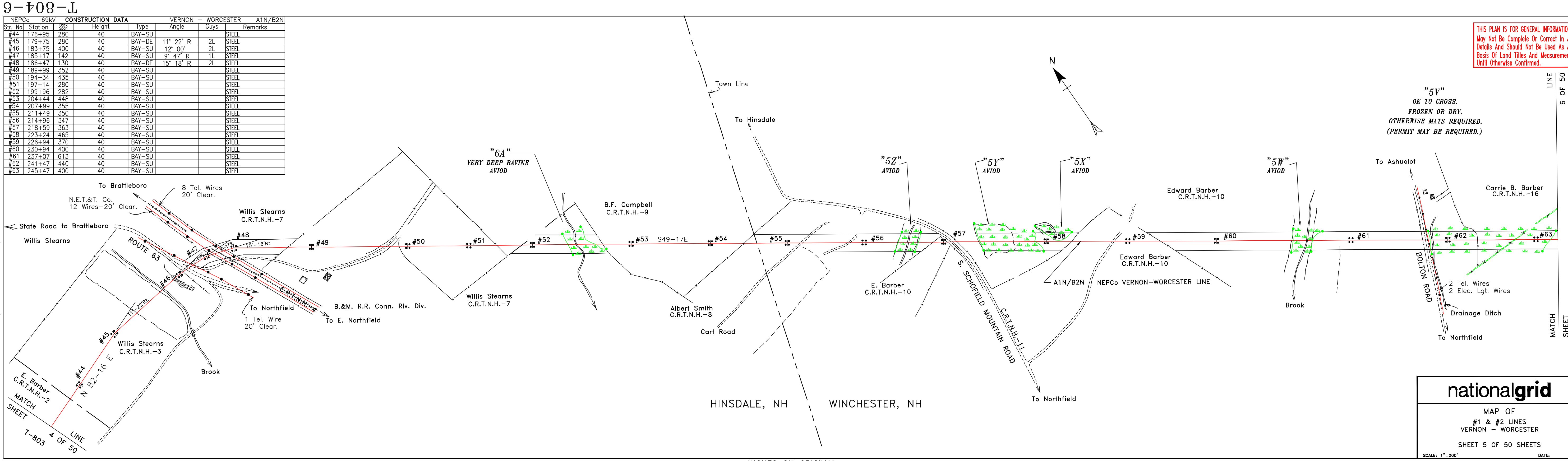
SCALE: 1"=200' DATE:

T-803-6

INCHES ON ORIGINAL

T-804-6

NEPCo 69kV CONSTRUCTION DATA					VERNON – WORCESTER		A1N/B2N
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#44	176+95	280	40	BAY–SU			STEEL
#45	179+75	280	40	BAY–DE	11° 22' R	2L	STEEL
#46	183+75	400	40	BAY–SU	12° 00'	2L	STEEL
#47	185+17	142	40	BAY–SU	9° 47' R	1L	STEEL
#48	186+47	130	40	BAY–DE	15° 18' R	2L	STEEL
#49	189+99	352	40	BAY–SU			STEEL
#50	194+34	435	40	BAY–SU			STEEL
#51	197+14	280	40	BAY–SU			STEEL
#52	199+96	282	40	BAY–SU			STEEL
#53	204+44	448	40	BAY–SU			STEEL
#54	207+99	355	40	BAY–SU			STEEL
#55	211+49	350	40	BAY–SU			STEEL
#56	214+96	347	40	BAY–SU			STEEL
#57	218+59	363	40	BAY–SU			STEEL
#58	223+24	465	40	BAY–SU			STEEL
#59	226+94	370	40	BAY–SU			STEEL
#60	230+94	400	40	BAY–SU			STEEL
#61	237+07	613	40	BAY–SU			STEEL
#62	241+47	440	40	BAY–SU			STEEL
#63	245+47	400	40	BAY–SU			STEEL



REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
1		ORIGINAL–ISSUE 1			
2	09/22/41	Revised as per Field Check by S.W.S.	A.L.P.		
3	07/14/67	Title Change	DEM		
4	08/18/97	Digitized on AutoCad Release 12 by Infotech.	J.F.H.		
5	07/17/03	Added Access, Wetlands & Wetland, Access Text.	J.F.H.		
6	05/13/11	RENAME A1/B2 TO A1N/B2N	TEC		
7					
8					

ORIGINAL	
DATE	
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

INCHES ON ORIGINAL

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MAP OF
#1 & #2 LINES
VERNON – WORCESTER

SHEET 5 OF 50 SHEETS

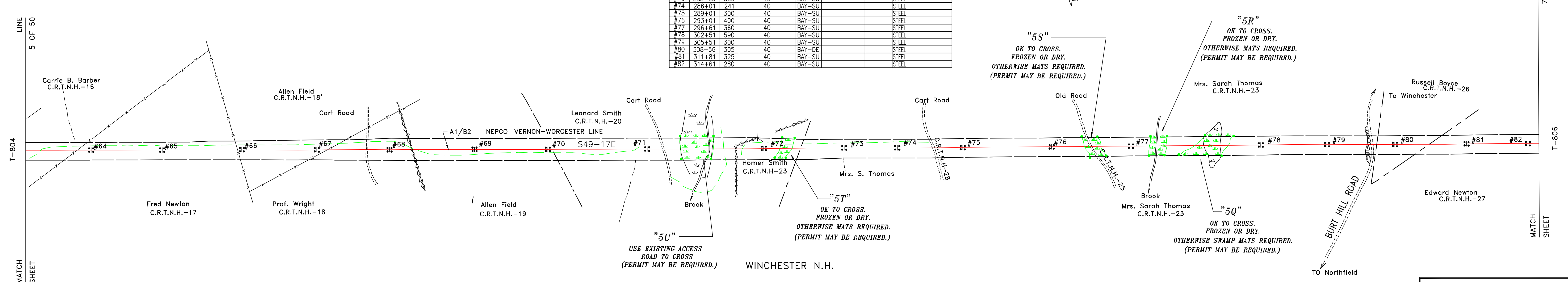
SCALE: 1"=200' DATE:

T–804–6

T-805-6

NEPCo 69kV CONSTRUCTION DATA				VERNON – WORCESTER A1N/B2N			
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#64	249+42	395	40	BAY–SU			STEEL
#65	252+67	325	40	BAY–SU			STEEL
#66	256+27	360	40	BAY–SU			STEEL
#67	259+67	340	40	BAY–SU			STEEL
#68	262+97	330	40	BAY–DE			STEEL
#69	266+82	385	40	BAY–SU			STEEL
#70	270+16	334	40	BAY–SU			STEEL
#71	274+66	450	40	BAY–SU			STEEL
#72	279+94	528	40	BAY–SU			STEEL
#73	283+60	366	40	BAY–SU			STEEL
#74	286+01	241	40	BAY–SU			STEEL
#75	289+01	300	40	BAY–SU			STEEL
#76	293+01	400	40	BAY–SU			STEEL
#77	296+61	360	40	BAY–SU			STEEL
#78	302+51	590	40	BAY–SU			STEEL
#79	305+51	300	40	BAY–SU			STEEL
#80	308+56	305	40	BAY–DE			STEEL
#81	311+81	325	40	BAY–SU			STEEL
#82	314+61	280	40	BAY–SU			STEEL

THIS PLAN IS FOR GENERAL INFORMATION. May Not Be Complete Or Correct In All Details And Should Not Be Used As A Basis Of Land Titles And Measurements Until Otherwise Confirmed.



INCHES ON ORIGINAL

nationalgrid

MAP OF
#1 & #2 LINES
VERNON – WORCESTER

SHEET 6 OF 50 SHEETS

SCALE: 1"=200' DATE:

T-805-6

REV	DATE	DESCRIPTION	MADE	CH'K'D.	APP'D.
1		ORIGINAL			
2	09/22/4	Revised as per Field Check by S.W.S.	A.L.P.		
3	07/14/67	Title Change	DEM		
4	08/18/93	Digitized on AutoCad Release 12 by Infotech.	J.F.H.		
5	07/17/03	Added Access, Wetlands & Wetland Access Text.	J.F.H.		
6	05/13/11	RENAME A1/B2 TO A1N/B2N	TEC		
7					
8					

REVISIONS

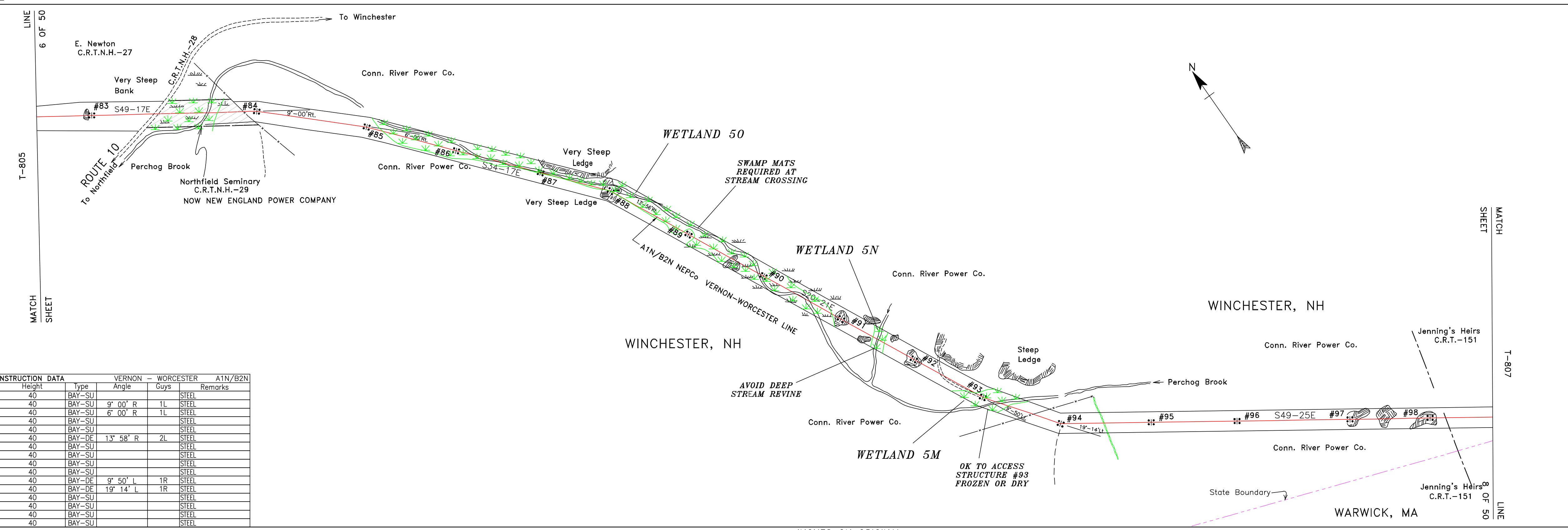
ORIGINAL: DATE, DESIGNED, CHECKED, SUPERVISOR, INSPECTED, REVIEWED, REVIEWED, APPROVED, APPROVED

REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
1		ORIGINAL			
2	09/22/41	Revised as per field check by S.W.S.	A.L.P.		
3	07/14/67	Title Change	DEM		
4	09/25/97	Digitized on AutoCad Release 12 by Infotech.	W.F.D.		
5	08/11/03	Added Wetlands and Notes	JME		
6	05/13/11	RENAME A1/B2 TO A1N/B2N	TEC		
7					
8					

ORIGINAL	
DATE	
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

T-806-6



NEPCo 69kV CONSTRUCTION DATA					VERNON – WORCESTER		A1N/B2N
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#83	317+21	260	40	BAY–SU			STEEL
#84	323+56	635	40	BAY–SU	9° 00' R	1L	STEEL
#85	327+84	428	40	BAY–SU	6° 00' R	1L	STEEL
#86	331+39	355	40	BAY–SU			STEEL
#87	334+74	335	40	BAY–SU			STEEL
#88	337+57	283	40	BAY–DE	13° 58' R	2L	STEEL
#89	341+02	345	40	BAY–SU			STEEL
#90	344+32	330	40	BAY–SU			STEEL
#91	347+77	345	40	BAY–SU			STEEL
#92	350+95	318	40	BAY–SU			STEEL
#93	354+04	309	40	BAY–DE	9° 50' L	1R	STEEL
#94	357+19	315	40	BAY–DE	19° 14' L	1R	STEEL
#95	360+66	347	40	BAY–SU			STEEL
#96	363+96	330	40	BAY–SU			STEEL
#97	368+33	437	40	BAY–SU			STEEL
#98	371+39	306	40	BAY–SU			STEEL

THIS PLAN IS FOR GENERAL INFORMATION. May Not Be Complete Or Correct In All Details And Should Not Be Used As A Basis Of Land Titles And Measurements Until Otherwise Confirmed.

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nationalgrid

MAP OF
#1 & #2 LINES
VERNON – WORCESTER

SHEET 7 OF 50 SHEETS

SCALE: 1"=200' DATE:

INCHES ON ORIGINAL

T-806-6

REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
1		ORIGINAL			
2	09/22/41	Revised as per field check by S.W.S.	A.L.P.		
3	11/06/50	Revised prop. lines as shown in red.	S.V.H		
4	07/14/67	Title Change	DEM		
5	08/18/97	Digitized on AutoCad Release 12 by Infotech.	JFH		
6	08/11/03	Added Wetlands and Notes	JE		
7	05/13/11	RENAME A1/B2 TO A1N/B2N	TEC		
8					

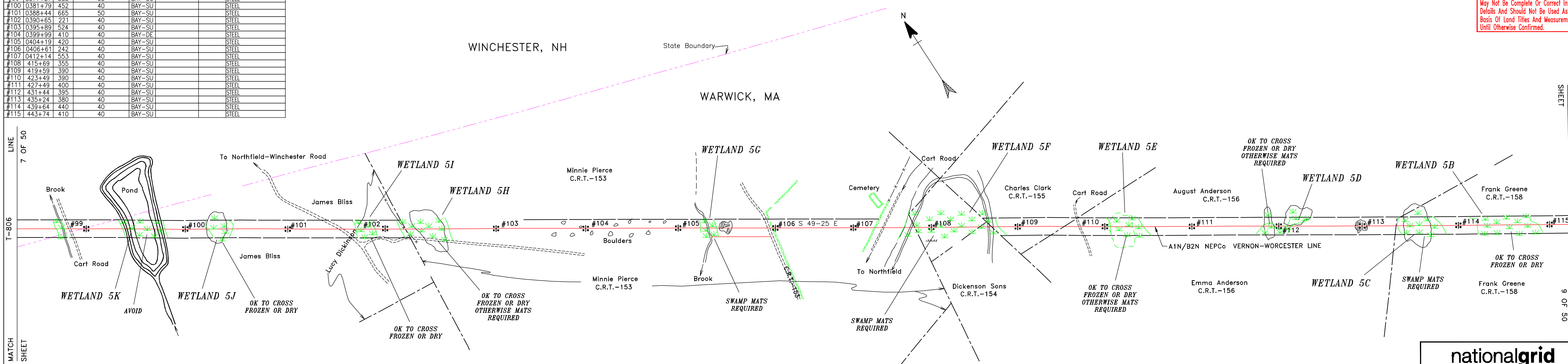
ORIGINAL	
DATE	
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

T-807-7

NEPCo 69kV **CONSTRUCTION DATA** VERNON – WORCESTER A1N/B2N

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#99	0377+27	588	60	BAY–SU			STEEL
#100	0381+79	452	40	BAY–SU			STEEL
#101	0388+44	665	50	BAY–SU			STEEL
#102	0390+65	221	40	BAY–SU			STEEL
#103	0395+89	524	40	BAY–SU			STEEL
#104	0399+99	410	40	BAY–DE			STEEL
#105	0404+19	420	40	BAY–SU			STEEL
#106	0406+61	242	40	BAY–SU			STEEL
#107	0412+14	553	40	BAY–SU			STEEL
#108	415+69	355	40	BAY–SU			STEEL
#109	419+59	390	40	BAY–SU			STEEL
#110	423+49	390	40	BAY–SU			STEEL
#111	427+49	400	40	BAY–SU			STEEL
#112	431+44	395	40	BAY–SU			STEEL
#113	435+24	380	40	BAY–SU			STEEL
#114	439+64	440	40	BAY–SU			STEEL
#115	443+74	410	40	BAY–SU			STEEL

THIS PLAN IS FOR GENERAL INFORMATION. May Not Be Complete Or Correct In All Details And Should Not Be Used As A Basis Of Land Titles And Measurements Until Otherwise Confirmed.



INCHES ON ORIGINAL

nationalgrid

MAP OF
#1 & #2 LINES
VERNON – WORCESTER

SHEET 8 OF 50 SHEETS

SCALE: 1"=200' DATE:

T-807-7

REVISIONS

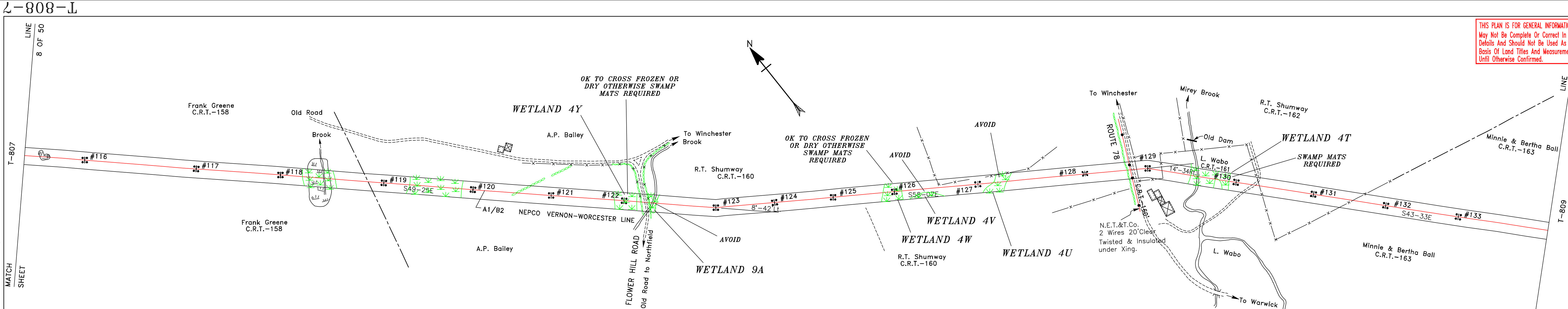
REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
1		ORIGINAL			
2	09/24/41	Revised as per field check by S.WS.	A.L.P.		
3	07/14/67	Title Change	DEM		
4	08/18/97	Digitized on AutoCad Release 12 by Infotech.	JFH		
5	06/15/01	Removed Warwick Switch.	BMR		
6	08/11/03	Added Wetlands and Notes	JE		
7	05/13/11	RENAME A1/B2 TO A1N/B2N	TEC		
8					

ORIGINAL

DATE
DESIGNED
CHECKED
SUPERVISOR
INSPECTED
REVIEWED
REVIEWED
APPROVED
APPROVED

T-808-7

THIS PLAN IS FOR GENERAL INFORMATION. May Not Be Complete Or Correct In All Details And Should Not Be Used As A Basis Of Land Titles And Measurements Until Otherwise Confirmed.



NEPCo 69kV CONSTRUCTION DATA				VERNON – WORCESTER			A1/B2
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#116	447+39	365	40	BAY-DE			STEEL
#117	452+49	510	40	BAY-SU			STEEL
#118	456+34	385	40	BAY-SU			STEEL
#119	461+09	475	40	BAY-SU			STEEL
#120	465+14	405	40	BAY-SU			STEEL
#121	468+74	360	40	BAY-SU			STEEL
#122	472+04	330	40	BAY-SU			STEEL
#123	476+26	422	40	BAY-SU	8° 42' L	1R	STEEL
#124	478+92	266	40	BAY-SU			STEEL
#125	481+62	270	40	BAY-SU			STEEL
#126	484+42	280	40	BAY-SU			STEEL
#127	488+25	383	40	BAY-SU			STEEL
#128	493+16	491	30	BAY-DE			STEEL
#129	496+05	266	40	BAY-DE	14° 34' R	2L	STEEL
#130	500+10	405	40	BAY-SU			STEEL
#131	503+65	355	40	BAY-SU			STEEL
#132	506+97	332	40	BAY-SU			STEEL
#133	510+29	332	40	BAY-SU			STEEL

nationalgrid

MAP OF
#1 & #2 LINES
VERNON – WORCESTER

SHEET 9 OF 50 SHEETS

SCALE: 1"=200' DATE:

INCHES ON ORIGINAL

T-808-7

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T-809-6

NEPCo 69kV **CONSTRUCTION DATA**				VERNON – WORCESTER			A1N/B2N
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#134	514+96	467	40	BAY–SU			STEEL
#135	517+16	220	40	BAY–SU			STEEL
#136	522+16	502	40	BAY–SU			STEEL
#137	526+21	403	40	BAY–SU			STEEL
#138	530+41	420	40	BAY–SU			STEEL
#139	533+03	262	40	BAY–SU			STEEL
#140	536+74	371	40	BAY–DE			STEEL
#141	540+76	404	40	BAY–SU			STEEL
#142	543+42	264	40	BAY–SU			STEEL
#143	547+46	404	40	BAY–SU			STEEL

NEPCo 69kV **CONSTRUCTION DATA**				VERNON – WORCESTER			A1N/B2N
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#144	551+45	399	50	BAY–SU			STEEL
#145	556+92	547	40	BAY–SU			STEEL
#146	559+20	228	40	BAY–SU			STEEL
#147	562+27	307	40	BAY–SU			STEEL
#148	566+61	434	40	BAY–SU			STEEL
#149	569+57	296	40	BAY–DE	16° 26' L	2R	STEEL
#150	573+10	353	40	BAY–SU			STEEL
#151	577+07	397	40	BAY–SU			STEEL
#152	580+93	386	40	BAY–SU			STEEL
#153	584+85	392	50	BAY–SU			STEEL

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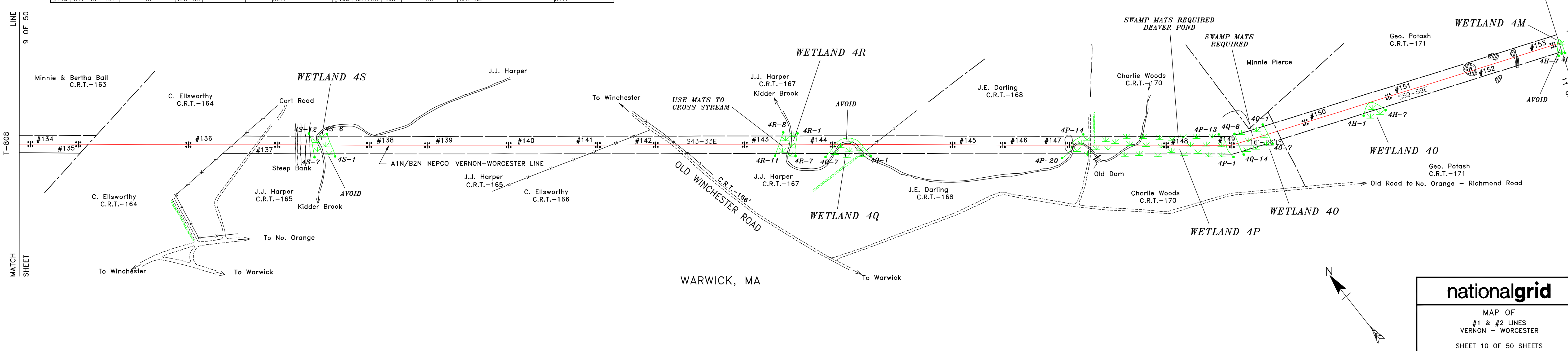


nationalgrid

MAP OF
#1 & #2 LINES
VERNON – WORCESTER

SHEET 10 OF 50 SHEETS

SCALE: 1"=200'   DATE:

T-809-6

INCHES ON ORIGINAL

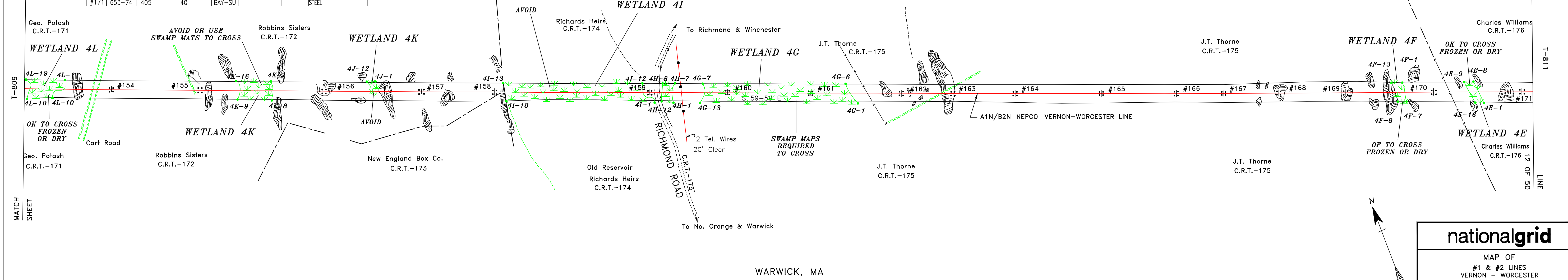
REVISIONS

REV	DATE	DESCRIPTION
1		ORIGINAL
2	09/24/41	Revised as per field check by S.W.S.
3	07/14/67	Title Change
4	08/18/97	Digitized on AutoCad Release 12 by Infotech.
5	07/11/03	Added wetlands
6	05/16/11	RENAME A1/B2 TO A1N/B2N
7		
8		

ORIGINAL		MADE	CHK'D.	APP'D.
DATE				
DESIGNED		A.L.P.		
CHECKED		DEM		
SUPERVISOR		BMR		
INSPECTED		JE		
REVIEWED		TEC		
REVIEWED				
APPROVED				
APPROVED				

T-810-6

NEPCo 69kV CONSTRUCTION DATA				VERNON – WORCESTER A1N/B2N			
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#154	589+08	423	40	BAY–SU			STEEL
#155	593+13	405	40	BAY–SU			STEEL
#156	598+82	569	40	BAY–SU			STEEL
#157	603+29	447	40	BAY–DE			STEEL
#158	606+61	332	60	BAY–SU			STEEL
#159	613+71	710	60	BAY–SU			STEEL
#160	617+26	355	40	BAY–SU			STEEL
#161	621+06	380	40	BAY–SU			STEEL
#162	625+24	418	40	BAY–SU			STEEL
#163	627+58	234	40	BAY–SU			STEEL
#164	630+46	288	40	BAY–SU			STEEL
#165	634+41	395	40	BAY–SU			STEEL
#166	637+84	343	40	BAY–SU			STEEL
#167	640+03	219	40	BAY–SU			STEEL
#168	642+56	253	40	BAY–DE			STEEL
#169	645+61	305	40	BAY–SU			STEEL
#170	649+69	408	40	BAY–SU			STEEL
#171	653+74	405	40	BAY–SU			STEEL



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WARWICK, MA

nationalgrid

MAP OF
#1 & #2 LINES
VERNON – WORCESTER

SHEET 11 OF 50 SHEETS

SCALE: 1"=200' DATE:

INCHES ON ORIGINAL

T–810–6

REVISIONS

REV	DATE	DESCRIPTION	MADE	CHK'D.	APV'D.
1		ORIGINAL			
2	09/24/41	Revised as per field chech by S.W.S.	A.L.P.		
3	07/14/67	Title Change	DEM		
4	09/10/97	Digitized on AutoCad Release 12 by Infotech.	BMR		
5	07/11/03	Added wetlands	JE		
6	05/16/11	RENAME A1/B2 TO A1N/B2N	TEC		
7					
8					

ORIGINAL

DATE	
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

REVISIONS

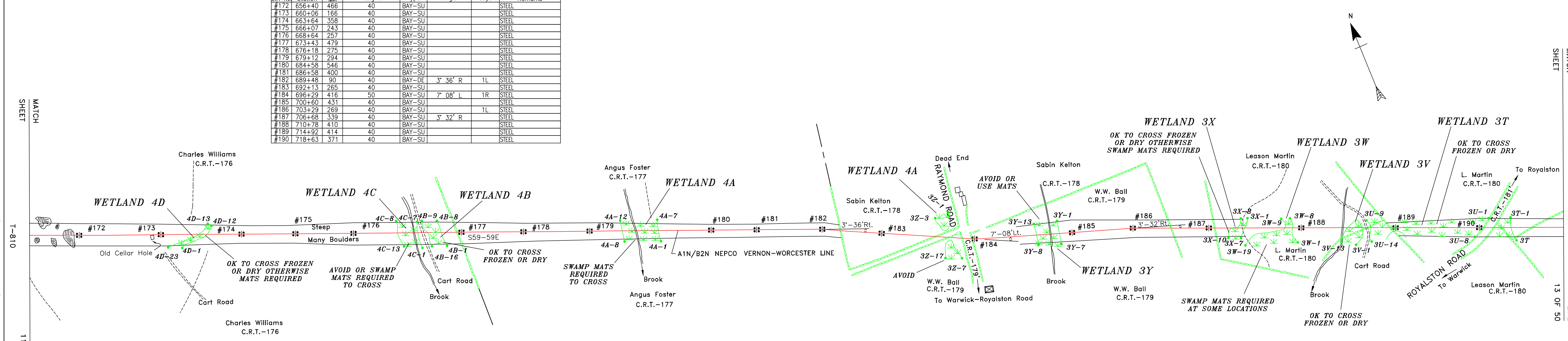
REV	DATE	DESCRIPTION	MADE	CHK'D.	APV'D.
1		ORIGINAL			
2	10/29/41	Construction Tables brought to date per field check.	R.L.P.		
3	07/14/67	Title Change	DEM		
4	07/14/97	Digitized on AutoCad Release 12 by Infotech.	BMR		
5	07/12/03	Added wetlands	JE		
6	05/16/11	RENAME A1/B2 TO A1N/B2N	TEC		
7					
8					

ORIGINAL

DATE
DESIGNED
CHECKED
SUPERVISOR
INSPECTED
REVIEWED
REVIEWED
APPROVED
APPROVED

NEPCo 69kV **CONSTRUCTION DATA** VERNON – WORCESTER A1N/B2N

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#172	656+40	466	40	BAY–SU			STEEL
#173	660+06	166	40	BAY–SU			STEEL
#174	663+64	358	40	BAY–SU			STEEL
#175	666+07	243	40	BAY–SU			STEEL
#176	668+64	257	40	BAY–SU			STEEL
#177	673+43	479	40	BAY–SU			STEEL
#178	676+18	275	40	BAY–SU			STEEL
#179	679+12	294	40	BAY–SU			STEEL
#180	684+58	546	40	BAY–SU			STEEL
#181	686+58	400	40	BAY–SU			STEEL
#182	689+48	90	40	BAY–DE	3° 36' R	1L	STEEL
#183	692+13	265	40	BAY–SU			STEEL
#184	696+29	416	50	BAY–SU	7° 08' L	1R	STEEL
#185	700+60	431	40	BAY–SU			STEEL
#186	703+29	269	40	BAY–SU		1L	STEEL
#187	706+68	339	40	BAY–SU	3° 32' R		STEEL
#188	710+78	410	40	BAY–SU			STEEL
#189	714+92	414	40	BAY–SU			STEEL
#190	718+63	371	40	BAY–SU			STEEL



WARWICK, MA

nationalgrid

MAP OF
#1 & #2 LINES
VERNON – WORCESTER

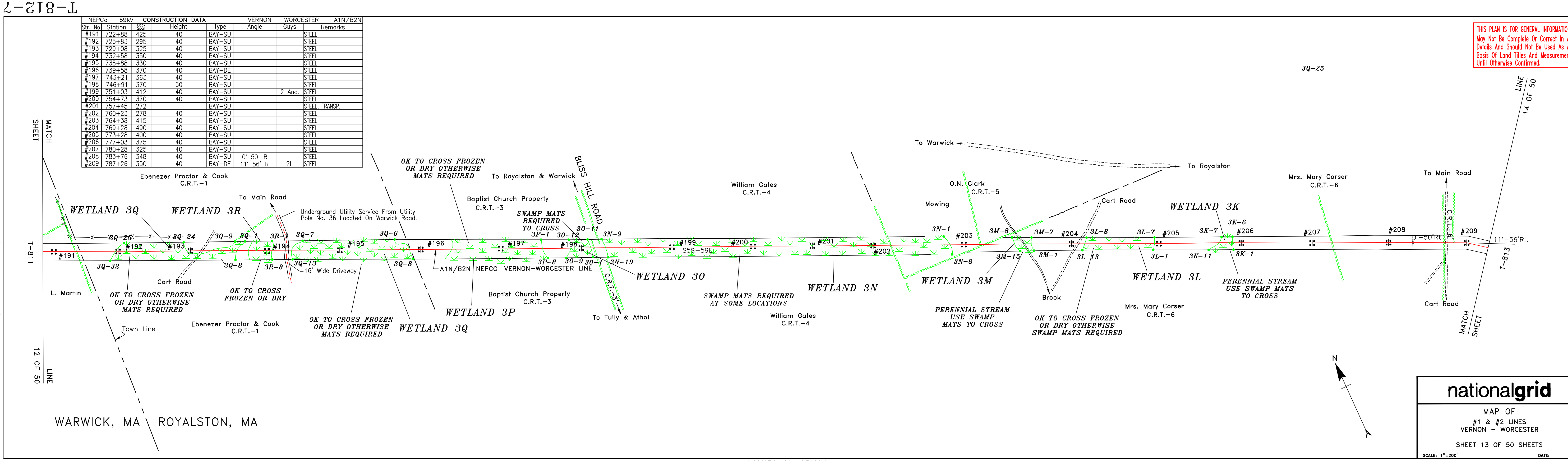
SHEET 12 OF 50 SHEETS

SCALE: 1"=200'
DATE:

INCHES ON ORIGINAL

T-811-6

T-812-7



NEPCo 69kV CONSTRUCTION DATA					VERNON – WORCESTER A1N/B2N		
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#191	722+88	425	40	BAY-SU			STEEL
#192	725+83	295	40	BAY-SU			STEEL
#193	729+08	325	40	BAY-SU			STEEL
#194	732+58	350	40	BAY-SU			STEEL
#195	735+88	330	40	BAY-SU			STEEL
#196	739+58	370	40	BAY-DE			STEEL
#197	743+21	363	40	BAY-SU			STEEL
#198	746+91	370	50	BAY-SU			STEEL
#199	751+03	412	40	BAY-SU		2 Anc.	STEEL
#200	754+73	370	40	BAY-SU			STEEL
#201	757+45	272		BAY-SU			STEEL, TRANSP.
#202	760+23	278	40	BAY-SU			STEEL
#203	764+38	415	40	BAY-SU			STEEL
#204	769+28	490	40	BAY-SU			STEEL
#205	773+28	400	40	BAY-SU			STEEL
#206	777+03	375	40	BAY-SU			STEEL
#207	780+28	325	40	BAY-SU			STEEL
#208	783+76	348	40	BAY-SU	0° 50' R		STEEL
#209	787+26	350	40	BAY-DE	11° 56' R	2L	STEEL

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REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
1		ORIGINAL			
2	10/29/41	Corrected per field chech by R.W.F	R.L.P.		
3	07/14/67	Title Change	DEM		
4	07/14/97	Digitized on AutoCad Release 12 by Infotech.	BMR		
5	02/08/00	Added Ramsdell Driveway Between Nos. 194 & 195.	J.F.H.		
6	07/11/03	Added wetlands	JE		
7	05/16/11	RENAME A1/B2 TO A1N/B2N	TEC		
8					

ORIGINAL

DATE	
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

nationalgrid

MAP OF
#1 & #2 LINES
VERNON – WORCESTER

SHEET 13 OF 50 SHEETS

SCALE: 1"=200' DATE:

T-812-7

INCHES ON ORIGINAL

REVISIONS

REV	DATE	DESCRIPTION	MADE	CHK'D.	APP'D.
1		ORIGINAL			
2	09/24/41	Revised as per Field Check by S.W.S.	A.L.P.		
3	07/14/67	Title Change	D.E.M.		
4	07/23/97	Digitized on AutoCad Release 12 by Infotech.	BMR		
5	07/11/03	Added wetlands	JE		
6	05/16/11	RENAME A1/B2 TO A1N/B2N	TEC		
7	11/28/17	C056886, 90000146231 – A1N/B2N LINES, REPLACE STRUCTURES 219 & 220	TEC		
8					

ORIGINAL: DATE / DESIGNED / CHECKED / SUPERVISOR / INSPECTED / REVIEWED / REVIEWED / APPROVED / APPROVED

T-813-7

NEPCo 69kV CONSTRUCTION DATA VERNON – WORCESTER A1N/B2N

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#210	790+92	366	40	BAY-SU			STEEL
#211	794+46	354	40	BAY-SU			STEEL
#212	799+16	470	50	BAY-SU			STEEL
#213	803+69	453	40	BAY-DE			STEEL
#214	805+74	205	40	BAY-SU			STEEL
#215	807+73	199	40	BAY-SU			STEEL
#216	813+96	623	40	BAY-SU			STEEL
#217	817+18	322	40	BAY-SU			STEEL
#218	820+62	344	40	BAY-SU			STEEL
#219-1	821+78	116	55/2,55/2,70/2,55/2,55/2	(2) H-DE		5H,5B	IND. SW POLE
#220-1	829+16	740	60/2,60/2,75/2,60/2,60/2	(2) H-DE		5H,5B	IND. SW POLE
#221	830+98	180	40	BAY-SU			STEEL
#222	834+08	310	40	BAY-SU			STEEL
#223	837+18	310	40	BAY-SU			STEEL
#224	840+58	340	40	BAY-SU			STEEL
#225	844+21	363	40	BAY-SU			STEEL
#226	847+88	367	40	BAY-SU			STEEL
#227	851+66	378	40	BAY-SU			STEEL
#228	856+00	434	40	BAY-SU			STEEL

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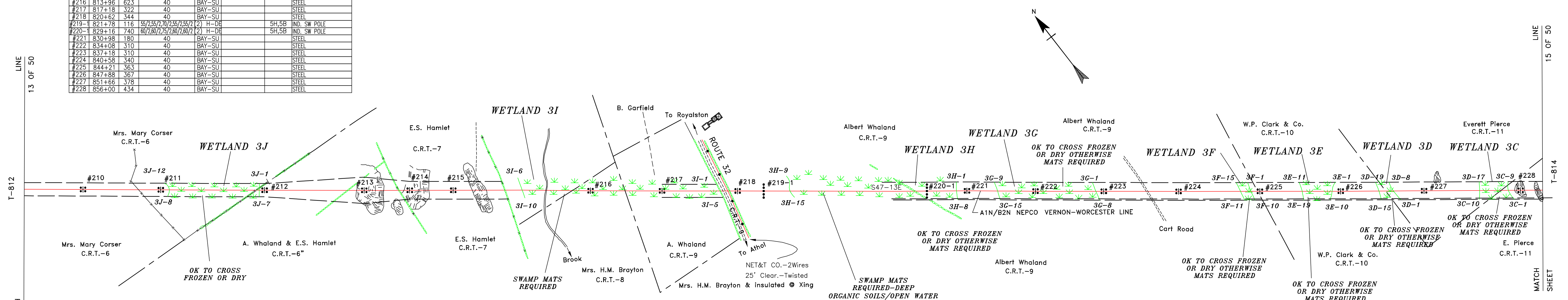


ROYALSTON, MA

INCHES ON ORIGINAL

nationalgrid

MAP OF
#1 & #2 LINES
VERNON – WORCESTER

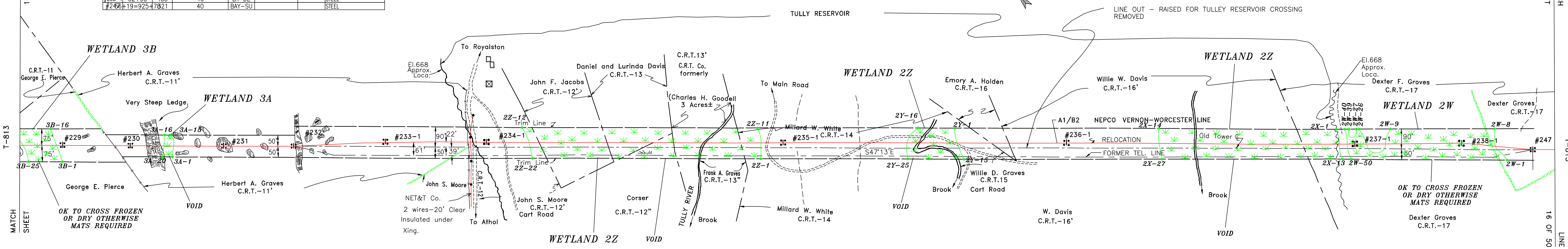
SHEET 14 OF 50 SHEETS

SCALE: 1"=200' DATE:

T-813-7

NEPCo 69kV CONSTRUCTION DATA				VERNON – WORCESTER A1N/B2N			
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#229	858+95	295	40	BAY-SU			STEEL
#230	862+04	309	40	BAY-DE			STEEL
#231	866+30	426	40	BAY-SU			STEEL
#232	869+48=0+00	318	40	BAY-SU			STEEL
#233-1	4+11	411	46	LA-DE			STEEL
#234-1	8+64	453	80	LA-SU			STEEL
#235-1	22+15	1351	80	LA-SU			STEEL
#236-1	35+08	1293	80	LA-SU			STEEL
#237-1	48+15	1307	80	LA-SU			STEEL
#238-1	52+98	483	46	LA-DE			STEEL
#2456	+19=925+78	321	40	BAY-SU			STEEL

ROYALSTON, MA



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REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
1		ORIGINAL			
2	09/24/41	Revised as per field check by S.W.S.	ALP		
3	05/09/49	Revised as Line Raised For Tulley Reservoir Crossing	JV		
4	10/31/49	Revised a/c Relocation of Line "TULLY RESERVOIR""	CMB		
5	07/14/67	Title Change	DEM		
6	07/23/97	Digitized on AutoCad Release 12 by Infotech.	BMR		
7	07/11/03	Added wetlands	JE		
8	05/16/11	RENAME A1/B2 TO A1N/B2N			

ORIGINAL	
DATE	
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

nationalgrid

MAP OF
#1 & #2 LINES
VERNON – WORCESTER

SHEET 15 OF 50 SHEETS

SCALE: 1"=200' DATE:

T-814-8

INCHES ON ORIGINAL

T-815-6

NEPCo 69kV CONSTRUCTION DATA				VERNON – WORCESTER			A1N/B2N
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#248	929+57	379	50	BAY–SU			STEEL
#249	934+75	518	40	BAY–SU			STEEL
#250	937+85	310	40	BAY–DE	3° 04' L	1 2Hd.	STEEL
#251	940+94	309	40	BAY–SU	1° 16' L		STEEL
#252	944+80	386	40	BAY–SU			STEEL
#253	949+55	475	40	BAY–SU			STEEL
#254	955+15	560	40	BAY–SU			STEEL
#254A	956+62	147	55/1,65/1,55/1	DBL DADE		3H,3B,1S	WOOD
#255–1	960+93	430	55/1,65/1,55/1	DBL DADE		3H,3B,1S	WOOD
#256	962+66	173	40	BAY–SU			STEEL
#257	967+03	437	40	BAY–SU			STEEL
#258	970+84	381	40	BAY–SU			STEEL
#259	975+26	442	40	BAY–SU			STEEL
#260	979+03	377	40	BAY–SU			STEEL
#261	982+00	297	30	BAY–DE			STEEL
#262	985+20	320	40	BAY–SU			STEEL
#263	988+54	334	50	BAY–SU			STEEL
#264	992+86	432	40	BAY–SU			STEEL

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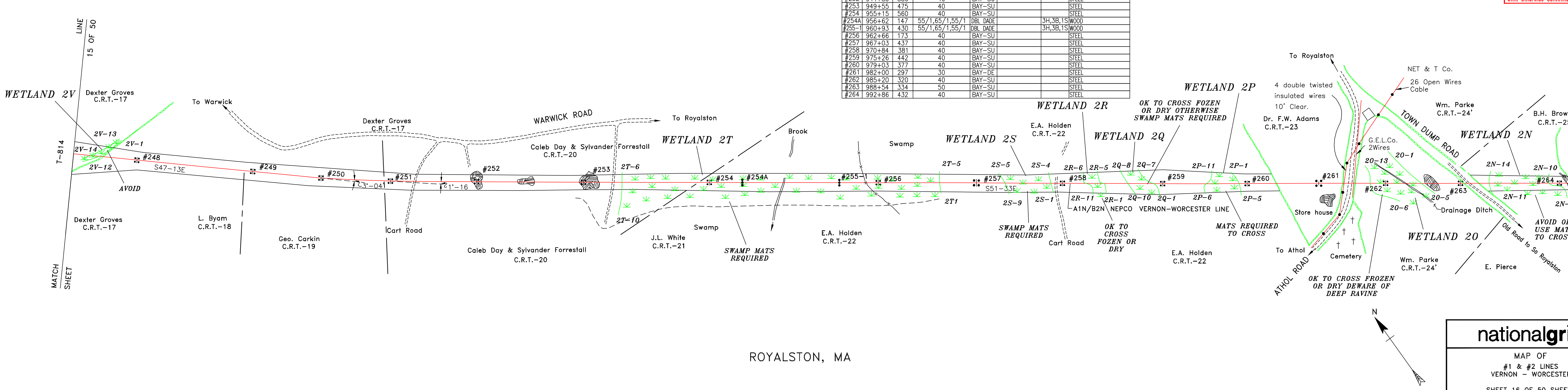

ROYALSTON, MA

nationalgrid

MAP OF
#1 & #2 LINES
VERNON – WORCESTER

SHEET 16 OF 50 SHEETS

SCALE: 1"=200'

T–815–6

INCHES ON ORIGINAL

REVISIONS

REV	DATE	DESCRIPTION	MADE	CHK'D	APP'D
1		ORIGINAL	ALP		
2		Correct as per field check by R.W.F	DEM		
3		Title Change	BMR		
4		Digitized on AutoCad Release 12 by Infotech.	JE		
5	07/11/03	Added wetlands	TEC	KAD	KAD
6	06/06/11	RENAME A1/B2 TO A1N/B2N	ML		
7	11-8-16	ADD STR 254A, MOVE STR 255 & RENAME TO 255-1			
8					

T-816-6

NEPCo 69kV CONSTRUCTION DATA							A1N/B2N
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#265	996+39	353	40	BAY-SU	4° 38' R	1L	STEEL
#266	1001+08	469	40	BAY-SU			STEEL
#267	1004+48	340	40	BAY-SU			STEEL
#268	1008+46	398	40	BAY-SU			STEEL
#269	1012+28	382	40	BAY-SU			STEEL
#270	1015+63	335	40	BAY-SU			STEEL
#271	1019+36	373	40	BAY-SU	3° 30' L	1R	STEEL
#272	1024+06	470	40	BAY-SU			STEEL
#273	1027+68	382	40	BAY-SU			STEEL
#274	1030+74	286	40	BAY-SU			STEEL
#275	1035+77	503	40	BAY-SU			STEEL
#276	1038+78	301	40	BAY-SU			STEEL
#277	1041+83	305	40	BAY-SU			STEEL
#278	1046+18	435	40	BAY-SU			STEEL
#279	1049+28	310	40	BAY-SU			STEEL
#281	1055+80	382	40	BAY-SU			STEEL
#282	1058+12	232	40	BAY-SU		1L	STEEL

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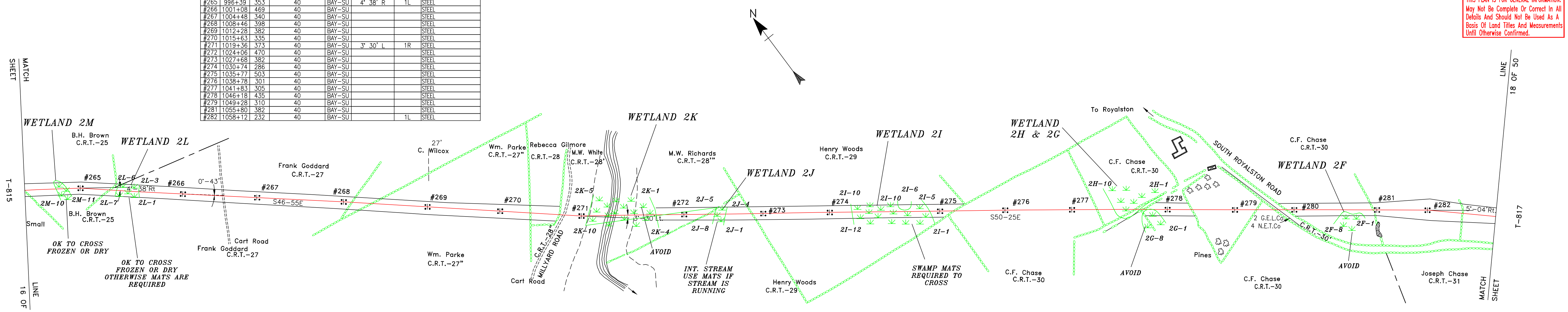


ROYALSTON, MA

nationalgrid

MAP OF
#1 & #2 LINES
VERNON - WORCESTER

SHEET 17 OF 50 SHEETS

SCALE: 1"=200' DATE:

T-816-6

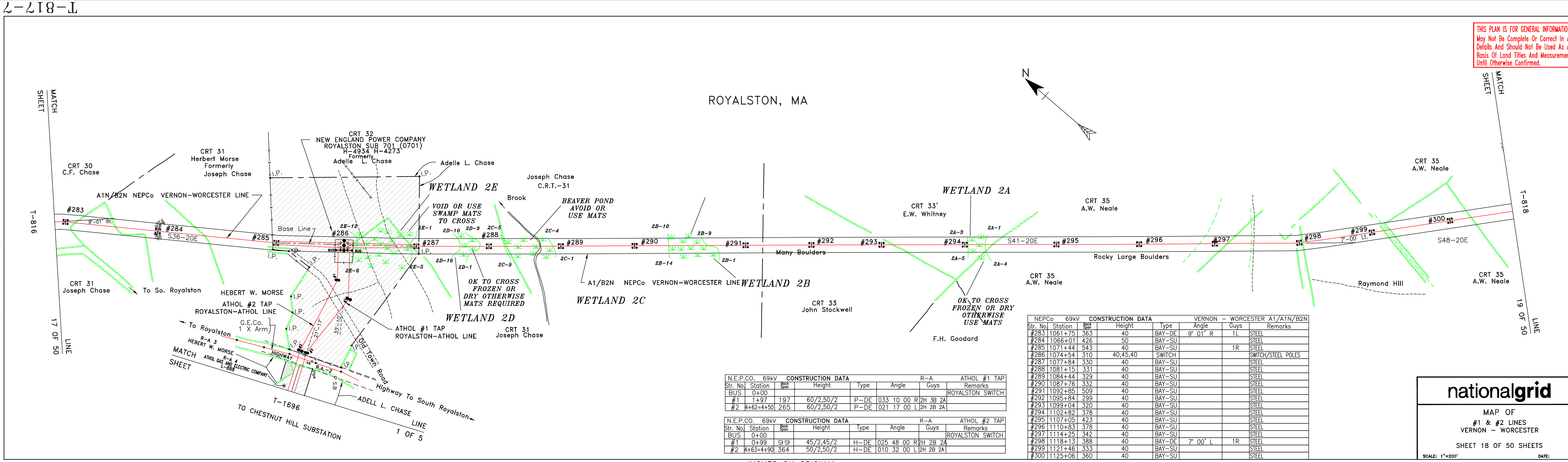
INCHES ON ORIGINAL

REVISIONS

REV	DATE	DESCRIPTION	MADE	CHK'D.	APP'D.
1		ORIGINAL			
2	09/24/4	Revised as per field check by S.W.S.	RLP		
3	07/14/6	Title Change	DEM		
4	07/14/93	Digitized on AutoCad Release 12 by Infotech.	BMR		
5	07/11/03	Added wetlands	JE		
6	06/06/11	RENAME A1/B2 TO A1N/B2N	TEC		
7					
8					

ORIGINAL: DATE, DESIGNED, CHECKED, SUPERVISOR, INSPECTED, REVIEWED, REVIEWED, APPROVED, APPROVED

T-817-7



THIS PLAN IS FOR GENERAL INFORMATION. May Not Be Complete Or Correct In All Details And Should Not Be Used As A Basis Of Land Titles And Measurements Until Otherwise Confirmed.

N.E.P.CO. 69kV CONSTRUCTION DATA					R–A		ATHOL #1 TAP
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
BUS	0+00						ROYALSTON SWITCH
#1	1+97	197	60/2,50/2	P–DE	033 10 00 R	2H 3B 2A	
#2	4+62=4+50	265	60/2,50/2	P–DE	021 17 00 L	2H 2B 2A	

N.E.P.CO. 69kV CONSTRUCTION DATA					R–A		ATHOL #2 TAP
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
BUS	0+00						ROYALSTON SWITCH
#1	0+99	99	45/2,45/2	H–DE	025 48 00 R	2H 2B 2A	
#2	4+63=4+90	364	50/2,50/2	H–DE	010 32 00 L	2H 2B 2A	

INCHES ON ORIGINAL

NEPCo 69kV CONSTRUCTION DATA					VERNON – WORCESTER A1/A1N/B2N		
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#283	1061+75	363	40	BAY–DE	9° 01' R	1L	STEEL
#284	1066+01	426	50	BAY–SU			STEEL
#285	1071+44	543	40	BAY–SU		1R	STEEL
#286	1074+54	310	40,45,40	SWITCH			SWITCH/STEEL POLES
#287	1077+84	330	40	BAY–SU			STEEL
#288	1081+15	331	40	BAY–SU			STEEL
#289	1084+44	329	40	BAY–SU			STEEL
#290	1087+76	332	40	BAY–SU			STEEL
#291	1092+85	509	40	BAY–SU			STEEL
#292	1095+84	299	40	BAY–SU			STEEL
#293	1099+04	320	40	BAY–SU			STEEL
#294	1102+82	378	40	BAY–SU			STEEL
#295	1107+05	423	40	BAY–SU			STEEL
#296	1110+83	378	40	BAY–SU			STEEL
#297	1114+25	342	40	BAY–SU			STEEL
#298	1118+13	388	40	BAY–DE	7° 00' L	1R	STEEL
#299	1121+46	333	40	BAY–SU			STEEL
#300	1125+06	360	40	BAY–SU			STEEL

nationalgrid

MAP OF
#1 & #2 LINES
VERNON – WORCESTER

SHEET 18 OF 50 SHEETS

SCALE: 1"=200' DATE:

T-817-7

REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
1		ORIGINAL			
2	01/13/39	Royalston Substation Added etc.	C.M.B.		
3	07/14/67	Title Change	D.E.M.		
4	07/23/97	Digitized on AutoCad Release 12 by Infotech.	BMR		
5	07/11/03	Added wetlands	JE		
6	06/06/11	RENAMED A1/B2 TO A1N/B2N AND A1/B2N	TEC		
7	08/09/12	Updated A1/B2 – Chestnut Hill Taps 1&2 per Refurbishment Project – 04/2012	DRD		
8					

ORIGINAL	
DATE	
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

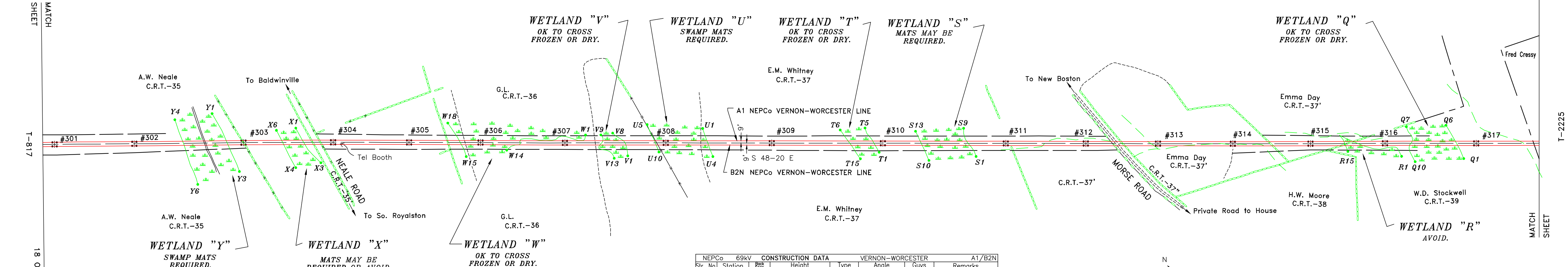
T-818-5

REVISIONS

REV	DATE	DESCRIPTION	MADE	CHK'D.	APP'D.
1		ORIGINAL			
2	07/14/61	Title Change	D.E.M.		
3	07/14/93	Digitized on AutoCad Release 12 by Infotech.	BMR		
4	06/18/03	Added Wetlands, Access and Wetlands Access Text.	J.F.H.		
5	06/07/11	RENAMED B2 LINE TO B2N	TEC		
6					
7					
8					

ORIGINAL: DATE, DESIGNED, CHECKED, SUPERVISOR, INSPECTED, REVIEWED, REVIEWED, APPROVED, APPROVED

ROYALSTON, MA



NEPCo 69kV CONSTRUCTION DATA VERNON-WORCESTER A1/B2N							
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#301	1128+44	338	40	BAY-SU			STEEL
#302	1131+81	337	40	BAY-SU			STEEL
#303	1136+46	465	40	BAY-SU			STEEL
#304	1140+32	386	40	BAY-SU			STEEL
#305	1143+51	319	40	BAY-DE			STEEL
#306	1146+57	306	40	BAY-SU			STEEL
#307	1150+16	359	40	BAY-SU			STEEL
#308	1154+47	431	50	BAY-SU			STEEL
#309	1159+00	453	40	BAY-SU			STEEL
#310	1163+72	472	40	BAY-SU			STEEL
#311	1168+93	521	40	BAY-SU			STEEL
#312	1172+32	339	40	BAY-SU			STEEL
#313	1175+38	306	40	BAY-SU			STEEL
#314	1178+61	323	40	BAY-SU			STEEL
#315	1181+88	327	40	BAY-SU			STEEL
#316	1185+07	319	40	BAY-SU			STEEL
#317	1188+93	386	40	BAY-SU			STEEL

INCHES ON ORIGINAL

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LINE WAS RELOCATED FROM T#318 to T#347 ON ACCOUNT OF BIRCHHILL RESERVOIR CONSTRUCTION WAS COMPLETED 1941

nationalgrid

MAP OF
#1 & #2 LINES
VERNON - WORCESTER

SHEET 19 OF 50 SHEETS

SCALE: 1"=200' DATE:

T-818-5

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REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
3	07/14/67	TITLE CHANGE	DEM		
4	07/23/97	DIGITIZED ON AUTOCAD RELEASE 12 by INFOTECH	BMR		
5	11/10/98	ADDED OTTER RIVER SUB STA & NORTH BALDWINVILLE TAP	JFH		
6	10/14/99	ADDED MATCH LINE ON A1/B2 TAP LINE	JFH		
7	07/25/03	ADDED WETLANDS AND NOTES	JE		
8	10/16/06	ADDED EXISTING ACCESS ROAD			
9	01/13/10	FI 863 – UPDATED A1/B2 TAP LINE, AND SHEET DATA	DRD		
10	06/08/11	RENAME A1 AND B2 LINES TO A1S AND B2N	TEC		

ORIGINAL

DATE 00/00/0000

DESIGNED

CHECKED

SUPERVISOR

INSPECTED

REVIEWED

REVIEWED

APPROVED

APPROVED

T–820–10

N.E.P.CO. CONSTRUCTION DATA A1/B2N

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#352	1320+82	400	40	BAY–SU			STEEL
#353	1324+24	342	40	BAY–SU			STEEL
#354	1327+59	335	40	BAY–DE			STEEL

N.E.P.CO. CONSTRUCTION DATA A1S/B2N

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#356	1331+52	99	40	BAY–SU	17° 50' L	2 R	STEEL
#357	1335+19	367	40	BAY–SU			STEEL
#358	1339+43	424	40	BAY–SU	12° 10' R	2L	STEEL

N.E.P.CO. CONSTRUCTION DATA A1S

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#354C	1330+53	130±	45	WOOD		1A	

N.E.P.CO. CONSTRUCTION DATA B2N

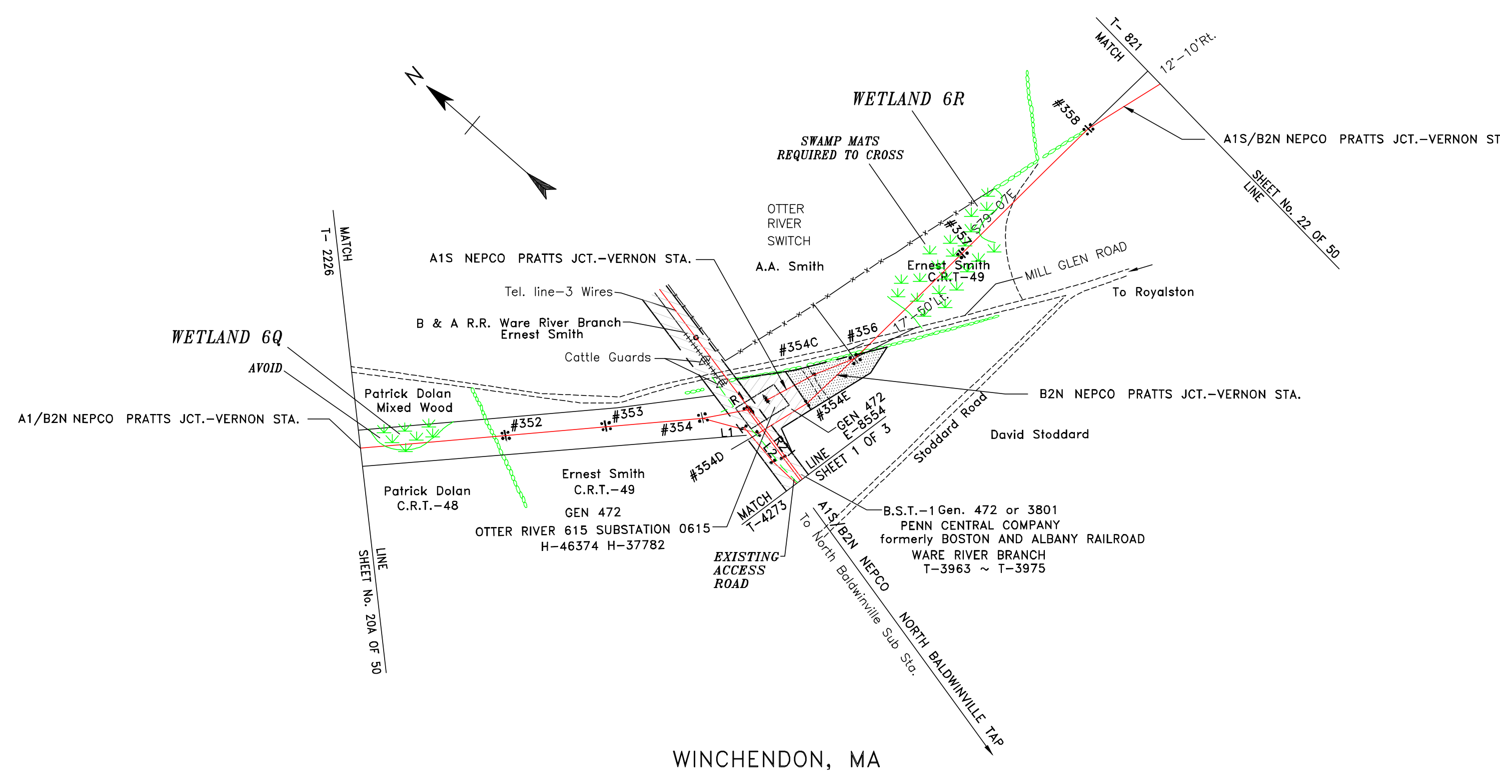
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#354E	1329+55	138±	55,55	WOOD		2H2B2A	
#354D	1325+55	116±	55,55	WOOD		2A	

N.E.P.CO. CONSTRUCTION DATA A1S N. BALDWINSVILLE TAP

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
L2	3+18	150	45/2,45/2	SWITCH		2H2B2S	
L1	1+68	–	40/2,40/2	T–DE		2B1A	

N.E.P.CO. CONSTRUCTION DATA B2N N. BALDWINSVILLE TAP

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
R2	3+8	150	45/2,45/2	SWITCH		2H2B2S	
R1	1+58	–	35/2,35/2	STEEL TAP			



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MAP OF

#1&#2 LINES VERNON–WORCESTER RIGHT OF WAY

SHEET 21 OF 50 SHEETS

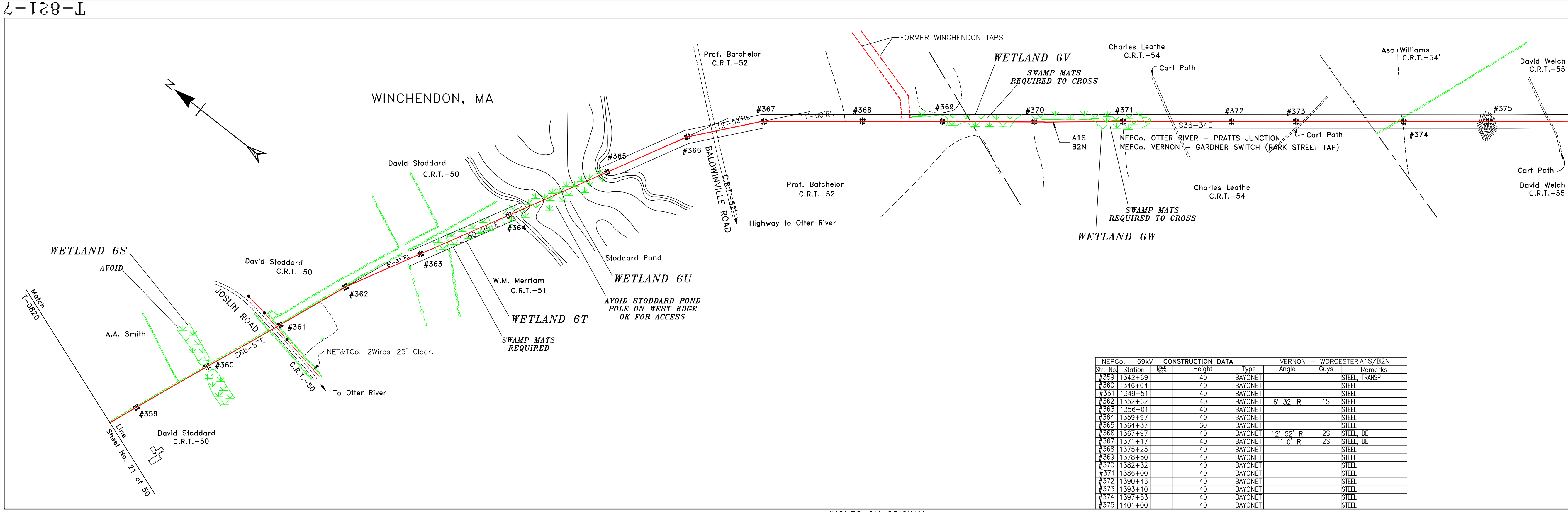
SCALE: 1"=200' DATE: 00/00/0000

INCHES ON ORIGINAL

T–820–10

REVISIONS

ORIGINAL		REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
DATE		1					
DESIGNED		2	09/30/41	Added Second Circuit on Winch. Tap & corrected one line diagram.	ALP		
CHECKED		3	07/14/69	TITLE CHANGE	DEM		
SUPERVISOR		4	07/14/97	Digitized on AutoCad Release 12 by Infotech.	BMR		
INSPECTED		5	04/21/03	Removed Winchendon Taps.	JFH		
REVIEWED		6	07/25/03	Added Wetlands and Notes	JE		
REVIEWED		7	05/14/15	CORRECT LINE NAME AND DESIGNATION	TEC		
APPROVED		8					
APPROVED							



NEPCo. 69kV CONSTRUCTION DATA				VERNON – WORCESTER A1S/B2N			
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#359	1342+69		40	BAYONET			STEEL, TRANSP
#360	1346+04		40	BAYONET			STEEL
#361	1349+51		40	BAYONET			STEEL
#362	1352+62		40	BAYONET	6° 32' R	1S	STEEL
#363	1356+01		40	BAYONET			STEEL
#364	1359+97		40	BAYONET			STEEL
#365	1364+37		60	BAYONET			STEEL
#366	1367+97		40	BAYONET	12° 52' R	2S	STEEL, DE
#367	1371+17		40	BAYONET	11° 0' R	2S	STEEL, DE
#368	1375+25		40	BAYONET			STEEL
#369	1378+50		40	BAYONET			STEEL
#370	1382+32		40	BAYONET			STEEL
#371	1386+00		40	BAYONET			STEEL
#372	1390+46		40	BAYONET			STEEL
#373	1393+10		40	BAYONET			STEEL
#374	1397+53		40	BAYONET			STEEL
#375	1401+00		40	BAYONET			STEEL

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MAP OF
#1 & #2 LINES
VERNON – WORCESTER

SHEET 22 OF 50 SHEETS

SCALE: 1"=200'
DATE:

T-821-7

INCHES ON ORIGINAL

T-822-6

NEPCo. 69kV CONSTRUCTION DATA				VERNON – WORCESTER			A1S/B2N
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#376	1405+80		40	BAYONET			STEEL
#377	1408+80		40	BAYONET			STEEL
#378	1412+31		40	BAYONET			STEEL
#379	1415+38		40	BAYONET			STEEL
#380	1418+58		40	BAYONET			STEEL
#381	1421+82		40	BAYONET			STEEL
#382	1425+02		40	BAYONET			STEEL
#383	1428+22		40	BAYONET			STEEL
#384	1431+75		40	BAYONET			STEEL
#385	1435+75		40	BAYONET			STEEL
#386	1438+60		40	BAYONET	1° –0' R		STEEL
#387	1441+95		40	BAYONET	1° –0' R		STEEL
#388	1445+75		40	BAYONET			STEEL
#389	1449+40		40	BAYONET			STEEL
#390	1452+83		40	BAYONET			STEEL
#391	1456+60		40	BAYONET			STEEL
#392	1460+69		40	BAYONET			STEEL
#393	1464+68		40	BAYONET		1A	STEEL
#394	1468+65		40	BAYONET			STEEL
#395	1472+38		40	BAYONET			STEEL

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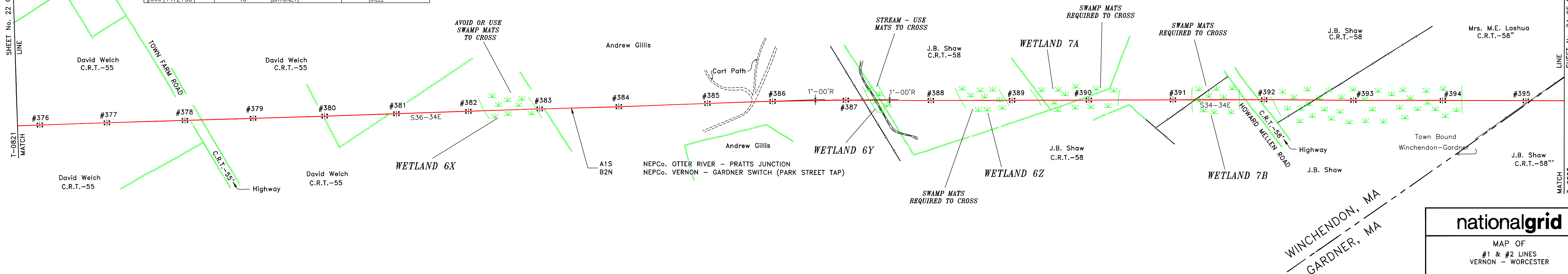

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MAP OF
#1 & #2 LINES
VERNON – WORCESTER

SHEET 23 OF 50 SHEETS

SCALE: 1"=200' DATE:

T-822-6

INCHES ON ORIGINAL

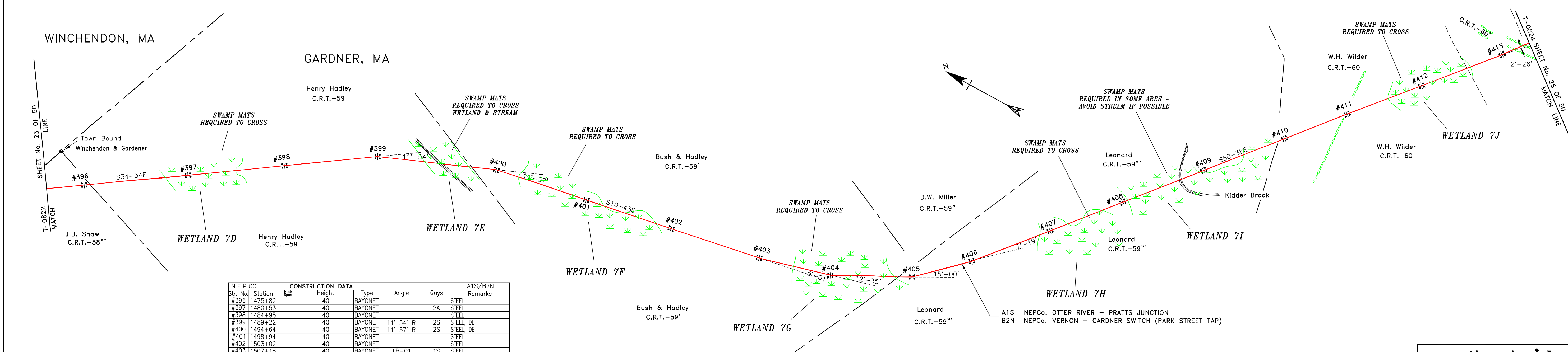
REVISIONS

REV	DATE	DESCRIPTION	MADE	CHK'D	APV'D
1	07/14/93	3 Title Change	DEM		
2	07/25/93	Digitized on AutoCad Release 12 by Infotech.	BMR		
3					
4					
5	07/28/03	Added Wetlands and Notes	JME		
6	05/14/15	CORRECT LINE NAME AND DESIGNATION	TEC		
7					
8					

ORIGINAL
DATE
DESIGNED
CHECKED
SUPERVISOR
INSPECTED
REVIEWED
REVIEWED
APPROVED
APPROVED

REVISIONS

ORIGINAL		REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
DATE							
DESIGNED		1					
CHECKED		2	09/30/41	Corrected as per field Data fur. by S.W.S.	ALP		
SUPERVISOR		3	07/14/67	TITLE CHANGE	DEM		
INSPECTED		4	07/14/97	Digitized on AutoCad Release 12 by Infotech.	BMR		
REVIEWED		5	07/28/03	ADDED WETLANDS AND NOTES	JE		
REVIEWED		6	05/15/15	CORRECT LINE NAME AND DESIGNATION	TEC		
APPROVED		7					
APPROVED		8					



N.E.P.CO.			CONSTRUCTION DATA				A1S/B2N
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#396	1475+82		40	BAYONET			STEEL
#397	1480+53		40	BAYONET		2A	STEEL
#398	1484+95		40	BAYONET			STEEL
#399	1489+22		40	BAYONET	11° 54' R	2S	STEEL, DE
#400	1494+64		40	BAYONET	11° 57' R	2S	STEEL, DE
#401	1498+94		40	BAYONET			STEEL
#402	1503+02		40	BAYONET			STEEL
#403	1507+18		40	BAYONET	LR-01	1S	STEEL
#404	1510+52		40	BAYONET	12° 35' L	2S	STEEL, DE
#405	1514+22		40	BAYONET	15° 0' L	2S	STEEL, DE
#406	1517+04		40	BAYONET	7° 19' L	1S	STEEL
#407	1520+86		40	BAYONET			STEEL
#408	1524+43		40	BAYONET			STEEL
#409	1528+36		40	BAYONET			STEEL
#410	1532+35		40	BAYONET			STEEL
#411	1535+44		40	BAYONET			STEEL
#412	1539+06		40	BAYONET			STEEL
#413	1543+00		40	BAYONET	2° 26' L		STEEL, DE

nationalgrid

MAP OF
#1 & #2 LINES
VERNON - WORCESTER

SHEET 24 OF 50 SHEETS

SCALE: 1"=200' DATE:

INCHES ON ORIGINAL

T-823-6

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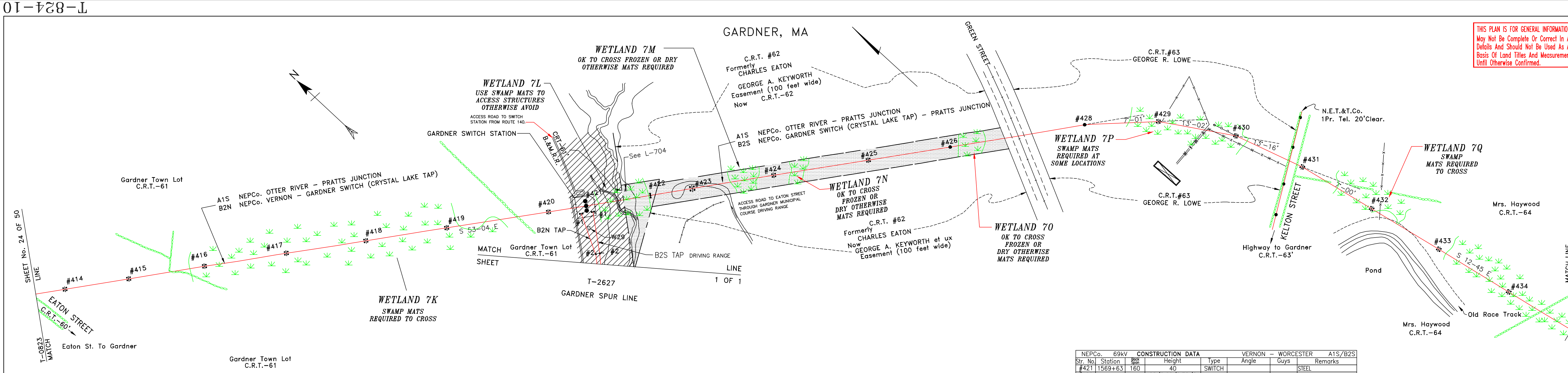


THIS PLAN IS FOR GENERAL INFORMATION. May Not Be Complete Or Correct In All Details And Should Not Be Used As A Basis Of Land Titles And Measurements Until Otherwise Confirmed.

NEPCo. 69kV **CONSTRUCTION DATA** VERNON – WORCESTER A1S/B2N							
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#414	1545+69		40	BAYONET			STEEL
#415	1548+65		40	BAYONET			STEEL
#416	1552+16		40	BAYONET			STEEL
#417	1555+92		40	BAYONET		1R–1L	STEEL
#418	1559+60		40	BAYONET		1R	STEEL
#419	1563+30		40	BAYONET			STEEL
#420	1568+03	473	40	BAYONET			STEEL
#421	1569+63	160	40	SWITCH			STEEL

NEPCo. 69kV **CONSTRUCTION DATA** GARDNER SPUR LINE B2N TAP							
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#1	0+00			BUS			NEW GARDNER SWITCH STA.
#2	1+95	195	50/2	DADI	3°41' Rt.	1A	

NEPCo. 69kV **CONSTRUCTION DATA** GARDNER SPUR LINE B2S TAP							
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#1	0+00			BUS			NEW GARDNER SWITCH STA.
#2	2+02	202	50/2	DADI	14°16' Rt.	1A	

NEPCo. 69kV **CONSTRUCTION DATA** VERNON – WORCESTER A1S/B2S							
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#421	1569+63	160	40	SWITCH			STEEL
#422	1572+63	300	60/2,60/2,70/2	DASI			X-BRACE
#423	1574+72	243	40	BAYONET			STEEL
#424	1578+52	378	40	BAYONET			STEEL
#425	1582+88	465	40	BAYONET			STEEL
#426	1586+62		70	POLE			STEEL
#428	1596+24		65	POLE	R7–01	2L	STEEL
#429	1596+24		40	BAYONET	R13–02	2L	STEEL
#430	1599+83		40	BAYONET	R13–16	2L	STEEL
#431	1603+16		40	BAYONET	R7–00	1L	STEEL
#432	1606+84		40	BAYONET			STEEL
#433	1610+42		40	BAYONET			STEEL
#434	1614+15		40	BAYONET			STEEL

INCHES ON ORIGINAL

REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
3	——	ADDED ROUTE 140 & GENERAL REVISIONS	RED		
4	07/14/97	DIGITIZED ON AUTOCAD RELEASE 12 by INFOTECH	BMR		
5	08/05/03	ADDED WETLANDS AND NOTES	JE		
6	01/07/05	REV'D GARDNER SWITCH STA. TAPS 1&2, A1/B2 STRUCT'S 420 THRU 423	JFH		
7	02/11/08	ADDED TOWER EXTENSION AT STR. 424	JFH		
8	10/22/09	FI 717 – UPDATED A1/B2 LINES, AND SHEET DATA	DRD		
9	05/15/15	CORRECT LINE NAME AND DESIGNATION	TEC		
10	11/23/16	C029828, 900000083838 – CHANGED SUBSTATION INFO	LET	PM	PEB

ORIGINAL DATE 06/19/1950
DESIGNED / CHECKED / SUPERVISOR / INSPECTED / REVIEWED / REVIEWED / APPROVED / APPROVED

nationalgrid

MAP OF
A1 & B2 LINES
VERNON–WORCESTER

SHEET 25 OF 50 SHEETS

SCALE: 1"=200' DATE: 06/19/1950

T–824–10

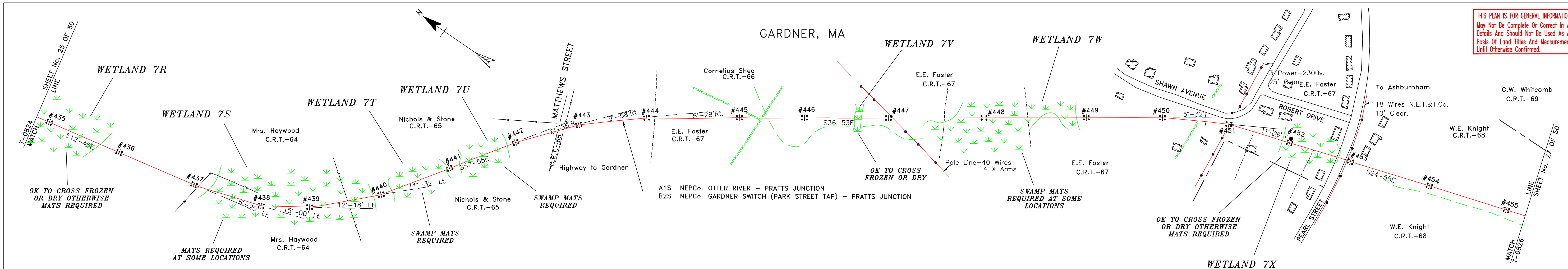
T–824–10

REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
1		INITIAL ISSUE			
2					
3	07/14/67	TITLE CHANGE	DEM		
4	07/23/97	Digitized on AutoCad Release 12 by Infotech.	BMR		
5	02/02/00	Added Robert Drive & Shawn Avenue	BMR		
6	06/17/03	REMOVED POLES NOS. #443A THRU #454A.	JFH		
7	07/25/03	Added Wetlands and Notes	JE		
8	05/18/15	CORRECT LINE NAME AND DESIGNATION	TEC		

ORIGINAL	
DATE	
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

THIS PLAN IS FOR GENERAL INFORMATION. May Not Be Complete Or Correct In All Details And Should Not Be Used As A Basis Of Land Titles And Measurements Until Otherwise Confirmed.



NEPCo 69kV CONSTRUCTION DATA					VERNON – WORCESTER		A1S/B2S
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#435	1617+99		40	BAYONET			STEEL
#436	1621+48		40	BAYONET			STEEL
#437	1625+19		40	BAYONET	6° 20' L	1R	STEEL
#438	1628+39		40	BAYONET	15° 00' L	2R	STEEL
#439	1630+64		40	BAYONET	12° 18' L	2R	STEEL
#440	1633+91		40	BAYONET	11° 32' L	2R	STEEL
#441	1637+28		40	BAYONET			STEEL
#442	1640+50		40	BAYONET	5° 36' R	1R	STEEL
#443	1643+48		40	BAYONET	9° 58' R	1L	STEEL
#444	1646+60		40	BAYONET	5° 28' R	1L	STEEL
#445	1650+83		40	BAYONET			STEEL
#446	1653+83		40	BAYONET			STEEL
#447	1657+63		40	BAYONET			STEEL
#448	1662+05		40	BAYONET			STEEL
#449	1666+72		40	BAYONET			STEEL
#450	1670+18		40	BAYONET	5° 32' R	1L	STEEL
#451	1673+26		40	BAYONET	11° 26' R	2L	STEEL
#452	1676+13		40	BAYONET			STEEL
#453	1679+04		40	BAYONET			STEEL
#454	1682+82		40	BAYONET			STEEL
#455	1686+50		40	BAYONET			STEEL

nationalgrid

MAP OF
#1 & #2 LINES
VERNON – WORCESTER

SHEET 26 OF 50 SHEETS

SCALE: 1"=200'

DATE:

INCHES ON ORIGINAL

PRINTED 5/18/2015 8:29 AM

REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
1		INITIAL ISSUE			
2					
3	07/13/67	TITLE CHANGE	DEM		
4	08/14/81	Added Route 140 Relocation	HES		
5	07/27/97	Digitized on AutoCad Release 12 by Infotech.	BMR		
6	06/17/03	REMOVED POLES NOS. #455A THRU #473A.	JFH		
7	08/04/03	Added Wetlands and Notes	JE		
8	05/18/15	CORRECT LINE NAME AND DESIGNATION	TEC		

ORIGINAL	
DATE	
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

T-826-8

NEPCo. 69kV CONSTRUCTION DATA					VERNON – WORCESTER A1S/B2S		
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#456	1690+13		40	BAYONET			STEEL
#457	1693+60		40	BAYONET	2° 16' R	1L	STEEL
#458	1697+45		40	BAYONET	0° 51' L		STEEL
#459	1701+07		40	BAYONET			STEEL
#460	1704+66		40	BAYONET			STEEL
#461	1708+30		40	BAYONET			STEEL
#462	1711+96		40	BAYONET			STEEL
#463	1715+99		40	BAYONET	8° 24' L	1L	STEEL
#464	1719+56		40	BAYONET			STEEL
#465	1723+09		40	BAYONET	16° 54' L	2R	STEEL
#466	1726+62		40	BAYONET			STEEL
#467	1730+06		40	BAYONET	8° 30' R	1L	STEEL
#468	1733+31		40	BAYONET			STEEL
#469	1737+39		40	BAYONET			STEEL
#470	1739+91		40	BAYONET	20° 57' L	2R	STEEL, DEADEND
#471-1	1744+84		75	DA-DE	63° 37' L		STEEL
#472-1	1747+96		75	DA-DE	36° 33' R	1R	STEEL
#473	1749+88=, 1750+93		40	BAYONET			STEEL
#474	1754+63		40	BAYONET			STEEL

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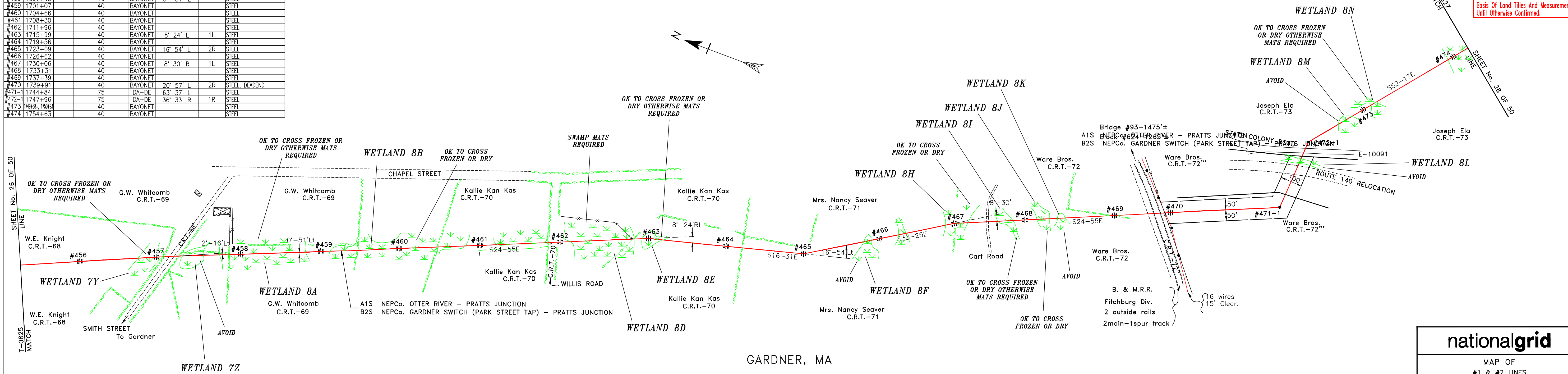


nationalgrid

MAP OF
#1 & #2 LINES
VERNON – WORCESTER

SHEET 27 OF 50 SHEETS

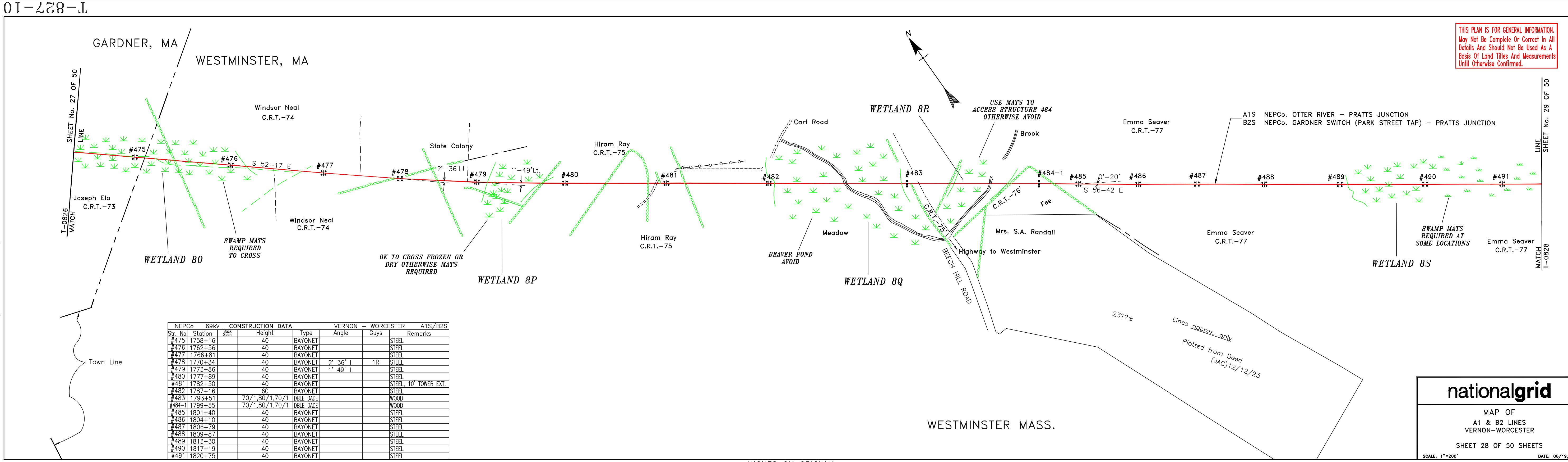
SCALE: 1"=200'   DATE:

INCHES ON ORIGINAL

T-826-8

REVISIONS

ORIGINAL		REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
DATE 06/19/1950							
DESIGNED		4	07/13/67	TITLE CHANGE	DEM		
CHECKED		5	07/14/97	DIGITIZED ON AUTOCAD RELEASE 12 by INFOTECH	BMR		
SUPERVISOR		6	06/17/03	REMOVED POLES NOS. #474A THRU #483A	JFH		
INSPECTED		7	08/04/03	ADDED WETLANDS AND NOTES	JE		
REVIEWED		8	02/11/08	ADDED TOWER EXTENSION AT STR.481	JFH		
REVIEWED		9	10/22/09	FI 717 – UPDATED A1/B2 LINES, AND SHEET DATA	DRD		
APPROVED		10	05/19/15	CORRECT LINE NAME AND DESIGNATION	TEC		
APPROVED		11	11/10/16	REPLACE & RELOCATE #483 AH 10' & #484-1 AH 175'	ML		



NEPCo 69kV CONSTRUCTION DATA				VERNON – WORCESTER			A1S/B2S
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#475	1758+16		40	BAYONET			STEEL
#476	1762+56		40	BAYONET			STEEL
#477	1766+81		40	BAYONET			STEEL
#478	1770+34		40	BAYONET	2° 36' L	1R	STEEL
#479	1773+86		40	BAYONET	1° 49' L		STEEL
#480	1777+89		40	BAYONET			STEEL
#481	1782+50		40	BAYONET			STEEL, 10' TOWER EXT.
#482	1787+16		60	BAYONET			STEEL
#483	1793+51		70/1,80/1,70/1	DBLE DADE			WOOD
#484-1	1799+55		70/1,80/1,70/1	DBLE DADE			WOOD
#485	1801+40		40	BAYONET			STEEL
#486	1804+10		40	BAYONET			STEEL
#487	1806+79		40	BAYONET			STEEL
#488	1809+87		40	BAYONET			STEEL
#489	1813+30		40	BAYONET			STEEL
#490	1817+19		40	BAYONET			STEEL
#491	1820+75		40	BAYONET			STEEL

nationalgrid

MAP OF
A1 & B2 LINES
VERNON–WORCESTER

SHEET 28 OF 50 SHEETS

SCALE: 1"=200' DATE: 06/19/1950

INCHES ON ORIGINAL

T-827-10

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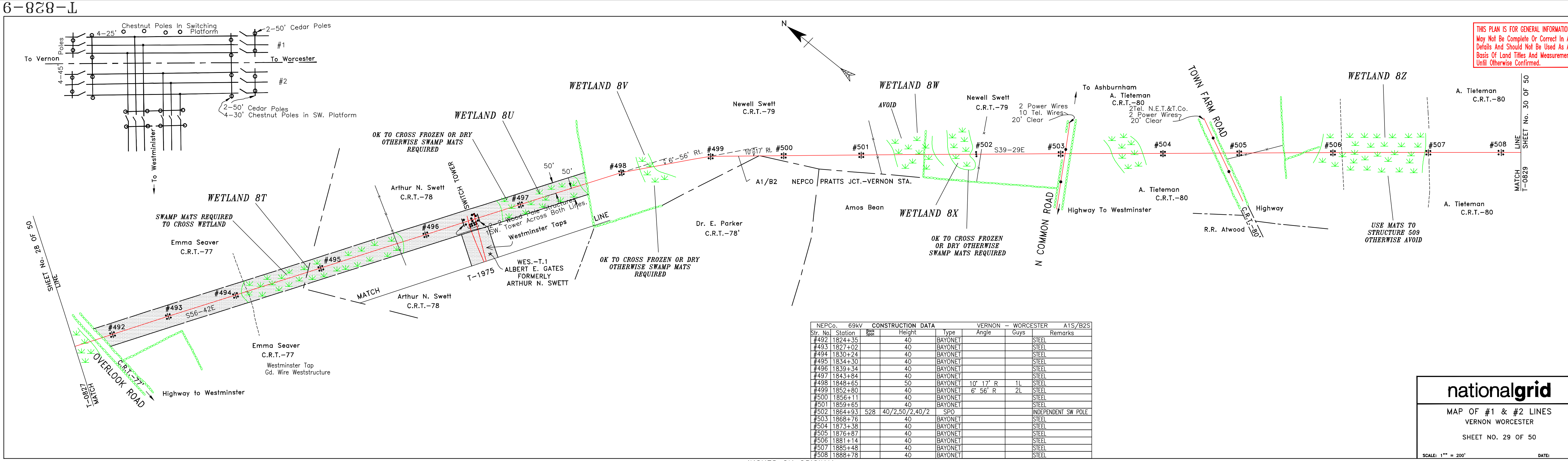
T-828-9



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NEPCo. 69kV CONSTRUCTION DATA				VERNON – WORCESTER A1S/B2S			
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#492	1824+35		40	BAYONET			STEEL
#493	1827+02		40	BAYONET			STEEL
#494	1830+24		40	BAYONET			STEEL
#495	1834+30		40	BAYONET			STEEL
#496	1839+34		40	BAYONET			STEEL
#497	1843+84		40	BAYONET			STEEL
#498	1848+65		50	BAYONET	10° 17' R	1L	STEEL
#499	1852+80		40	BAYONET	6° 56' R	2L	STEEL
#500	1856+11		40	BAYONET			STEEL
#501	1859+65		40	BAYONET			STEEL
#502	1864+93	528	40/2,50/2,40/2	SPO			INDEPENDENT SW POLE
#503	1868+76		40	BAYONET			STEEL
#504	1873+38		40	BAYONET			STEEL
#505	1876+87		40	BAYONET			STEEL
#506	1881+14		40	BAYONET			STEEL
#507	1885+48		40	BAYONET			STEEL
#508	1888+78		40	BAYONET			STEEL

INCHES ON ORIGINAL

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MAP OF #1 & #2 LINES
VERNON WORCESTER

SHEET NO. 29 OF 50

SCALE: 1" = 200'
DATE:

T-828-9

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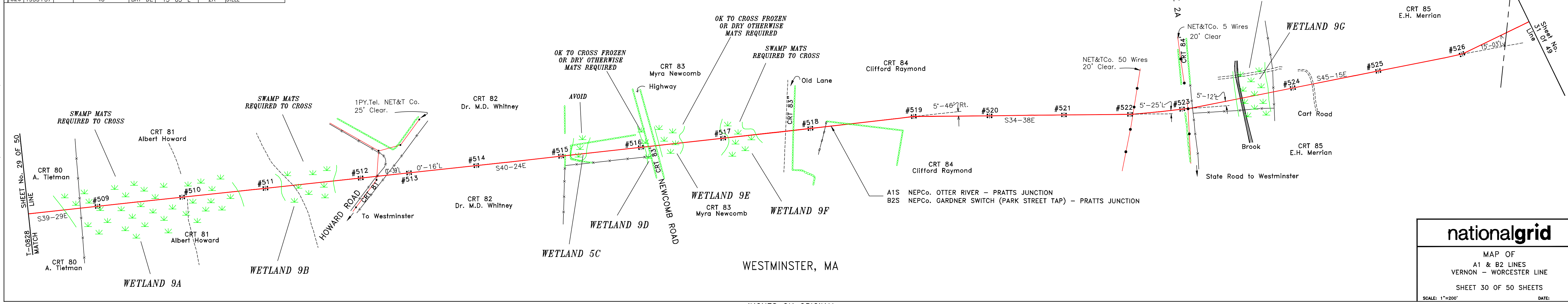
REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
2					
3	7/13/67	Title Change	DEM		
4	7/23/97	Digitized on AutoCad Release 12 by Infotech.	BMR		
5	6/17/03	REMOVED POLES NOS. #492A THRU #507A.	J.F.H.		
6	8/4/03	Added Wetlands and Notes	J.E.		
7	4/8/04	Revised Structure No. 502 per A1/B2 Transmission Line Refurbishment.	J.F.H.		
8	1/5/09	T1975 Match Line was T828	JE		
9	05/19/15	CORRECT LINE NAME AND DESIGNATION	TEC		

ORIGINAL	
DATE	
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

T-829-7

NEPCo. 69KV CONSTRUCTION DATA				VERNON – WORCESTER		A1S/B2S	
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#509	1892+86		40	BAY-SU			STEEL
#510	1896+73		40	BAY-SU			STEEL
#511	1900+54		40	BAY-SU			STEEL
#512	1904+93		40	BAY-DE	0° 39' L		STEEL
#513	1907+15		40	BAY-SU	0° 16' L		STEEL
#514	1910+22		40	BAY-SU			STEEL
#515	1914+12		40	BAY-SU			STEEL
#516	1917+78		40	BAY-SU			STEEL
#517	1919+57		40	BAY-SU			STEEL
#518	1925+57		50	BAY-SU			STEEL
#519	1930+32		40	BAY-SU	5° 46' R		STEEL
#520	1933+77		40	BAY-SU			STEEL
#521	1937+16		40	BAY-SU			STEEL
#522	1940+16		40	BAY-SU	5° 25' L	1R	STEEL
#523	1942+54		50	BAY-DE	5° 12' L	2R	STEEL
#524	1947+69		40	BAY-SU			STEEL
#525	1951+69		40	BAY-SU			STEEL
#526	1955+57		40	BAY-DE	15° 03' L	2R	STEEL



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REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
1					
2	10/29/41	Corrected as per field check by. R.W.F.	ALP		
3	07/13/67	Title Change	DEM		
4	07/23/97	Digitized on AutoCad Release 12 by Infotech.	BMR		
5	06/17/03	REMOVED POLES NOS. #508A THRU #526A.	J.F.H.		
6	08/05/03	Added Wetlands and Notes	J.E.		
7	04/08/11	UPDATED BORDER, BLOCKS AND FORMAT	TEC		
8	05/19/15	CORRECT LINE NAME AND DESIGNATION	TEC		

ORIGINAL	
DATE	
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

nationalgrid

MAP OF
A1 & B2 LINES
VERNON – WORCESTER LINE

SHEET 30 OF 50 SHEETS

SCALE: 1"=200' DATE:

INCHES ON ORIGINAL

T-829-7

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REVISIONS

ORIGINAL		REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
DATE	11/05/1926						
DESIGNED		3	——	ADDED INDUSTRIAL ROAD	EO'B		
CHECKED		4	06/10/77	ADD S.O. TO FLAGG POND SUB	HES		
SUPERVISOR		5	01/13/86	ADDED #313A STR. TO I-135/J-136 LINES, REMOVED TELE. LINE	AES		
INSPECTED		6	08/18/97	DIGITIZED ON AUTOCAD RELEASE 12 by INFOTECH	JFH		
REVIEWED		7	11/09/99	ADDED MATCH LINES	JFH		
REVIEWED		8	01/05/10	FI 950 – ADDED NEW STR.S OUTSIDE OF FLAGG POND SUB, UPDATED SHEET DATA	DRD		
APPROVED		9	02/12/10	UPDATED LINE INFORMATION	TEC		
APPROVED		10	06/21/10	I-135S & J-136S RECONDUCTORING AND SHIELDWIRE REPLACEMENT – AS-BUILT	TY	PEB	LRG

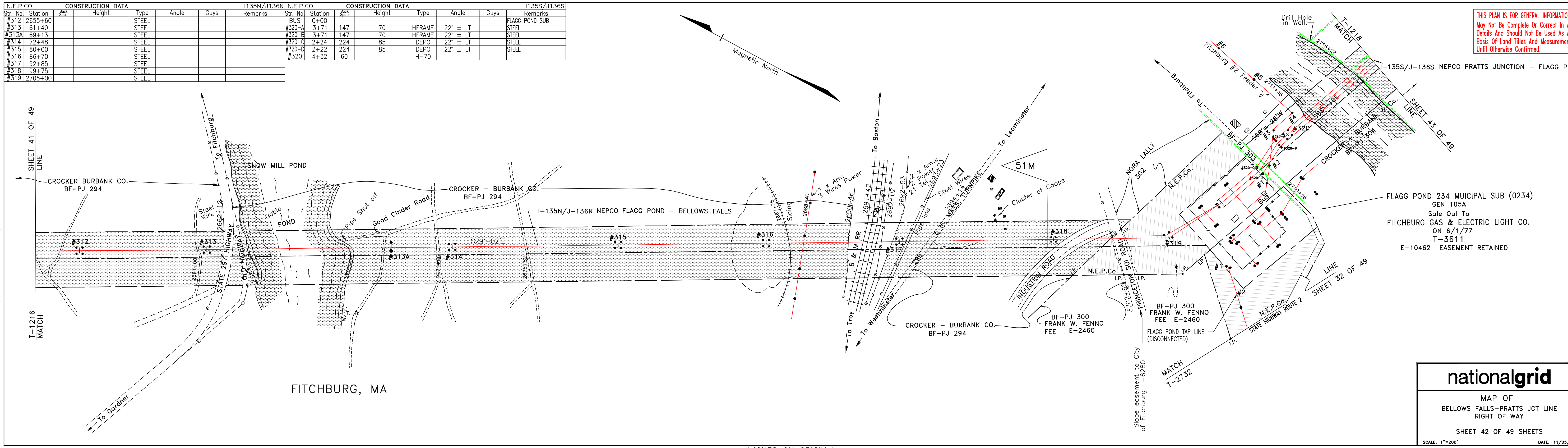
T-1217-10

N.E.P.CO. CONSTRUCTION DATA I135N/J136N

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#312	2655+60			STEEL			
#313	61+40			STEEL			
#313A	69+13			STEEL			
#314	72+48			STEEL			
#315	80+00			STEEL			
#316	86+70			STEEL			
#317	92+85			STEEL			
#318	99+75			STEEL			
#319	2705+00			STEEL			

N.E.P.CO. CONSTRUCTION DATA I135S/J136S

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
BUS	0+00						FLAGG POND SUB
#320-A	3+71	147	70	HFRAME	22° ± LT		STEEL
#320-B	3+71	147	70	HFRAME	22° ± LT		STEEL
#320-C	2+24	224	85	DEPO	22° ± LT		STEEL
#320-D	2+22	224	85	DEPO	22° ± LT		STEEL
#320	4+32	60		H-70			



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MAP OF
BELLOWS FALLS–PRATTS JCT LINE
RIGHT OF WAY

SHEET 42 OF 49 SHEETS

SCALE: 1"=200' DATE: 11/05/1926

T-1217-10

INCHES ON ORIGINAL

REVISIONS

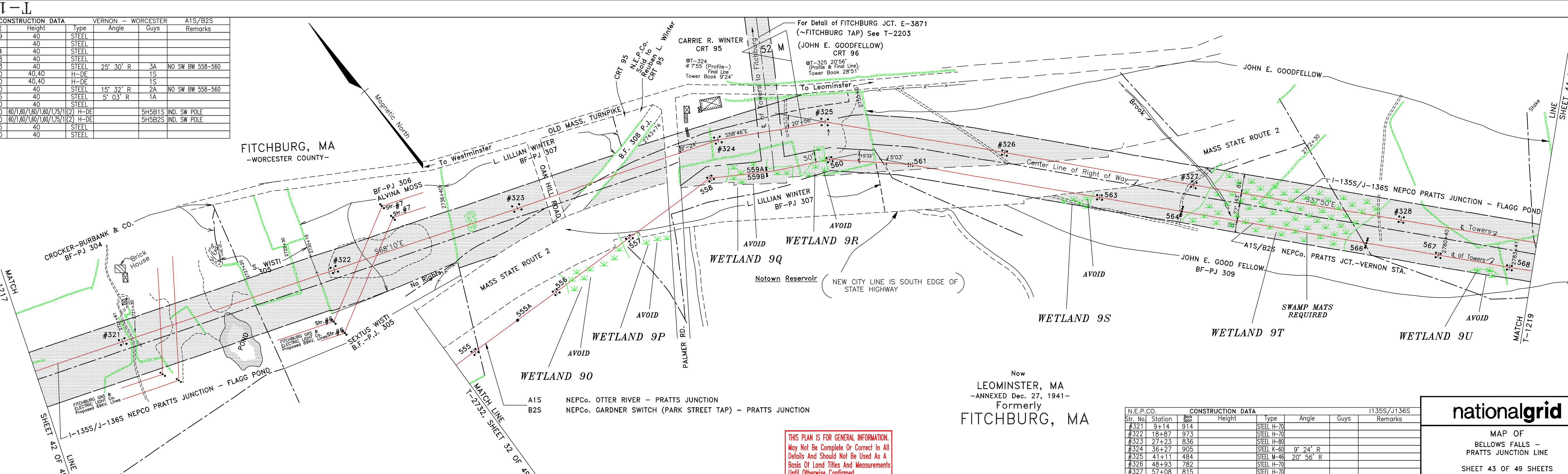
REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
4	11/09/99	Added Match Lines And Revised Construction Data Boxes.	J.F.H.		
5	08/05/03	Added Wetlands and Notes	J.E.		
6	06/21/10	I-135S & J-136S RECONDUCTORING AND SHIELDWIRE REPLACEMENT – AS-BUILT	TY	PEB	LRG
7	08/10/10	C31990, 9000092629 – A1/B2 ICE STORM PERMANENT REPAIRS	TEC		
8	02/07/11	C31990, 9000092629 – A1/B2 ICE STORM PERMANENT REPAIRS – AS BUILT	TEC		
9	10/02/14	C044056, 9000124345 – SWITCHES REMOVED PER 400299-C-H-01	TEC		
10	02/12/15	C044056, 9000124345 – A1/B2 Fitchburg Switch Replacement – AsBuilt	ML		
11	10/16/15	CORRECT LINE NAME AND DESIGNATION, A1S/B2S LINES	TEC		

ORIGINAL	
DATE	
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

T-1218-11

NEPCo. 69Kv CONSTRUCTION DATA VERNON – WORCESTER A1S/B2S

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
555	2075+32	359	40	STEEL			
555A			40	STEEL			
556	2079+66	434	40	STEEL			
557	2083+54	378	40	STEEL			
558	2087+47	393	40	STEEL	25° 30' R	3A	NO SW BW 558-560
559A	2090+17	270	40,40	H-DE		1S	
559B	2090+17	270	40,40	H-DE		1S	
560	2093+17	300	40	STEEL	15° 32' R	2A	NO SW BW 558-560
561	2096+62	345	40	STEEL	5° 03' R	1A	
563	2104+72	810	40	STEEL			
564	2108+02	330	60/1,60/1,60/1,60/1,75/1	(2) H-DE		5H5B1S	IND. SW POLE
566	2116+22	820	60/1,60/1,60/1,60/1,75/1	(2) H-DE		5H5B2S	IND. SW POLE
567	2119+67	345	40	STEEL			
568	2122+22	310	40	STEEL			



THIS PLAN IS FOR GENERAL INFORMATION. May Not Be Complete Or Correct In All Details And Should Not Be Used As A Basis Of Land Titles And Measurements Until Otherwise Confirmed.

N.E.P.CO. CONSTRUCTION DATA I135S/J136S

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#321	9+14	914		STEEL H-70			
#322	18+87	973		STEEL H-70			
#323	27+23	836		STEEL H-80			
#324	36+27	905		STEEL K-60	9° 24' R		
#325	41+11	484		STEEL M-46	20° 56' R		
#326	48+93	782		STEEL H-70			
#327	57+08	815		STEEL H-70			
#328	66+23	915		STEEL H-70			

nationalgrid

MAP OF
BELLOWS FALLS –
PRATTS JUNCTION LINE

SHEET 43 OF 49 SHEETS

SCALE: 1"=200' DATE: 11/15/1926

T-1218-11

INCHES ON ORIGINAL

PRINTED 10/16/2015 11:07 AM

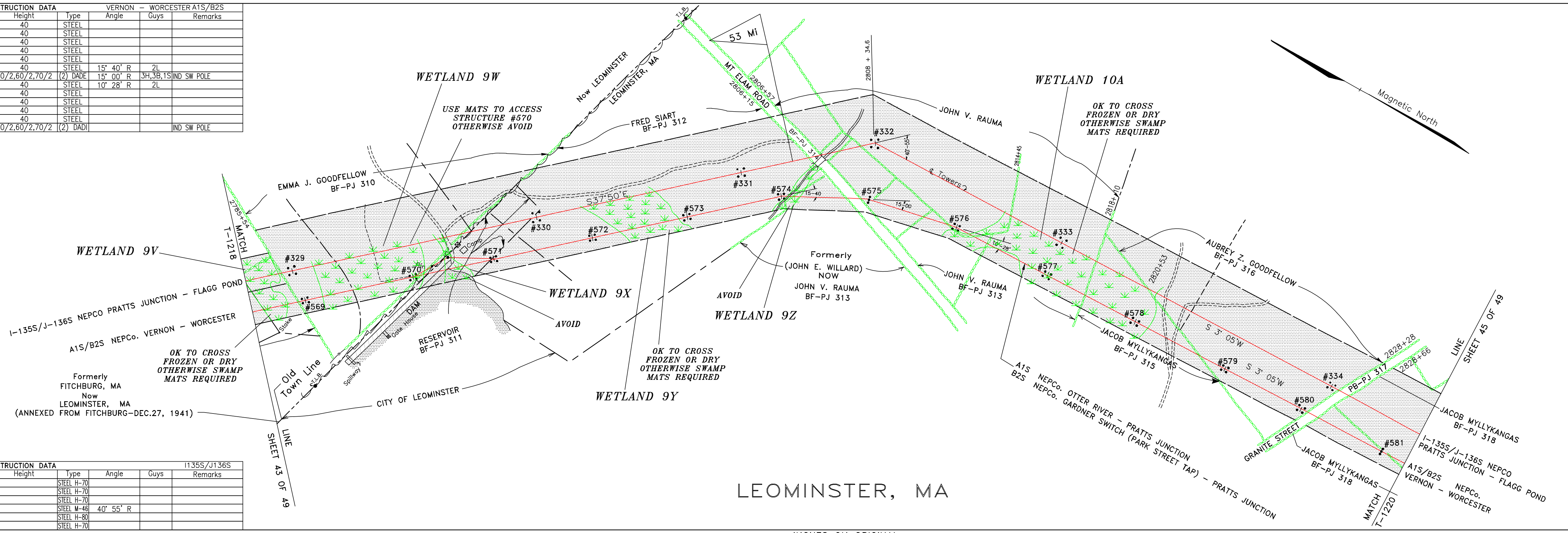
REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
2	06/23/50	Town Line Changed	C.M.B.		
3	08/18/97	Digitized on AutoCad Release 12 by Infotech.	J.F.H.		
4	11/10/99	Added Match Lines.	J.F.H.		
5	01/31/00	Revised A1 & B2 Construction Data.	J.F.H.		
6	08/11/03	Added Wetands and Notes	JME		
7	06/21/10	I-135S & J-136S RECONDUCTORING AND SHIELDWIRE REPLACEMENT - AS-BUILT	TY	PEB	LRG
8	08/10/10	C31990, 9000092629 - A1/B2 ICE STORM PERMANENT REPAIRS	TEC		
9	05/19/15	CORRECT LINE NAME AND DESIGNATION, A1S/B2S LINES	TEC		

ORIGINAL	DATE
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

T-1219-9

NEPCo. 69kV CONSTRUCTION DATA				VERNON - WORCESTER A1S/B2S			
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#569	2125+85	308	40	STEEL			
#570	2130+04	419	40	STEEL			
#571	2133+17	313	40	STEEL			
#572	2137+03	386	40	STEEL			
#573	2140+73	370	40	STEEL			
#574	2144+43	370	40	STEEL	15° 40' R	2L	
#575	2147+89	346	60/2,60/2,70/2	(2) DADE	15° 00' R	3H,3B,1S	IND SW POLE
#576	2151+30	351	40	STEEL	10° 28' R	2L	
#577	2155+80	388	40	STEEL			
#578	2158+98	380	40	STEEL			
#579	2162+83	385	40	STEEL			
#580	2166+12	329	40	STEEL			
#581	2169+68	356	60/2,60/2,70/2	(2) DADI			IND SW POLE



N.E.P.CO. CONSTRUCTION DATA				I135S/J136S			
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#329	73+98	774		STEEL H-70			
#330	83+37	940		STEEL H-70			
#331	91+31	794		STEEL H-70			
#332	96+53	521		STEEL M-46	40° 55' R		
#333	104+49	796		STEEL H-80			
#334	115+00	1051		STEEL H-70			

nationalgrid

MAP OF
BELLOWS FALLS - PRATTS JUNCTION LINE

SHEET 44 OF 49 SHEETS

SCALE: 1"=200'

DATE: 11/15/1926

T-1219-9

INCHES ON ORIGINAL

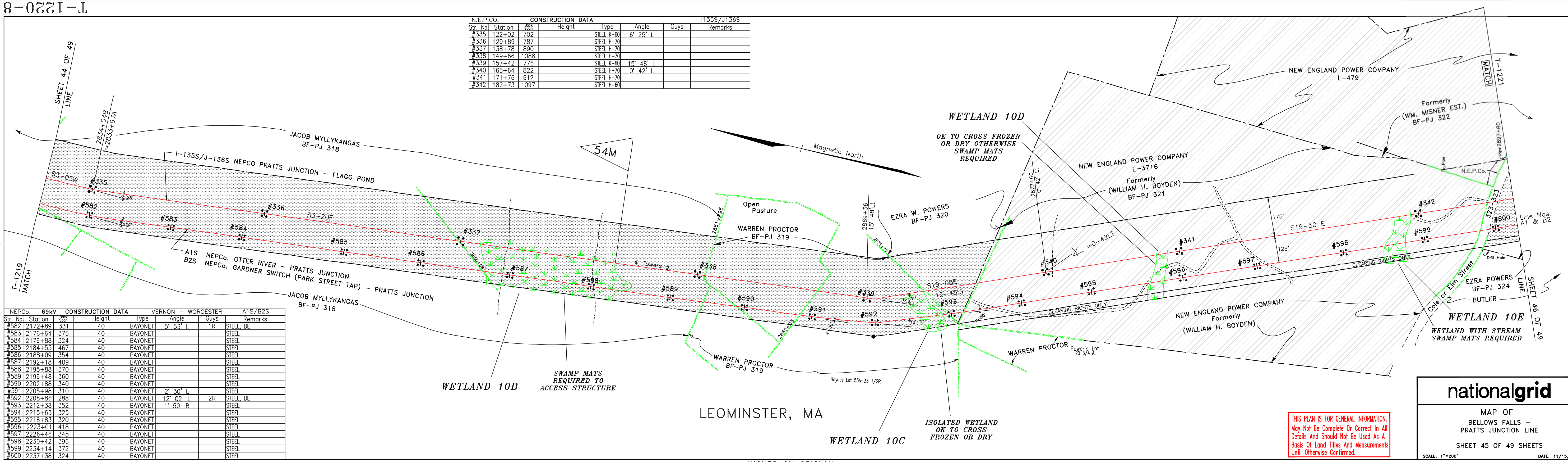
REVISIONS

ORIGINAL		REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
DATE							
DESIGNED		1					
CHECKED		2	10/10/97	Digitized on AutoCad Release 12 by Infotech.	BMR		
SUPERVISOR		3	11/16/99	Added Match Lines.	J.F.H.		
INSPECTED		4	01/31/00	Revised A1 & B2 Construction Data.	J.F.H.		
REVIEWED		5	08/12/03	Added Wetlands and Notes	JME		
REVIEWED		6	06/21/10	I-135S & J-136S RECONDUCTORING AND SHIELDWIRE REPLACEMENT – AS-BUILT	TY	PEB	LRG
APPROVED		7	08/10/10	C31990, 9000092629 – A1/B2 ICE STORM PERMANENT REPAIRS	TEC		
APPROVED		8	05/20/15	CORRECT LINE NAME AND DESIGNATION, A1S/B2S LINES	TEC		

T-1220-8

N.E.P.CO. **CONSTRUCTION DATA** I135S/J136S

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#335	122+02	702		STEEL K-60	6° 25' L		
#336	129+89	787		STEEL H-70			
#337	138+78	890		STEEL H-70			
#338	149+66	1088		STEEL H-70			
#339	157+42	776		STEEL K-60	15° 48' L		
#340	165+64	822		STEEL H-70	0° 42' L		
#341	171+76	612		STEEL H-70			
#342	182+73	1097		STEEL H-60			



NEPCo. **69kV CONSTRUCTION DATA** VERNON – WORCESTER A1S/B2S

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#582	2172+89	331	40	BAYONET	5° 53' L	1R	STEEL, DE
#583	2176+64	375	40	BAYONET			STEEL
#584	2179+88	324	40	BAYONET			STEEL
#585	2184+55	467	40	BAYONET			STEEL
#586	2188+09	354	40	BAYONET			STEEL
#587	2192+18	409	40	BAYONET			STEEL
#588	2195+88	370	40	BAYONET			STEEL
#589	2199+48	360	40	BAYONET			STEEL
#590	2202+88	340	40	BAYONET			STEEL
#591	2205+98	310	40	BAYONET	2° 30' L		STEEL
#592	2208+86	288	40	BAYONET	12° 02' L	2R	STEEL, DE
#593	2212+38	352	40	BAYONET	1° 50' R		STEEL
#594	2215+63	325	40	BAYONET			STEEL
#595	2218+83	320	40	BAYONET			STEEL
#596	2223+01	418	40	BAYONET			STEEL
#597	2226+46	345	40	BAYONET			STEEL
#598	2230+42	396	40	BAYONET			STEEL
#599	2234+14	372	40	BAYONET			STEEL
#600	2237+38	324	40	BAYONET			STEEL

INCHES ON ORIGINAL

THIS PLAN IS FOR GENERAL INFORMATION. May Not Be Complete Or Correct In All Details And Should Not Be Used As A Basis Of Land Titles And Measurements Untill Otherwise Confirmed.

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MAP OF
BELLOWS FALLS – PRATTS JUNCTION LINE

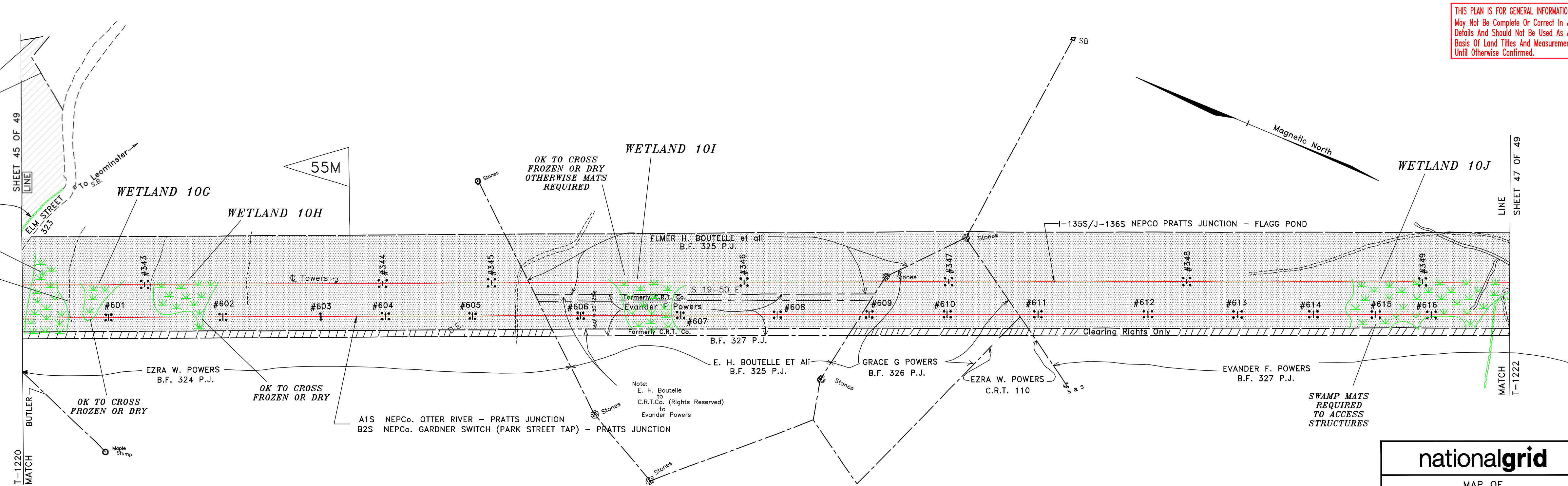
SHEET 45 OF 49 SHEETS

SCALE: 1"=200' DATE: 11/15/1926

T-1220-8

T-1221-9

N.E.P.CO.		CONSTRUCTION DATA					I135S/J136S
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#343	191+33	840		STEEL H-70			
#344	199+84	871		STEEL H-60			
#345	203+79	394		STEEL H-60			
#346	213+05	927		STEEL H-80			
#347	220+55	749		STEEL H-70			
#348	229+26	871		STEEL H-70			
#349	237+85	860		STEEL H-70			



THIS PLAN IS FOR GENERAL INFORMATION. May Not Be Complete Or Correct In All Details And Should Not Be Used As A Basis Of Land Titles And Measurements Until Otherwise Confirmed.

NEPCo.	69kV	CONSTRUCTION DATA			VERNON – WORCESTER		A1S/B2S
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#601	2241+56	418	40	BAYONET			STEEL
#602	2245+71	415	40	BAYONET			STEEL
#603	2249+37	366	50/2,60/2,50/2	DASI			INDEPENDENT SW POLE
#604	2251+68	231	40	BAYONET			STEEL
#605	2254+90	322	40	BAYONET			STEEL, DE
#606	2258+82	392	40	BAYONET			STEEL
#607	2262+45	363	40	BAYONET			STEEL
#608	2266+03	358	40	BAYONET			STEEL
#609	2269+39	336	40	BAYONET			STEEL
#610	2272+22	283	40	BAYONET			STEEL
#611	2275+52	330	40	BAYONET			STEEL
#612	2279+55	403	40	BAYONET			STEEL
#613	2282+83	328	40	BAYONET			STEEL
#614	2285+62	279	40	BAYONET			STEEL
#615	2287+90	228	40	BAYONET			STEEL
#616	2289+91	201	40	BAYONET			STEEL, TRANSP. #3

REVISIONS

ORIGINAL		REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
DATE							
DESIGNED		2	03/21/45	Property lines & shading corrected.	CEB.		
CHECKED		3	10/10/97	Digitized on AutoCad Release 12 by Infotech.	BMR		
SUPERVISOR		4	11/16/99	Added Match Lines.	J.F.H.		
INSPECTED		5	01/31/00	Revised A1 & B2 Construction Data.	J.F.H.		
REVIEWED		6	08/11/03	Added Wetlands and Notes	JME		
REVIEWED		7	04/08/04	Rev'd. Structure No.603 per A1/B2 Transmission Line Refurbishment.	J.F.H.		
APPROVED		8	06/21/10	I-135S & J136S RECONDUCTORING AND SHIELDWIRE REPLACEMENT – AS-BUILT	TY	PEB	LRG
APPROVED		9	05/20/15	CORRECT LINE NAME AND DESIGNATION, A1S/B2S LINES	TEC		

LEOMINSTER, MA

INCHES ON ORIGINAL

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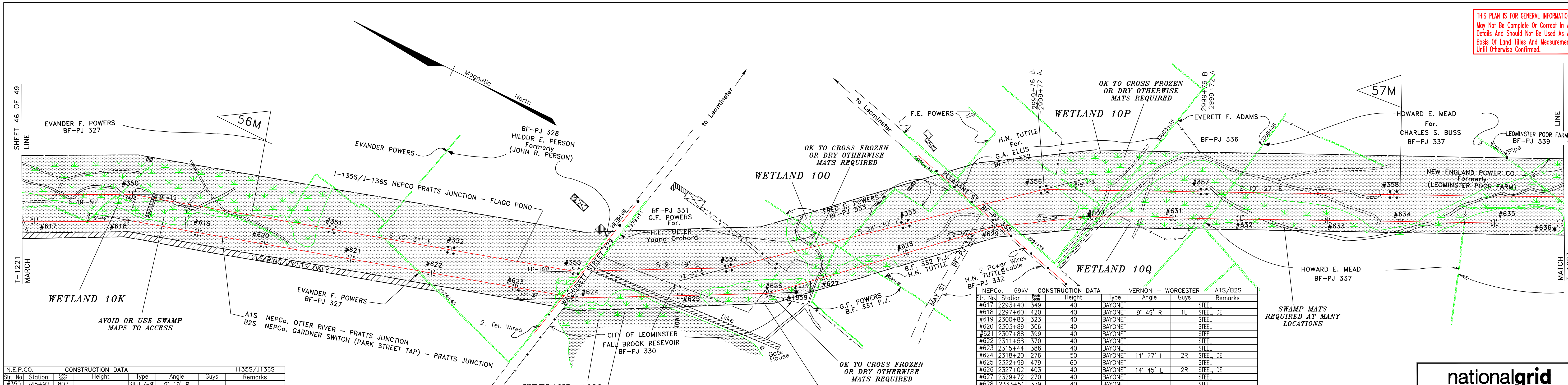
MAP OF
BELLOWS FALLS –
PRATTS JUNCTION LINE

SHEET 46 OF 49 SHEETS

SCALE: 1"=200' DATE: 11/15/1926

T-1221-9

T-1222-8



N.E.P.CO.			CONSTRUCTION DATA				I135S/J136S
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#350	245+92	807		STEEL K-60	9° 19' R		
#351	255+15	923		STEEL H-60			
#352	260+66	550		STEEL H-60			
#353	266+37	571		STEEL K-60	11° 18' L		
#354	372+32	695		STEEL K-60	12° 41' L		
#355	281+70	838		STEEL H-60			
#356	287+79	609		STEEL K-60	12° 3' R		
#357	295+20	742		STEEL H-80			
#358	303+99	879		STEEL H-80			

NEPCo. 69kV			CONSTRUCTION DATA		VERNON – WORCESTER		A1S/B2S
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#617	2293+40	349	40	BAYONET			STEEL
#618	2297+60	420	40	BAYONET	9° 49' R	1L	STEEL, DE
#619	2300+83	323	40	BAYONET			STEEL
#620	2303+89	306	40	BAYONET			STEEL
#621	2307+88	399	40	BAYONET			STEEL
#622	2311+58	370	40	BAYONET			STEEL
#623	2315+44	386	40	BAYONET			STEEL
#624	2318+20	276	50	BAYONET	11° 27' L	2R	STEEL, DE
#625	2322+99	479	60	BAYONET			STEEL
#626	2327+02	403	40	BAYONET	14° 45' L	2R	STEEL, DE
#627	2329+72	270	40	BAYONET			STEEL
#628	2333+51	379	40	BAYONET			STEEL
#629	2337+71	420	60	BAYONET	9° 56' R	2L	STEEL, DE
#630	2342+14	443	40	BAYONET	7° 04' R	1L	STEEL
#631	2345+88	374	40	BAYONET			STEEL
#632	2348+93	305	40	BAYONET			STEEL
#633	2352+87	394	40	BAYONET			STEEL
#634	2356+18	331	40	BAYONET			STEEL
#635	2360+43	425	40	BAYONET			STEEL
#636	2363+33	290	40	BAYONET	13° 38' L	2R	STEEL, DE

REVISIONS

ORIGINAL	REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
DESIGNED	1					
CHECKED	2	08/18/97	Digitized on AutoCad Release 12 by Infotech.	J.F.H.		
SUPERVISOR	3	11/17/99	Added Match Line.	J.F.H.		
INSPECTED	4	01/31/00	Revised A1 & B2 Construction Data.	J.F.H.		
REVIEWED	5	08/11/03	Added Wetlands and Notes	JE		
REVIEWED	6	06/11/10	UPDATED SHEET DATA	TEC		
APPROVED	7	06/21/10	I-135S & J136S RECONDUCTORING AND SHIELDWIRE REPLACEMENT – AS-BUILT	TY	PEB	LRG
APPROVED	8	05/20/15	CORRECT LINE NAME AND DESIGNATION, A1S/B2S LINES	TEC		

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MAP OF
BELLOWS FALLS – PRATTS JUNCTION LINE

SHEET 47 OF 49 SHEETS

SCALE: 1"=200' DATE: 11/15/1926

INCHES ON ORIGINAL

T-1222-8

REVISIONS

ORIGINAL		REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
DATE	11/15/1926	8	08/11/03	ADDED WETLANDS AND NOTES	JFH		
DESIGNED		9	02/19/04	ADDED WETLAND AND NOTE	JFH		
CHECKED		10	09/29/04	ADDED/REVISED WETLANDS	JE		
SUPERVISOR		11	10/04/04	WETLANDS, ACCESS & WETLANDS ACCESS TEXT ADDED	TRC		
INSPECTED		12	12/19/08	MATCH LINE TEXT REVISED	TRC		
REVIEWED		13	10/22/09	FI 717 – UPDATED A1 & B2 LINES, AND SHEET DATA	DRD		
REVIEWED		14	06/21/10	I-135S & J-136S RECONDUCTORING AND SHIELDWIRE REPLACEMENT – AS-BUILT	TY	PEB	LRG
APPROVED		15	12/30/10	E205 REFURB: From #523 to Pratts Jct.; Design As-Built Updates.	CAI		
APPROVED							

T-1223-15

N.E.P.CO.	CONSTRUCTION DATA						I135S/J136S
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#359	311+93	794		STEEL M-46	19° 30' I		
#360	320+57	864		STEEL H-60			
#361	329+03	846		STEEL H-60			
#362	337+89	886		STEEL H-70			
#363	343+55	566		STEEL H-60			
#364	350+84	729		STEEL H-60			
#365	358+64	780		STEEL H-70			
#366	367+64	901		STEEL H-70			
#367	376+52	888		STEEL K-60	5° 17' R		

N.E.P.CO. 230kV	CONSTRUCTION DATA				NY-PJ		E-205E
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#1079	3695+93	559	80,80,80	3P-DE	047 28 57 R	3H3B4A	CART ROAD
#1080	3700+49	456	80,80	SUSP	0		CART ROAD/AERIAL MARKER/X-Brace
#1081	3705+73	524	75,75	SUSP	0		CART ROAD/X-Brace
#1082	3710+03	430	70,70	SUSP	0		X-Brace
#1083	3712+27	223	70,70,70	3P-DE	005 09 40 R	3H3B4A	

WETLAND DETERMINATION BOUNDARY

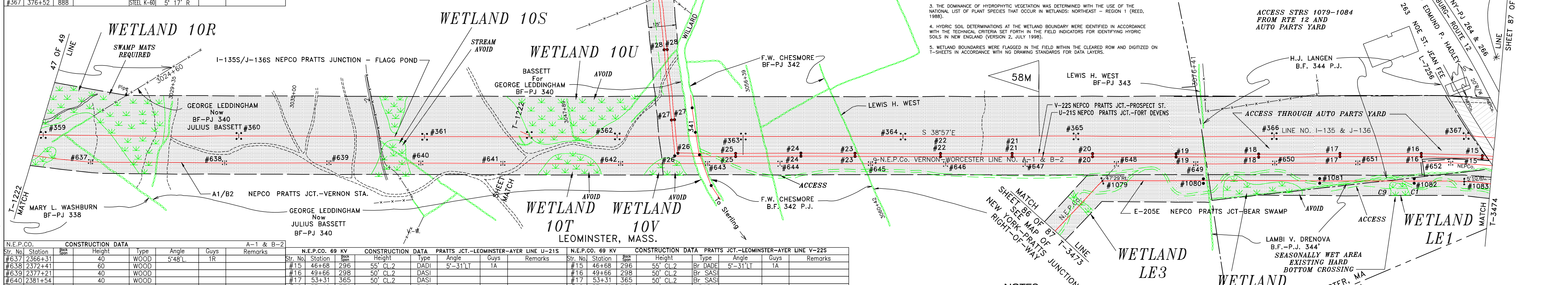
1. THE WETLAND RESOURCE BOUNDARY DETERMINATION WAS CONDUCTED BY TRC ENVIRONMENTAL CORPORATION DURING SEPTEMBER 2004.

2. WETLAND RESOURCES WERE IDENTIFIED AND FLAGGED IN ACCORDANCE WITH RESOURCE DEFINITIONS AND DELINEATION CRITERIA IN THE WETLANDS PROTECTION ACT REGULATIONS (310 CMR 10.54–10.58). THE WETLAND BOUNDARY DETERMINATION WAS ALSO GENERALLY CONDUCTED USING THE THREE-PARAMETER APPROACH CONSISTENT WITH THE FEDERAL WETLAND DELINEATION METHODOLOGY. OBVIOIUS WETLANDS WITH DISTINCT HYDROPHYTIC VEGETATION AND A DISTINCT BREAK IN TOPOGRAPHY, AND/OR INUNDATION WERE FLAGGED. IN AREAS WHERE THE WETLAND BOUNDARY WAS LESS DISTINCT BY VEGETATION CHARACTERIZATION, HYDRIC SOIL DETERMINATIONS WERE MADE.

3. THE DOMINANCE OF HYDROPHYTIC VEGETATION WAS DETERMINED WITH THE USE OF THE NATIONAL LIST OF PLANT SPECIES THAT OCCUR IN WETLANDS: NORTHEAST – REGION 1 (REED, 1988).

4. HYDRIC SOIL DETERMINATIONS AT THE WETLAND BOUNDARY WERE IDENTIFIED IN ACCORDANCE WITH THE TECHNICAL CRITERIA SET FORTH IN THE FIELD INDICATORS FOR IDENTIFYING HYDRIC SOILS IN NEW ENGLAND (VERSION 2, JULY 1998).

5. WETLAND BOUNDARIES WERE FLAGGED IN THE FIELD WITHIN THE CLEARED ROW AND DIGITIZED ON T-SHEETS IN ACCORDANCE WITH NG DRAWING STANDARDS FOR DATA LAYERS.



N.E.P.CO.	CONSTRUCTION DATA						A-1 & B-2
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#637	2366+31		40	WOOD	5°48'L.	1R	
#638	2372+41		60	WOOD			
#639	2377+21		40	WOOD			
#640	2381+54		40	WOOD			
#641	2385+26			WOOD			
#642	2390+65		40	WOOD			
#643	2394+60		40	WOOD			
#644	2397+93		40	WOOD			
#645	2402+05		40	WOOD			
#646	2405+49		40	WOOD			
#647	2409+11		40	WOOD			
#648	2413+30		40	WOOD			
#649	2416+85		40	WOOD			
#650	2420+41		40	WOOD			10' TOWER EXTENSION INST.
#651	2424+09		40	WOOD			
#652	2427+91		40	WOOD	3°18'R.		

N.E.P.CO. 69 KV	CONSTRUCTION DATA		PRATTS JCT.-LEOMINSTER-AYER LINE U-21S				
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#15	46+68	296	55' CL.2	DADI	5°-31'LT	1A	
#16	49+66	298	50' CL.2	DASI			
#17	53+31	365	50' CL.2	DASI			
#18	57+10	379	45' CL.2	DASI			
#19	60+79	369	45' CL.2	DASI			
#20	64+56	377	50' CL.2	DASI			
#21	68+20	364	45' CL.2	DASI			
#22	71+52	332	50' CL.2	DASI			
#23	75+10	358	45' CL.2	DASI			
#24	77+83	273	50' CL.2	DASI			
#25	80+49	266	50' CL.2	DASI			
#26	83+35	286	55' CL.1	DEPO	84°-42'RT	2A,3B,3H	WILLARD STREET
#27	85+47	212	50' CL.2	DASI			
#28	87+89	242	45' CL.2	DASI			
#29	90+88	299	50' CL.2	DADI	12°-53'RT	1A	

N.E.P.CO. 69 KV	CONSTRUCTION DATA		PRATTS JCT.-LEOMINSTER-AYER LINE V-22S				
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#15	46+68	296	55' CL.2	Br DADE	5°-31'LT	1A	
#16	49+66	298	50' CL.2	Br SASI			
#17	53+31	365	50' CL.2	Br SASI			
#18	57+10	379	45' CL.2	DASI			
#19	60+79	369	45' CL.2	DASI			
#20	64+56	377	50' CL.2	DASI			
#21	68+20	364	45' CL.2	Br DASI			
#22	71+52	332	50' CL.2	Br SASI			
#23	75+10	358	45' CL.2	Br DASI			
#24	77+83	273	50' CL.2	Br SASI			
#25	80+49	266	50' CL.2	DASI			
#26	83+35	286	55' CL.1	DEPO	84°-42'RT.	2A,3B,3H	WILLARD STREET
#27	85+47	212	50' CL.2	DASI			
#28	87+89	242	45' CL.2	Br SASI			
#29	90+88	299	50' CL.2	DADE	12°-53'RT	1A	

INCHES ON ORIGINAL

NOTES:

1) TO TURN ON WETLANDS & ACCESS ROADS CLICK ON THE EXPRESS TOOLS *"LAYER MANAGER ICON"*, OR TYPE *"LMAN"* ON THE COMMAND LINE.
2) HIGHLIGHT THE *"WETLANDS"* LAYER THEN CLICK RESTORE.
3) TO RETURN TO ORIGINAL SETTING HIGHLIGHT THE *"STANDARD T-SHEET SETTINGS"* THEN CLICK RESTORE OR EXIT DRAWING WITHOUT SAVING IT.

THIS PLAN IS FOR GENERAL INFORMATION. May Not Be Complete Or Correct In All Details And Should Not Be Used As A Basis Of Land Titles And Measurements Until Otherwise Confirmed.

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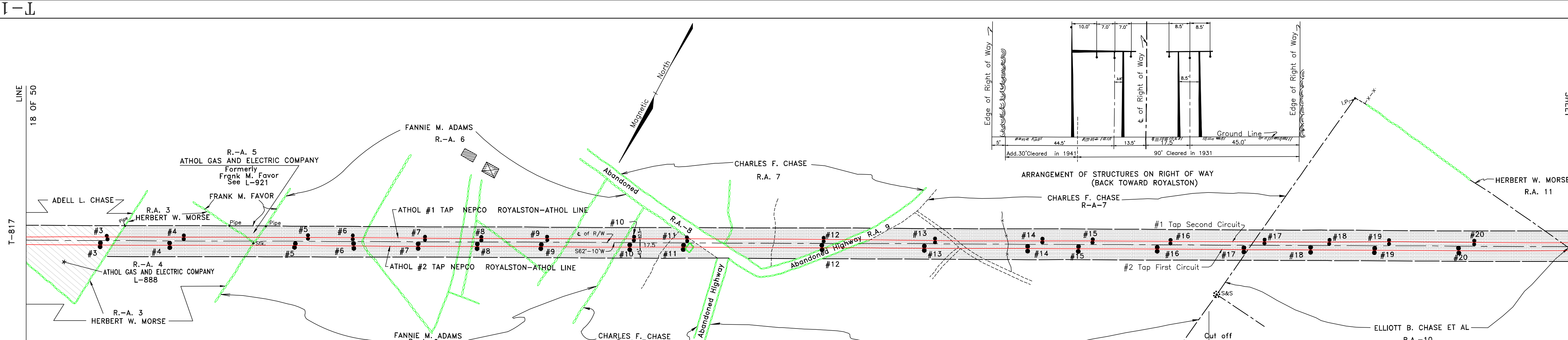
MAP OF
BELLOWS FALLS–PRATTS JUNCTION
RIGHT OF WAY

SHEET 48 OF 49 SHEETS

SCALE: 1"=200' DATE: 11/15/1926

T-1223-15



N.E.P.CO. 69kV	CONSTRUCTION DATA	SECOND CIRCUIT EAST		R-A	ATHOL #1 TAP		
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#3	9+52	505	65/2,65/2	P-SUSP	0		
#4	12+70	318	60/2,50/2	P-SUSP	0		24'-8" STEEL ARM
#5	17+76	506	60/2,50/2	P-SUSP	0		
#6	19+59	183	50/2,40/2	P-SUSP	0		24' 8" STEEL ARM, ROYALSTON ROAD
#7	22+58	299	50,40	P-SUSP	0		24'-8" STEEL ARM
#8	24+91	233	50,40	P-SUSP	0		24'-8" STEEL ARM
#9	27+58	267	55/2,45/2	P-SUSP	0		24'-8" STEEL ARM
#10	31+10	352	50/2,40/2	P-SUSP	0		24'-8" STEEL ARM
#11	33+38	226	55/2,45/2	P-SUSP	0		24'-8" STEEL ARM
#12	38+80	542	75/2,65/2	P-SUSP	0		
#13	43+36	445	45,40	P-SUSP	0		24'-8" STEEL ARM
#14	47+72	436	60/2,50/2	P-SUSP	0		
#15	49+80	208	55/2,45/2	P-SUSP	0		
#16	52+98	318	50/2,40/2	P-SUSP	0		
#17	56+85	387	50,40	P-SUSP	0		
#18	59+48	263	50,40	P-SUSP	0		24'-8" STEEL ARM
#19	61+90	242	55,45	P-SUSP	0		24'-8" STEEL ARM
#20	65+38	348	60/2,50/2	P-SUSP	0		24'-8" STEEL ARM

N.E.P.CO. 69kV	CONSTRUCTION DATA	FIRST CIRCUIT WEST		R-A	ATHOL #2 TAP		
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#3	10+04	514	45/2,45/2	H-SUSP	0		ROYALSTON ROAD
#4	12+90	286	50/2,50/2	H-SUSP	0		24'-8" STEEL ARM
#5	18+00	510	50/2,50/2	H-SUSP	0		USE DEADEND BAYONET
#6	20+40	240	45/2,45/2	H-SUSP	0		USE DEADEND BAYONET
#7	23+00	260	45/2,45/2	H-SUSP	0		17' STEEL ARM
#8	25+40	240	50/2,50/2	H-SUSP	0		
#9	28+00	260	45/2,45/2	H-SUSP	0		17' STEEL ARM
#10	31+60	360	50/2,50/2	H-SUSP	0		
#11	33+75	215	55/2,55/2	H-SUSP	0		
#12	39+15	540	55/2,55/2	H-SUSP	0		OLD ROAD, DEADEND BAYONET
#13	43+60	445	50/2,50/2	H-SUSP	0		17' STEEL ARM/OLD ROAD
#14	48+15	455	50/2,50/2	H-SUSP	0		17' STEEL ARM/OLD ROAD
#15	50+20	205	45/2,45/2	H-SUSP	0		
#16	53+40	320	50/2,50/2	H-SUSP	0		
#17	56+90	350	60/2,60/2	H-DE	0	2H 2B 2A	
#18	59+60	270	50/2,50/2	H-SUSP	0		24'-8" STEEL ARM
#19	62+20	260	45/2,45/2	H-SUSP	0		24'-8" STEEL ARM
#20	65+60	340	55/2,55/2	H-SUSP	0		24'-8" STEEL ARM

ROYALSTON, MA
(WORCESTER, COUNTY)

nationalgrid
MAP OF
ROYALSTON - ATHOL LINE
SHEET 1 OF 5 SHEETS
SCALE: 1"=200' DATE: 12/02/1930

T-1696-6

INCHES ON ORIGINAL

REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
1	01/13/39	Sub.Lot Added etc.	C.M.B.		
2	06/20/41	Added Royalston-Athol Second Circuit,Pole Data & Arrangement of structs	P.R.N.		
3	10/28/41	Added Mile Floggs & Changedownership	A.L.P.		
4	03/23/42	Added Struct. #1&#2 on See Cir Correctted pole list.	A.L.P.		
5	08/18/97	Digitized on AutoCad Release 12 by Infotech.	JFH		
6	08/01/12	Updated A1/B2 - Chestnut Hill Taps 1&2 per Refurbishment Project - 04/2012	DRD		
7					
8					

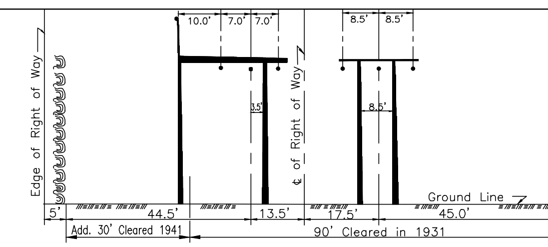
ORIGINAL: DATE, DESIGNED, CHECKED, SUPERVISOR, INSPECTED, REVIEWED, REVIEWED, APPROVED, APPROVED

T-1696-6

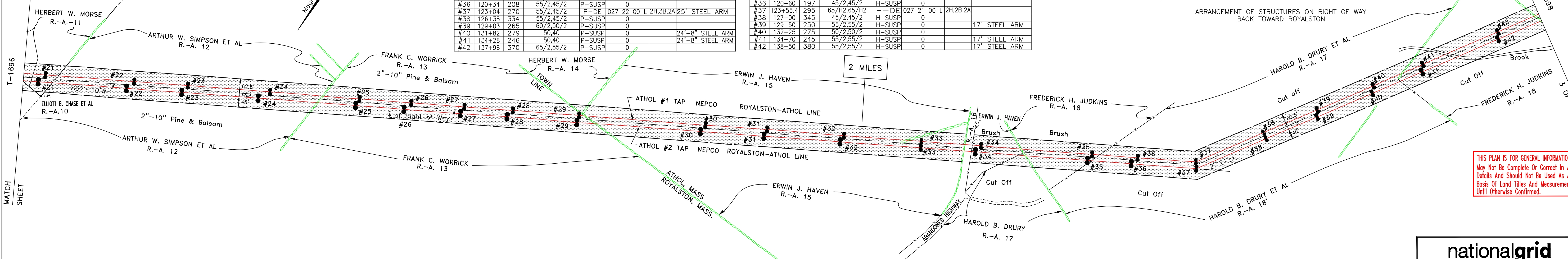
T-2697-7

N.E.P.CO. 69kV **CONSTRUCTION DATA** SECOND CIRCUIT EAST R-A ATHOL #1 TAP							
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#21	70+50	512	55,40	P-DE	0	2H-2B	
#22	74+54	404	60/2,50/2	P-SUSP	0		24'-8" STEEL ARM
#23	77+00	246	55,40	P-SUSP	0		
#24	80+73	373	70/2,60/2	P-SUSP	0		
#25	84+78	405	65/2,55/2	P-SUSP	0		24'-8" STEEL ARM
#26	87+17	239	60/2,50/2	P-SUSP	0		
#27	89+61	244	50,40	P-SUSP	0		
#28	91+82	221	60/2,50/2	P-SUSP	0		
#29	94+85	303	55,45	P-SUSP	0	2S	24'-8" STEEL ARM
#30	100+59	574	50,40	P-SUSP	0	2S	24'-8" STEEL ARM, FIRST STR. IN ATHOL
#31	103+40	281	55/2,45/2	P-SUSP	0		24'-8" STEEL ARM
#32	106+90	350	50,40	POLARM	0		24'-8" STEEL ARM
#33	110+40	350	50,40	P-SUSP	0		24'-8" STEEL ARM
#34	113+18	278	65/2,55/2	P-SUSP	0		
#35	118+26	508	55/2,45/2	P-SUSP	0		
#36	120+34	208	55/2,45/2	P-SUSP	0		
#37	123+04	270	55/2,45/2	P-DE	027 22 00 L	2H,3B,2A	25' STEEL ARM
#38	126+38	334	55/2,45/2	P-SUSP	0		
#39	129+03	265	60/2,50/2	P-SUSP	0		
#40	131+82	279	50,40	P-SUSP	0		24'-8" STEEL ARM
#41	134+28	246	50,40	P-SUSP	0		24'-8" STEEL ARM
#42	137+98	370	65/2,55/2	P-SUSP	0		

N.E.P.CO. 69kV **CONSTRUCTION DATA** FIRST CIRCUIT WEST R-A ATHOL #2 TAP							
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#21	71+00	540	55/2,55/2	H-SUSP	0	2S	17' STEEL ARM
#22	75+00	400	55/2,55/2	H-SUSP	0		
#23	77+55	255	55/2,55/2	H-SUSP	0		17' STEEL ARM
#24	81+00	345	55/2,55/2	H-SUSP	0		
#25	85+40	440	60/2,60/2	H-SUSP	0		
#26	87+60	220	55/2,55/2	H-SUSP	0		17' STEEL ARM
#27	90+15	255	50/2,50/2	H-SUSP	0		
#28	92+25	210	50/2,50/2	H-SUSP	0		
#29	95+40	315	60/2,60/2	H-SUSP	0		
#30	101+00	560	45/2,45/2	H-SUSP	0	2S	17' STEEL ARM, FIRST STRUCTURE IN ATHOL
#31	103+90	290	55/2,55/2	H-SUSP	0		
#32	107+35	345	50/2,50/2	H-SUSP	0		17' STEEL ARM
#33	111+00	365	55/2,55/2	H-SUSP	0		
#34	113+45	245	60/2,60/2	H-SUSP	0		OLD ROAD
#35	118+63	518	50/2,50/2	H-SUSP	0		17' STEEL ARM
#36	120+60	197	45/2,45/2	H-SUSP	0		
#37	123+55.4	295	65/H2,65/H2	H-DE	027 21 00 L	2H,2B,2A	
#38	127+00	345	45/2,45/2	H-SUSP	0		
#39	129+50	250	55/2,55/2	H-SUSP	0		17' STEEL ARM
#40	132+25	275	50/2,50/2	H-SUSP	0		
#41	134+70	245	55/2,55/2	H-SUSP	0		17' STEEL ARM
#42	138+50	380	55/2,55/2	H-SUSP	0		17' STEEL ARM



ARRANGEMENT OF STRUCTURES ON RIGHT OF WAY BACK TOWARD ROYALSTON



ROYALSTON, MA, WORCESTER COUNTY

ATHOL, MA, WORCESTER COUNTY

THIS PLAN IS FOR GENERAL INFORMATION. May Not Be Complete Or Correct In All Details And Should Not Be Used As A Basis Of Land Titles And Measurements Until Otherwise Confirmed.

nationalgrid

MAP OF

ROYALSTON – ATHOL LINE

SHEET 2 OF 5 SHEETS

SCALE: 1"=200' DATE: 06/20/1931

T-1697-7

INCHES ON ORIGINAL

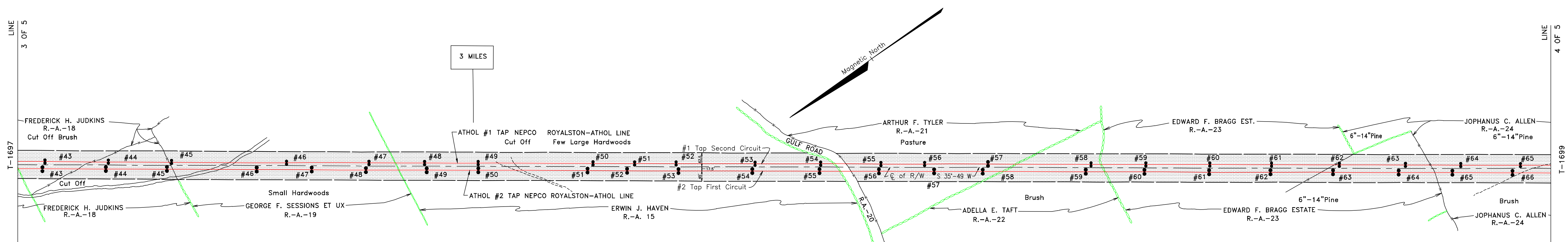
REVISIONS

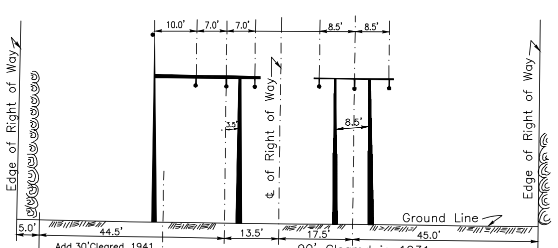
REV	DATE	DESCRIPTION	MADE
1			
2			
3	01/12/39	A.G.&E. Co. Added to Title.	C.M.B.
4	06/20/41	Added Royalston-Athol second circuit, Pole Data & Arrangement of structs	P.R.N.
5	10/28/41	Added Mile flaggs & Changed ownership	A.L.P.
6	08/18/97	Digitized on AutoCad Release 12 by Infotech.	JFH
7	06/01/12	Updated A1/B2 - Chestnut Hill Taps 1&2 per Refurbishment Project - 04/2012	DRD
8			

ORIGINAL: DATE, DESIGNED, CHECKED, SUPERVISOR, INSPECTED, REVIEWED, REVIEWED, APPROVED, APPROVED

REVISIONS

ORIGINAL		REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
DATE							
DESIGNED		1	01/12/39	A.G.&.E.Co. Added to title	C.M.B.		
CHECKED		2	06/20/41	Added Royalston–Athal second circuit, Pole data & Arrangement of Struct's.	P.R.N		
SUPERVISOR		3	10/28/41	Added Mile flaggs & changed ownership	A.L.P.		
INSPECTED		4	08/18/97	Digitized on AutoCad Release 12 by Infotech.	JFH		
REVIEWED		5	08/02/12	Updated A1/B2 Taps 1&2, Removed STR 46 on Tap 1 per Refurbishment Project	DRD		
REVIEWED		6					
APPROVED		7					
APPROVED		8					





ARRANGEMENT OF STRUCTURES ON RIGHT OF WAY
BACK TOWARDS ROYALSTON

N.E.P.CO. 69kV CONSTRUCTION DATA			SECOND CIRCUIT EAST		R-A		ATHOL #1 TAP
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#43	141+21	323	50,45	P-SUSP	0		25' STEEL ARM
#44	144+02	281	50,40	P-SUSP	0		24'-8" STEEL ARM
#45	146+83	391	70/2,60/2	P-SUSP	0		24'-8" STEEL ARM
#46	150+87	387	75/2,65/2	P-SUSP	0		FORMERLY STR#47
#47	153+42	255	60/2,50/2	P-SUSP	0		Special Bay, cut 5' off Bayonet
#48	155+65	225	50,40	P-SUSP	0		24'-8" STEEL ARM
#49	158+15	250	65/2,55/2	P-SUSP	0		24'-8" STEEL ARM
#50	160+54	239	70/2,45/2	P-SUSP	0		24'-8" STEEL ARM
#51	165+72	518	60/2,45/2	P-SUSP	0		Full Bayonet
#52	167+59	187	60/2,50/2	P-SUSP	0	2H 2B	24'-8" STEEL ARM
#53	169+45	188	55/2,45/2	P-SUSP	0		
#54	172+98	355	65/2,55/2	P-SUSP	0		24'-8" STEEL ARM
#55	175+91	293	55/2,45/2	P-SUSP	0		24'-8" STEEL ARM, GULF RD
#56	178+60	269	60/2,50/2	P-SUSP	0		
#57	180+57	197	50/2,40/2	P-SUSP	0		
#58	183+38	281	65/2,50/2	P-DE	0	2H 2B	25' STEEL ARM
#59	188+00	462	55/2,45/2	P-SUSP	0		
#60	190+43	243	50,40	P-SUSP	0		25' STEEL ARM
#61	193+30	287	55/2,45/2	P-SUSP	0		25' STEEL ARM
#62	196+04	274	60/2,50/2	P-SUSP	0		25' STEEL ARM
#63	199+07	303	55/2,45/2	P-SUSP	0		25' STEEL ARM
#64	202+04	297	55/2,45/2	P-SUSP	0		
#65	204+51	247	55/2,45/2	P-SUSP	0		

ATHOL, MA

N.E.P.CO. 69kV CONSTRUCTION DATA			FIRST CIRCUIT WEST		R-A		ATHOL #2 TAP
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#43	141+75	325	55/2,55/2	H-SUSP	0		
#44	144+60	285	55/2,55/2	H-SUSP	0		17' STEEL ARM
#45	147+30	270	55/2,55/2	H-SUSP	0		17' STEEL ARM
#46	151+30	400	55/2,55/2	H-SUSP	0		
#47	153+75	245	45/2,45/2	H-SUSP	0		
#48	156+20	245	50/2,50/2	H-SUSP	0		17' STEEL ARM
#49	158+95	275	55/2,55/2	H-SUSP	0		
#50	161+20	225	60/2,60/2	H-SUSP	0		17' STEEL ARM
#51	166+10	490	55/2,55/2	H-SUSP	0		17' STEEL ARM
#52	167+88	178	45/2,45/2	H-SUSP	0		17' STEEL ARM
#53	170+20	232	55/2,55/2	H-SUSP	0		
#54	173+46	326	40/2,40/2	H-SUSP	0		17' STEEL ARM
#55	176+50	304	50/2,45/2	H-SUSP	0		17' STEEL ARM
#56	179+15	265	55/2,55/2	H-SUSP	0		17' STEEL ARM, GULF ROAD
#57	181+65	250	50/2,50/2	H-SUSP	0		17' STEEL ARM
#58	183+80	215	50/2,50/2	H-SUSP	0		
#59	188+40	460	70/2,70/2	H-SUSP	0		
#60	191+20	280	50/2,50/2	H-SUSP	0		17' STEEL ARM
#61	194+05	285	55/2,55/2	H-SUSP	0		
#62	196+80	275	55/2,55/2	H-SUSP	0		
#63	199+60	280	55/2,55/2	H-SUSP	0		17' STEEL ARM
#64	202+55	295	55/2,55/2	H-SUSP	0		
#65	205+00	245	50/2,50/2	H-SUSP	0		
#66	207+70	270	50/2,50/2	H-SUSP	0		17' STEEL ARM

INCHES ON ORIGINAL

nationalgrid

MAP OF

ROYALSTON – ATHOL LINE

SHEET 3 OF 5 SHEETS

SCALE: 1"=200'

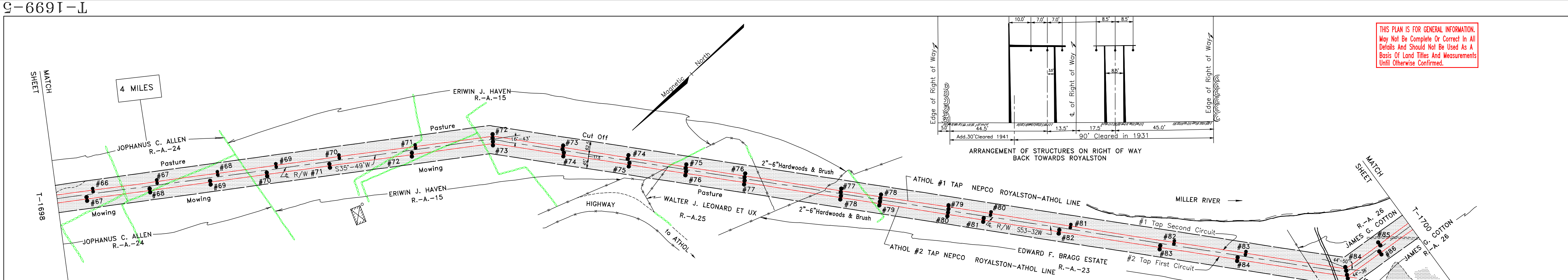
DATE: 12/08/1930

T-1684-5

REVISIONS

REV	DATE	DESCRIPTION	MADE	CHK'D.	APP'D.
1	10/17/38	A.G.& E.Co. Added to title	C.M.B.		
2	06/20/44	Added Royalston–Athol second circuit. Pole data & Arrangement of Struct's.	P.R.N.		
3	10/28/47	Added Mile flaggs & changed ownership	A.L.P.		
4	08/18/93	Digitized on AutoCad Release 12 by Infotech.	JFH		
5	08/02/12	Updated A1/B2 – Chestnut Hill Taps 1&2 per Refurbishment Project – 04/2012	DRD		
6					
7					
8					

ORIGINAL: DATE / DESIGNED / CHECKED / SUPERVISOR / INSPECTED / REVIEWED / REVIEWED / APPROVED / APPROVED



THIS PLAN IS FOR GENERAL INFORMATION. May Not Be Complete Or Correct In All Details And Should Not Be Used As A Basis Of Land Titles And Measurements Until Otherwise Confirmed.

N.E.P.CO. 69kV CONSTRUCTION DATA SECOND CIRCUIT EAST R–A ATHOL #1 TAP

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#66	207+20	269	55/2,45/2	P–SUSP	0		
#67	210+31	311	60/2,50/2	P–SUSP	0		
#68	213+25	294	50,40	P–SUSP	0		24'–8' STEEL ARM
#69	216+03	278	50,40	P–SUSP	0		24'–8' STEEL ARM
#70	218+65	262	60/2,50/2	P–SUSP	0		24'–8' STEEL ARM
#71	221+60	295	60/2,50/2	POLARM	0		
#72	224+90	330	55/2,45/2	P–DE	0	2H 2B 2A	
#73	228+54	364	55/2,45/2	P–SUSP			
#74	231+82	328	55/2,45/2	P–SUSP	0		24'–8' STEEL ARM
#75	234+80	298	50/2,40/2	P–SUSP	0		24'–8' STEEL ARM
#76	237+47	267	45,40	P–SUSP	0		24'–8' STEEL ARM
#77	240+18	271	60/2,50/2	P–SUSP	0		24'–8' STEEL ARM
#78	244+62	444	60/2,50/2	P–SUSP	0	2S	24'–8' STEEL ARM
#79	246+46	184	45,40	POLARM	0	2S	24'–8' STEEL ARM
#80	249+62	316	50,40	P–SUSP	0	2S	24'–8' STEEL ARM
#81	251+55	193	75/2,60/2	P–SUSP	0	2S	24'–8' STEEL ARM
#82	255+27	372	70/2,50/2	P–SUSP	0	2S	24'–8' STEEL ARM
#83	259+98	471	75/2,60/2	P–SUSP	0	2S	
#84	263+28	330	55,45	P–SUSP	0		24'–8' STEEL ARM
#85	268+01	473	60/2,50/2	SUSP		2S	

N.E.P.CO. 69kV CONSTRUCTION DATA FIRST CIRCUIT WEST R–A ATHOL #2 TAP

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#67	210+85	315	55/2,55/2	H–SUSP	0		17' STEEL ARM
#68	213+75	290	50/2,50/2	H–SUSP	0		17' STEEL ARM
#69	216+55	280	50/2,50/2	H–SUSP	0		17' STEEL ARM
#70	219+15	260	55/2,55/2	H–SUSP	0		17' STEEL ARM
#71	222+05	290	55/2,55/2	H–SUSP	0		
#72	225+30	325	60/2,60/2	H–SUSP	0		
#73	228+97	367	50/2,50/2	HDE	015 43 00 R	2H 2B 2A	18' STEEL ARM
#74	232+20	323	50/2,50/2	H–SUSP	0		17' STEEL ARM
#75	235+20	300	55/2,55/2	H–SUSP	0		
#76	237+85	265	50/2,50/2	H–SUSP	0		
#77	240+55	270	60/2,60/2	H–SUSP	0		
#78	245+00	445	55/2,55/2	H–SUSP	0		
#79	246+80	180	45/2,45/2	H–SUSP	0	2S	
#80	249+96	316	55/2,55/2	H–SUSP	0	2S	
#81	251+65	169	65/2,60/2	H–SUSP	0	2S	17' STEEL ARM
#82	255+15	350	75/2,70/2	H–SUSP	0	2S	
#83	259+80	465	60/2,60/2	H–SUSP	0	2S	
#84	263+40	360	65/2,65/2	H–SUSP	0	2S	
#85	268+38.3	498	50/2,50/2,50/2	SPO	044 35 00 L	2S	44°–38' Lt.
#86	270+25	187	50/2,50/2	H–SUSP	0	2S	17' STEEL ARM

ATHOL, MA
(WORCESTER COUNTY)

INCHES ON ORIGINAL

nationalgrid

MAP OF

ROYALSTON – ATHOL LINE

SHEET 4 OF 5 SHEETS

SCALE: 1"=200'   DATE: 12/09/1930

T-1699-5

PRINTED 3/31/2014 9:29 AM

T-1700-10

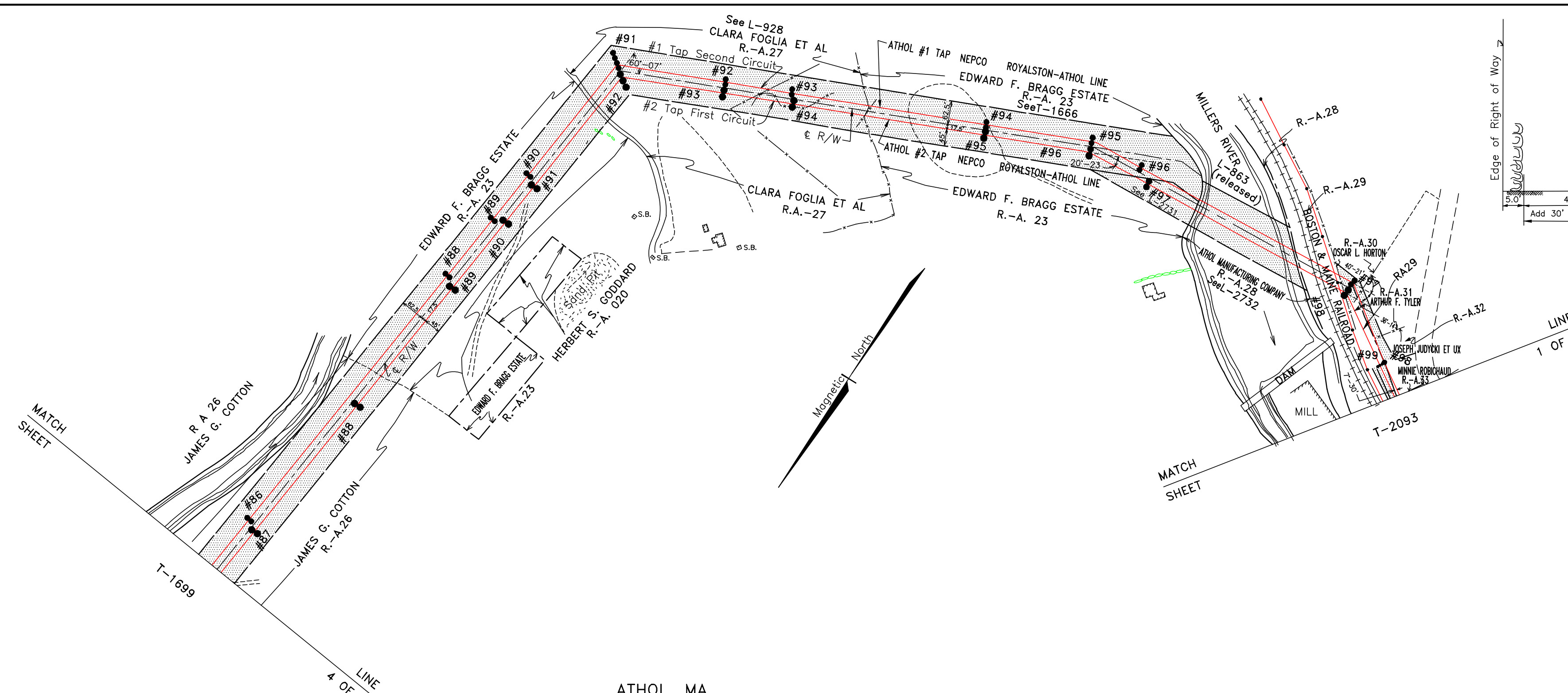
N.E.P.CO.			CONSTRUCTION DATA				ATHOL #1 TAP
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#86	269+93	499	70/2,55/2	P-SUSP	0	2S	24'-8' STEEL ARM
#87	-	—	-	——			REMOVED
#88	277+53	499	65/2,50/2	P-SUSP	0		24'-8" STEEL ARM/Rock G.W.P. Butt to Height of 5'
#89	281+50	397	60/2,50/2	P-SUSP	0		24'-8" STEEL ARM
#90	283+45	195	45,35	P-SUSP	0	2S	24'-8" STEEL ARM
#91	285+00	155	45,50,50,65	DEPO	61° 03' RT	4H 4B 4A	
#92	288+77	380	45,40	P-SUSP			
#93	291+72	292	55/2,45/2	P-SUSP	0° 40' LT		
#94	293+60	188	45,40	P-SUSP	0		
#95	298+92	290	55/2,45/2	P-DE	0	2H,2B,2A	
#96	301+82	142	70/2,60/2	P-DE		2B	
#97	303+24	635	50,45	PDE	0	2B	
#98	309+59	235	50/2	DC DADI		2A	

N.E.P.CO. 69kV			CONSTRUCTION DATA	FIRST CIRCUIT WEST		R-A	ATHOL #2 TAP
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#87	273+40	315	65/2,60/2	H-SUSP	0	2S	17' STEEL ARM
#88	277+85	445	75/2,70/2	H-SUSP	0	2S	Use Dead End Bayonet
#89	281+90	405	55/2,55/2	H-SUSP	0	2S	
#90	284+20	230	55/2,55/2	H-SUSP	0	2S	
#91	285+45	125	55/2,55/2	H-SUSP	0	2S	
#92	289+06.7	362	50/2,55/2,55/2	SPO	060 07 00 R	5A	
#93	291+80	273	45/2,45/2	H-SUSP	0		24'-8" STEEL ARM
#94	293+75	195	45/2,45/2	H-SUSP	0		24'-8" STEEL ARM
#95	299+00	525	50/2,50/2	H-SUSP	0		24'-8" STEEL ARM
#96	301+90	290	50/H2,50/H2	H-DE	020 23 00 R	2H,2B,2A	
#97	303+68	178	80/2,80/2	H-DE	0	2B	
#98	309+58	590	70/H2,70/H2	H-DE	036 14 00 R	3H,2A	25' STEEL ARM/B & M RR/Millers River
#99	311+94	236	50/2,55/2,60/2	DC DADI		2A	

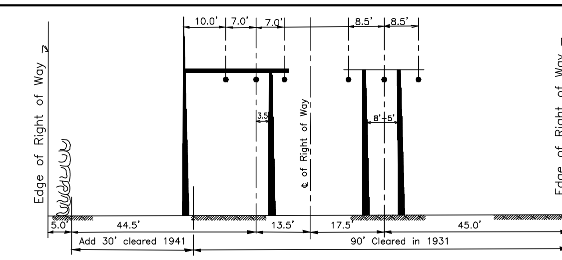
REVISIONS

REV.	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
3	1/11/39	Pole#97 Changed and New R/W Added etc.	C.M.B.		
4	6/20/41	"Added Royalstan-Athol Line Second Circuit, Pole data and Arrangement of Structs."	P.R.N.		
5	10/28/41	Added Mile flaggs & Changed ownership	A.L.P.		
6	10/10/97	Digitized on AutoCad Release 12 by Infotech.	BMR		
7	9/17/99	Added Match Line & Revised Construction Data.	J.F.H.		
8	4/18/08	"Structure 1,45',2,50',1-65 DEPO was 3-40',1-50'"	JE		
9	1/14/10	FI 811 - UPDATED STR.92 POLE INFO	DRD		
10	08/06/12	A1/B2 TAPS 1&2 UPDATED, STR 87 REMOVED(TAP 1) PER REFURB PROJECT - 04/12	DRD		

ORIGINAL	
DATE	Dec-1930
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	



ATHOL, MA
WORCESTER COUNTY



ARRANGEMENT OF STRUCTURES ON RIGHT OF WAY
BACK TOWARDS ROYALSTON

THIS PLAN IS FOR GENERAL INFORMATION. May Not Be Complete Or Correct In All Details And Should Not Be Used As A Basis Of Land Titles And Measurements Until Otherwise Confirmed.

NOTE:-
Crossing Over B.&M. R.R.- Fitchburg Division- DWG-E-5903

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NEW ENGLAND POWER COMPANY
MAP OF
ROYALSTON-ATHOL LINE
SHEET NO. 5 OF 5 SHEETS

SCALE: 1"=200' DATE: Dec-1930

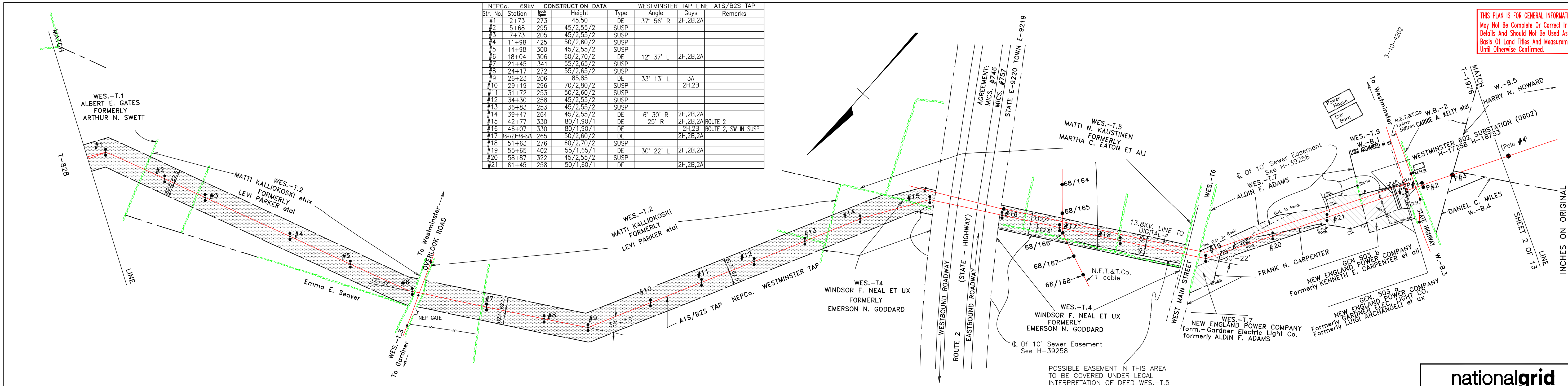
T-1700-10

INCHES ON ORIGINAL

INCHES ON ORIGINAL

T-1975-11

NEPCo. 69kV	CONSTRUCTION DATA			WESTMINSTER TAP LINE A1S/B2S TAP			
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#1	2+73	273	45,50	DE	37° 56' R	2H,2B,2A	
#2	5+68	295	45/2,55/2	SUSP			
#3	7+73	205	45/2,55/2	SUSP			
#4	11+98	425	50/2,60/2	SUSP			
#5	14+98	300	45/2,55/2	SUSP			
#6	18+04	306	60/2,70/2	DE	12° 37' L	2H,2B,2A	
#7	21+45	341	55/2,65/2	SUSP			
#8	24+17	272	55/2,65/2	SUSP			
#9	26+23	206	85,85	DE	33° 13' L	3A	
#10	29+19	296	70/2,80/2	SUSP		2H,2B	
#11	31+72	253	50/2,60/2	SUSP			
#12	34+30	258	45/2,55/2	SUSP			
#13	36+83	253	45/2,55/2	SUSP			
#14	39+47	264	45/2,55/2	DE	6° 30' R	2H,2B,2A	
#15	42+77	330	80/1,90/1	DE	25° R	2H,2B,2A	ROUTE 2
#16	46+07	330	80/1,90/1	DE		2H,2B	ROUTE 2, SW IN SUSP
#17	48+72B=48+87A	265	50/2,60/2	DE		2H,2B,2A	
#18	51+63	276	60/2,70/2	SUSP			
#19	55+65	402	55/1,65/1	DE	30° 22' L	2H,2B,2A	
#20	58+87	322	45/2,55/2	SUSP			
#21	61+45	258	50/1,60/1	DE		2H,2B,2A	



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INCHES ON ORIGINAL

WESTMINSTER, MA
(WORCESTER COUNTY)

INCHES ON ORIGINAL

nationalgrid

MAP OF

WESTMINSTER TAP LINE

SHEET 1 OF 1 SHEETS

SCALE: 1"=200'   DATE: 09/05/1941

T-1975-11

ORIGINAL		REVISIONS					
DATE		REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
DESIGNED		4	06/09/67	Poles Relocated a/c Rt.2	D.E.M C.		
CHECKED		5	11/12/70	Added 13.8KV. LINE To DIGITAL	R.D.		
SUPERVISOR		6	07/16/73	Added & Revised Substation Properties	R.E.D		
INSPECTED		7	10/09/75	Added 10' Sewer Easement For DIGITAL CORP.	D.L.T.		
REVIEWED		8	08/18/97	Digitized on AutoCad Release 12 by Infotech.	JFH		
REVIEWED		9	07/09/99	Revised per 10/30/84 field issue	AJS		
APPROVED		10	12/20/12	90000120613 - A1/B2 WESTMINSTER TAP REFURBISHMENT- 6/2012	TEC		
APPROVED		11	05/19/15	CORRECT LINE NAME AND DESIGNATION	TEC		

T-2093-3

REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
1	08/18/97	Digitized on AutoCad Release 12 by Infotech.	J.F.H.		
2	09/17/99	Added Match Line & Revised Construction Data.	J.F.H.		
3	08/06/12	UPDATED A1/B2 TAPS 1&2 PER REFURB PROJECT – 04/2012	DRD		
4					
5					
6					
7					
8					

ORIGINAL: DATE / DESIGNED / CHECKED / SUPERVISOR / INSPECTED / REVIEWED / REVIEWED / APPROVED / APPROVED

N.E.P.CO. 69kV CONSTRUCTION DATA R–A — ATHOL #1 TAP

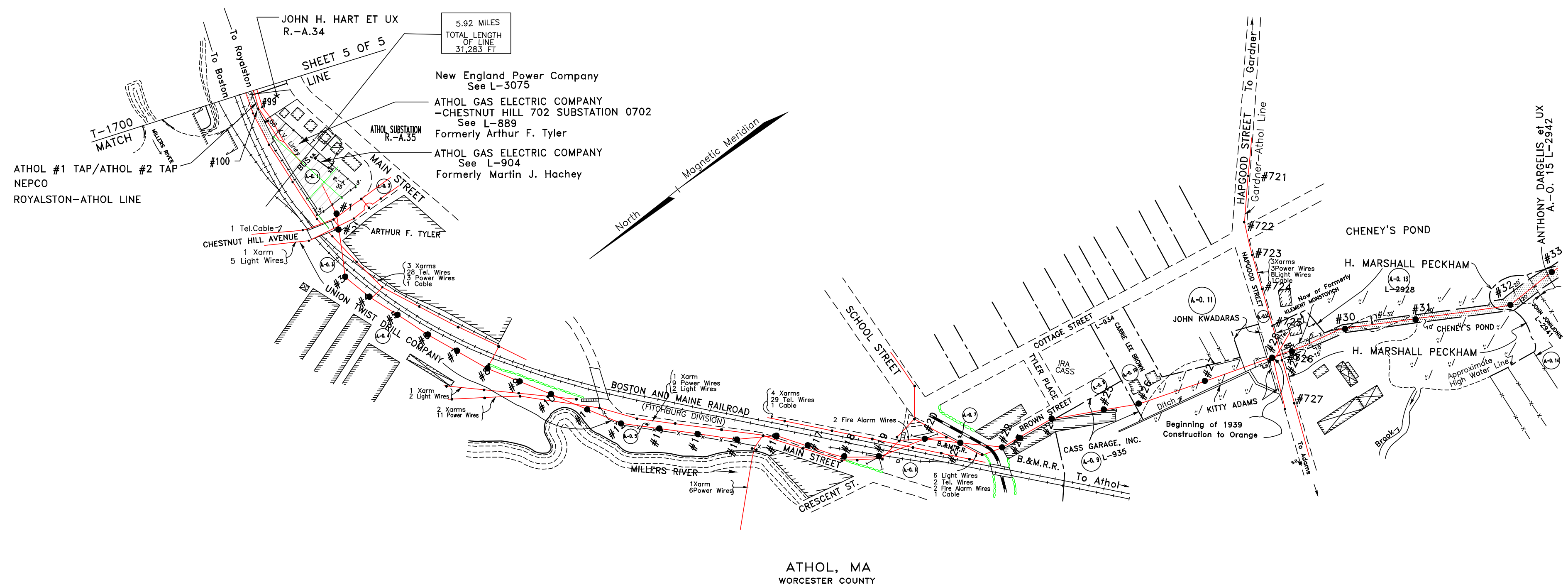
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
BUS	315+06	117					Chestnut Hill Sub
#99	313+89	195	65/2	DEPO		2H	

N.E.P.CO. 69kV CONSTRUCTION DATA R–A — ATHOL #2 TAP

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
BUS	315+06	117					Chestnut Hill Sub
#100	313+89	195	65/2	DEPO		2H	

N.E.P.CO. 13.8 kV CONSTRUCTION DATA — 702W1

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#1	0+45	45	35	DADE		1B+1A 7/16	RR CROSSING
#2	0+80.7	36'	35	DADE		1H,2S	RR CROSSING
#3	2+27.2	146'	40	DADE		1H,2A 1/2	RR CROSSING
#4	3+18.5	92'	40	DA	7° 32' L	1A	
#5	4+15.5	97'	40	SA			
#6	5+21.7	106'	40	SA	2° 22' L		
#7	6+14.5	93'	40	SA			
#8	7+14.7	100'	40	SA	7° 44' L	1A	
#9	8+15.7	101'	40	SA			
#10	9+17.2	101'	40	SA			
#11	10+27.2	110'	50	SA			
#12	11+34.8	108'	40	DA	13° 42' L	1A	
#13	12+46.8	112'	40	SA			
#14	13+58.8	112'	40	SA			
#15	14+70.8	112'	40	DA	13° 26' L	1A	
#16	15+89.2	118'	45	DA	22° 22' R	1A 7/16"	
#17	16+89.2	100'	40	SA			
#18	17+89.2	100'	40	DA	16° 15'L	1A 7/16"	
#19	18+97.7	109'	45	DADE	24° 24' L	1B,2S, 1/2"	RR CROSSING
#20	20+38	140'	45	DADE	30° 21' R	1H,2S 1/2"	RR CROSSING
#21	21+38.1	100'	40	SA			
#22	22+62.7	125'	40	DA	36° 58' L	1A 1/2"	
#23	23+19.3	56'	Old Pole	SA			
#24	24+26.7	108'	40	DA	20° 21' R	1A 7/16"	
#25	25+77.4	150'	40	SA			
#26	26+77.4	100'	40	DA	9° 24' L	1A	
#27	28+82.4	205'	50	DA			
#28	30+87.4	205'	40	SWITCH ARM		1A	
#29	31+32	45'	55	DA			
#30	32+92	160'	40	DA	15° 32' R	1A. 7/16"	
#31	35+03	211'	35	SA			
#32	37+74	271'	40	DA	27° 05' L	1A. 7/16"	
#33	39+39	165'	40	SA			



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ATHOL, MA
WORCESTER COUNTY

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MAP OF

ATHOL – ORANGE LINE

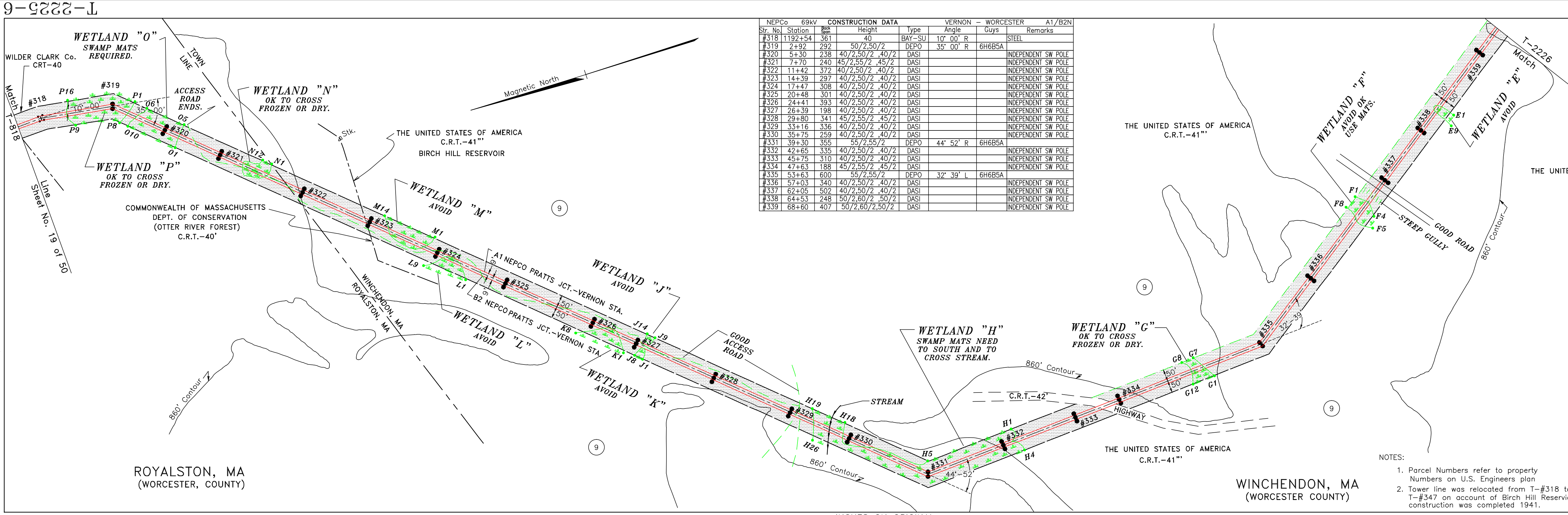
SHEET 1 OF 4 SHEETS

SCALE: 1"=200' DATE: 06/1939

INCHES ON ORIGINAL

T–2093–3

NEPCo 69kV CONSTRUCTION DATA				VERNON – WORCESTER			A1/B2N
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#318	1192+54	361	40	BAY–SU	10° 00' R		STEEL
#319	2+92	292	50/2,50/2	DEPO	35° 00' R	6H6B5A	
#320	5+30	238	40/2,50/2 ,40/2	DASI			INDEPENDENT SW POLE
#321	7+70	240	45/2,55/2 ,45/2	DASI			INDEPENDENT SW POLE
#322	11+42	372	40/2,50/2 ,40/2	DASI			INDEPENDENT SW POLE
#323	14+39	297	40/2,50/2 ,40/2	DASI			INDEPENDENT SW POLE
#324	17+47	308	40/2,50/2 ,40/2	DASI			INDEPENDENT SW POLE
#325	20+48	301	40/2,50/2 ,40/2	DASI			INDEPENDENT SW POLE
#326	24+41	393	40/2,50/2 ,40/2	DASI			INDEPENDENT SW POLE
#327	26+39	198	40/2,50/2 ,40/2	DASI			INDEPENDENT SW POLE
#328	29+80	341	45/2,55/2 ,45/2	DASI			INDEPENDENT SW POLE
#329	33+16	336	40/2,50/2 ,40/2	DASI			INDEPENDENT SW POLE
#330	35+75	259	40/2,50/2 ,40/2	DASI			INDEPENDENT SW POLE
#331	39+30	355	55/2,55/2	DEPO	44° 52' R	6H6B5A	
#332	42+65	335	40/2,50/2 ,40/2	DASI			INDEPENDENT SW POLE
#333	45+75	310	40/2,50/2 ,40/2	DASI			INDEPENDENT SW POLE
#334	47+63	188	45/2,55/2 ,45/2	DASI			INDEPENDENT SW POLE
#335	53+63	600	55/2,55/2	DEPO	32° 39' L	6H6B5A	
#336	57+03	340	40/2,50/2 ,40/2	DASI			INDEPENDENT SW POLE
#337	62+05	502	40/2,50/2 ,40/2	DASI			INDEPENDENT SW POLE
#338	64+53	248	50/2,60/2 ,50/2	DASI			INDEPENDENT SW POLE
#339	68+60	407	50/2,60/2,50/2	DASI			INDEPENDENT SW POLE



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NOTES:

1. Parcel Numbers refer to property Numbers on U.S. Engineers plan
2. Tower line was relocated from T–#318 to T–#347 on account of Birch Hill Reservior construction was completed 1941.

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MAP OF
VERNON – WORCESTER LINE
1941 BIRCH HILL RELOCATION

SHEET 19A OF 49 SHEETS

SCALE: 1"=200'   DATE: 01/22/1942

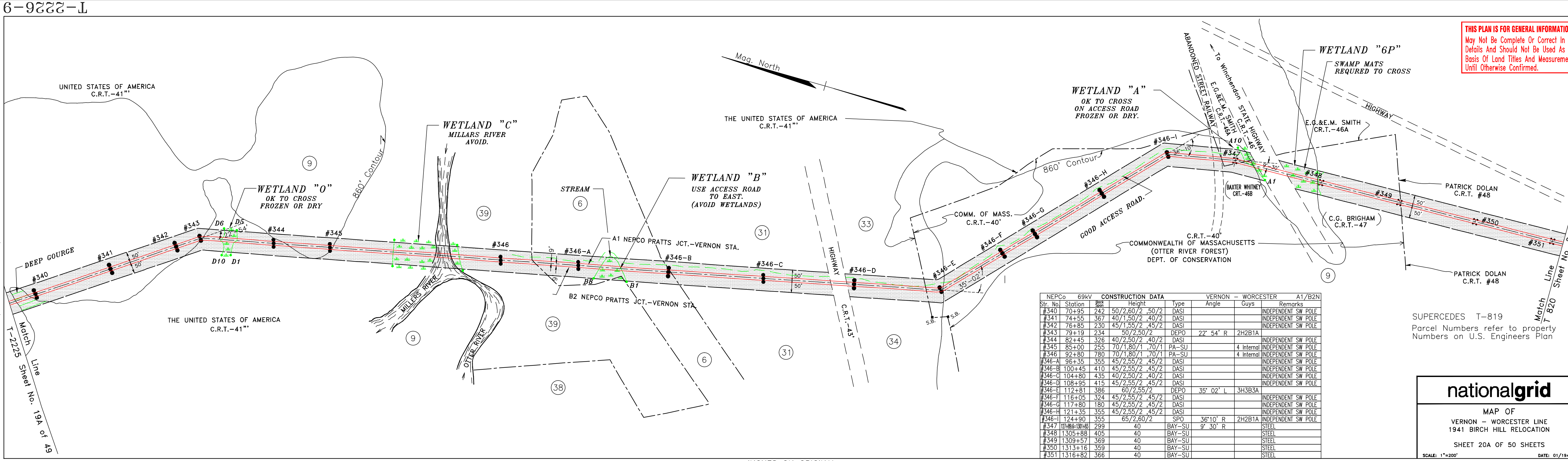
T–2225–6

INCHES ON ORIGINAL

REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
1	11/21/46	Boundary Line between U.S.A. & COMM.OF MASS.	M.E.L.		
2	08/18/97	Digitized on AutoCad Release 12 by Infotech.	JFH		
3	11/10/98	Added Match Line & Rev'd. Control Data.	JFH		
4	06/18/03	Added Wetlands, Access and Wetlands Access Text.	J.F.H.		
5	04/08/04	Rev'd. Structures Nos.319 thru 339 per A1/B2 Transmission Line Refurbishment.	J.F.H.		
6	06/07/11	RENAMED B2 LINE TO B2N LINE	TEC		
7					
8					

ORIGINAL	
DATE	
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	



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NEPCo 69kV **CONSTRUCTION DATA**					VERNON – WORCESTER		A1/B2N
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#340	70+95	242	50/2,60/2 ,50/2	DASI			INDEPENDENT SW POLE
#341	74+55	367	40/1,50/2 ,40/2	DASI			INDEPENDENT SW POLE
#342	76+85	230	45/1,55/2 ,45/2	DASI			INDEPENDENT SW POLE
#343	79+19	234	50/2,50/2	DEPO	22° 54' R	2H2B1A	
#344	82+45	326	40/2,50/2 ,40/2	DASI			INDEPENDENT SW POLE
#345	85+00	255	70/1,80/1 ,70/1	PA-SU		4 Internal	INDEPENDENT SW POLE
#346	92+80	780	70/1,80/1 ,70/1	PA-SU		4 Internal	INDEPENDENT SW POLE
#346-A	96+35	355	45/2,55/2 ,45/2	DASI			INDEPENDENT SW POLE
#346-B	100+45	410	45/2,55/2 ,45/2	DASI			INDEPENDENT SW POLE
#346-C	104+80	435	40/2,50/2 ,40/2	DASI			INDEPENDENT SW POLE
#346-D	108+95	415	45/2,55/2 ,45/2	DASI			INDEPENDENT SW POLE
#346-E	112+81	386	60/2,55/2	DEPO	35° 02' L	3H3B3A	
#346-F	116+05	324	45/2,55/2 ,45/2	DASI			INDEPENDENT SW POLE
#346-G	117+80	180	45/2,55/2 ,45/2	DASI			INDEPENDENT SW POLE
#346-H	121+35	355	45/2,55/2 ,45/2	DASI			INDEPENDENT SW POLE
#346-I	124+90	355	65/2,60/2	SPO	36°10' R	2H2B1A	INDEPENDENT SW POLE
#347	127+89.6=1301+83	299	40	BAY-SU	9° 30' R		STEEL
#348	1305+88	405	40	BAY-SU			STEEL
#349	1309+57	369	40	BAY-SU			STEEL
#350	1313+16	359	40	BAY-SU			STEEL
#351	1316+82	366	40	BAY-SU			STEEL

SUPERCEDES T-819

Parcel Numbers refer to property Numbers on U.S. Engineers Plan

REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
2					
3	07/13/67	Title Change	D.E.M.		
4	12/30/85	REVISED STRUCTURES 346E & 346 I	A.E.S.		
5	08/18/97	Digitized on AutoCad Release 12 by Infotech.	JFH		
6	11/10/98	Revised Control Data.	JFH		
7	07/28/03	Added Wetlands and Notes	JE		
8	04/09/04	Rev'd. Structures Nos.340 thru 361I per A1/B2 Transmission Line Refurbishment.	J.F.H.		
9	06/07/11	RENAME B2 LINE TO B2N LINE	TEC		

ORIGINAL	
DATE	
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

nationalgrid

MAP OF
VERNON – WORCESTER LINE
1941 BIRCH HILL RELOCATION

SHEET 20A OF 50 SHEETS

SCALE: 1"=200' DATE: 01/1942

T-2226-9

T-2226-9

INCHES ON ORIGINAL

REV	DATE	DESCRIPTION	MADE	CHK'D	APP'D
1	10/30/54	STRUCTURES NUMBERED PER S.W.S.MEMO 09/27/54			
2	10/03/98	DIGITIZED ON AUTOCAD RELEASE 12 by INFOTECH	CMB		
3	10/01/02	GARDNER TAPS REHAB	JFH		
4	01/07/05	REV'D GARDNER SWITCH STA. & TAPS 1&2, STRUCTURES 3 THRU 5	BMR		
5	10/22/09	FI 717 – UPDATED A1 & B2 LINES, AND UPDATED SHEET DATA	JFH		
6	07/18/14	CORRECTED LINE ANGLE ON TAP LINES 1 & 2, STRUCTURE 23	DRD		
7		CORRECTED LINE NAMES AND DESIGNATIONS	JFPR	AV	
8	11/17/16	ADDED STRS. 24-1, 24-2 & CRYS. LAKE SUB, R/W STRS. 24-37 & PARK ST SUB	LEC	PM	PEB

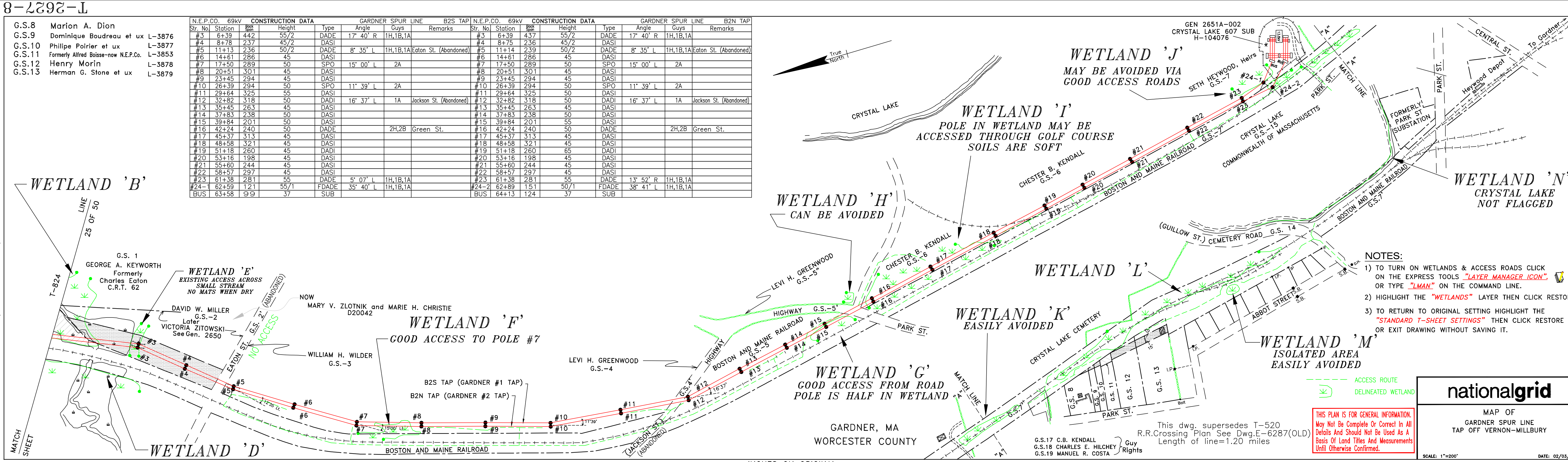
REVISIONS

ORIGINAL: DATE 02/03/1948

G.S.8 Marion A. Dion
G.S.9 Dominique Boudreau et ux L-3876
G.S.10 Philipe Poirier et ux L-3877
G.S.11 Formerly Alfred Boisse-now N.E.P.Co. L-3853
G.S.12 Henry Morin L-3878
G.S.13 Herman G. Stone et ux L-3879

N.E.P.CO. 69kV CONSTRUCTION DATA					GARDNER SPUR LINE		B2S TAP
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#3	6+39	442	55/2	DADE	17° 40' R	1H,1B,1A	
#4	8+78	237	45/2	DASI			
#5	11+13	236	50/2	DADE	8° 35' L	1H,1B,1A	Eaton St. (Abandoned)
#6	14+61	286	45	DASI			
#7	17+50	289	50	SPO	15° 00' L	2A	
#8	20+51	301	45	DASI			
#9	23+45	294	45	DASI			
#10	26+39	294	50	SPO	11° 39' L	2A	
#11	29+64	325	55	DASI			
#12	32+82	318	50	DADI	16° 37' L	1A	Jackson St. (Abandoned)
#13	35+45	263	45	DASI			
#14	37+83	238	50	DASI			
#15	39+84	201	50	DASI			
#16	42+24	240	50	DADE		2H,2B	Green St.
#17	45+37	313	45	DASI			
#18	48+58	321	45	DASI			
#19	51+18	260	45	DADI			
#20	53+16	198	45	DASI			
#21	55+60	244	45	DASI			
#22	58+57	297	45	DASI			
#23	61+38	281	55	DADE	5° 07' L	1H,1B,1A	
#24-1	62+59	121	55/1	FDADE	35° 40' L	1H,1B,1A	
BUS	63+58	99	37	SUB			

N.E.P.CO. 69kV CONSTRUCTION DATA					GARDNER SPUR LINE		B2N TAP
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#3	6+39	437	55/2	DADE	17° 40' R	1H,1B,1A	
#4	8+75	236	45/2	DASI			
#5	11+14	239	50/2	DADE	8° 35' L	1H,1B,1A	Eaton St. (Abandoned)
#6	14+61	286	45	DASI			
#7	17+50	289	50	SPO	15° 00' L	2A	
#8	20+51	301	45	DASI			
#9	23+45	294	45	DASI			
#10	26+39	294	50	SPO	11° 39' L	2A	
#11	29+64	325	50	DASI			
#12	32+82	318	50	DADI	16° 37' L	1A	Jackson St. (Abandoned)
#13	35+45	263	45	DASI			
#14	37+83	238	50	DASI			
#15	39+84	201	55	DASI			
#16	42+24	240	50	DADE		2H,2B	Green St.
#17	45+37	313	45	DASI			
#18	48+58	321	45	DASI			
#19	51+18	260	65	DADI			
#20	53+16	198	45	DASI			
#21	55+60	244	45	DASI			
#22	58+57	297	45	DASI			
#23	61+38	281	55	DADE	13° 52' R	1H,1B,1A	
#24-2	62+89	151	50/1	FDADE	38° 41' L	1H,1B,1A	
BUS	64+13	124	37	SUB			



GARDNER, MA
WORCESTER COUNTY

This dwg. supersedes T-520
R.R.Crossing Plan See Dwg.E-6287(OLD)
Length of line=1.20 miles

G.S.17 C.B. KENDALL
G.S.18 CHARLES E. HILCHEY
G.S.19 MANUEL R. COSTA
Guy Rights

NOTES:

1) TO TURN ON WETLANDS & ACCESS ROADS CLICK ON THE EXPRESS TOOLS "LAYER MANAGER ICON", OR TYPE "LMAN" ON THE COMMAND LINE.
2) HIGHLIGHT THE "WETLANDS" LAYER THEN CLICK RESTORE.
3) TO RETURN TO ORIGINAL SETTING HIGHLIGHT THE "STANDARD T-SHEET SETTINGS" THEN CLICK RESTORE OR EXIT DRAWING WITHOUT SAVING IT.

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MAP OF
GARDNER SPUR LINE
TAP OFF VERNON–MILLBURY

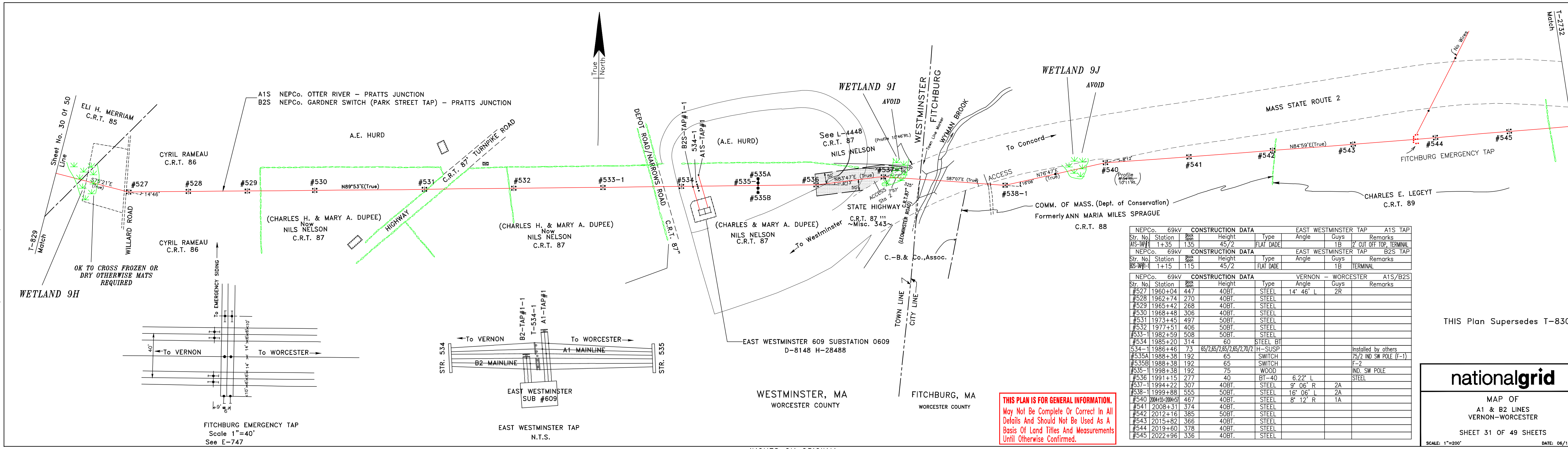
SCALE: 1"=200' DATE: 02/03/1948

INCHES ON ORIGINAL

T-2627-8

REVISIONS

ORIGINAL	REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
DATE 06/19/1950						
DESIGNED	4	10/20/99	ADDED EAST WESTMINSTER SUBSTATION No.609	JFH		
CHECKED	5	08/05/03	ADDED WETLANDS AND NOTES	JE		
SUPERVISOR	6	10/22/09	FI 717 – UPDATED A1/B2 LINE, AND SHEET DATA	DRD		
INSPECTED	7	04/23/12	EAST WESTMINSTER TAP REFURB PER W.O. #90000088573	ML		
REVIEWED	8	10/02/14	C044056, 90000124345 – A1/B2 SWITCH STRUCTURE REPLACEMENT	TEC		
REVIEWED	9	02/12/15	C044056, 90000124345 – A1/B2 Fitchburg Switch Replacement – AsBuilt	ML		
APPROVED	10	05/19/15	CORRECT LINE NAME AND DESIGNATION	TEC		
APPROVED	11	09/18/15	INCLUDE STR #534-1 ON AIS/B2S LINE	TEC		



NEPCo. 69kV CONSTRUCTION DATA				EAST WESTMINSTER TAP			A1S TAP
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
A1S-TAP#1	1+35	135	45/2	FLAT DADE		1B	2' CUT OFF TOP, TERMINAL

NEPCo. 69kV CONSTRUCTION DATA				EAST WESTMINSTER TAP			B2S TAP
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
B2S-TAP#1-1	1+15	115	45/2	FLAT DADE		1B	TERMINAL

NEPCo. 69kV CONSTRUCTION DATA				VERNON – WORCESTER			A1S/B2S
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#527	1960+04	447	40BT.	STEEL	14° 46' L	2R	
#528	1962+74	270	40BT.	STEEL			
#529	1965+42	268	40BT.	STEEL			
#530	1968+48	306	40BT.	STEEL			
#531	1973+45	497	50BT.	STEEL			
#532	1977+51	406	50BT.	STEEL			
#533-1	1982+59	508	50BT.	STEEL			
#534	1985+20	314	60	STEEL BT			
534-1	1986+46	73	65/2,65/2,65/2,65/2,70/2	H-SUSP			Installed by others
#535A	1988+38	192	65	SWITCH			75/2 IND SW POLE (F-1)
#535B	1988+38	192	65	SWITCH			F-2
#535-1	1998+38	192	75	WOOD			IND. SW POLE
#536	1991+15	277	40	BT-40	6.22° L		STEEL
#537-1	1994+22	307	40BT.	STEEL	9° 06' R	2A	
#538-1	1999+88	555	50BT.	STEEL	16° 06' L	2A	
#540	2004+55=2004+57	467	40BT.	STEEL	8° 12' R	1A	
#541	2008+31	374	40BT.	STEEL			
#542	2012+16	385	50BT.	STEEL			
#543	2015+82	366	40BT.	STEEL			
#544	2019+60	378	40BT.	STEEL			
#545	2022+96	336	40BT.	STEEL			

THIS Plan Supersedes T-830

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MAP OF
A1 & B2 LINES
VERNON–WORCESTER

SHEET 31 OF 49 SHEETS

SCALE: 1"=200'   DATE: 06/19/1950

T-2731-11

INCHES ON ORIGINAL

T-2732-7

NEPCo. 69kV CONSTRUCTION DATA					VERNIN – WORCESTER		A1S/B2S
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#546				STEEL			
#547	2029+64	280'	40BT.	WOOD	17° 51' R	2AH	
#548–2	2034+64	500	120	DE			STEEL POLE
#549–2	2043+14	850'	115	SU			STEEL POLE
#550–2	2049+64	650	65	DE			STEEL POLE
#551–B	2052+34	300	40BT.	STEEL	3° 00' L	1A1B	10' TOWER EXT.
#551–C	2057+96	562	50BT.	STEEL			
#551–D	2061+04	308	40BT.	STEEL	18° 03' L	2A	
#552	2064+74=2064+72	370	40BT.	STEEL			
#553	2067+98	326	40BT.	STEEL			
#554	2071+73	375	40BT.	STEEL			

69 kV		CONSTRUCTION DATA					FLAGG POND TAP
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
BUS	0+00						
1	1+67	~~167~~	2–45	HDE	66°20'Lt.	2H,2B,2A	
2	4+27	190	60'	DA			
3	6+77	320	60'	DA			Rte.#2
4	7+69	92	2–55	HDE		2H	Terminal Str.

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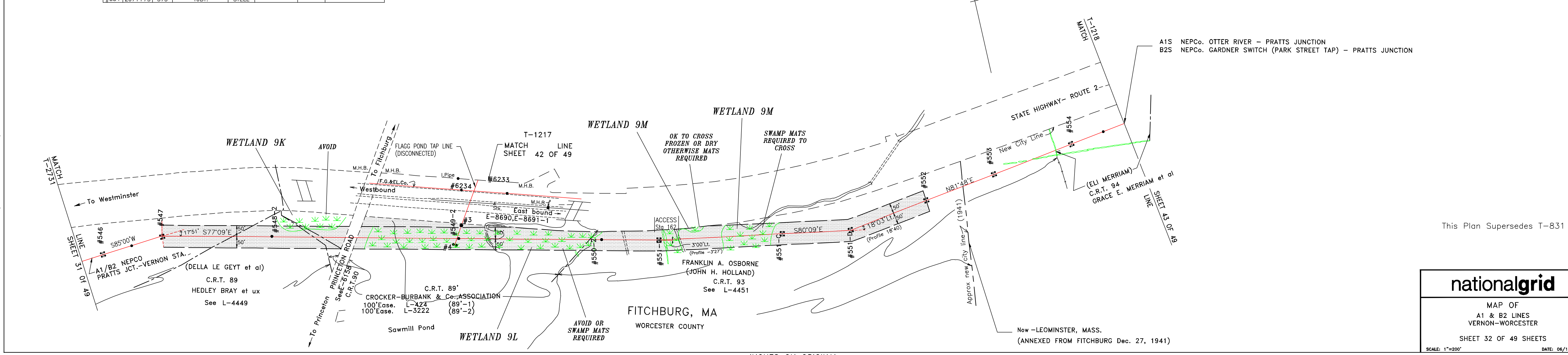

INCHES ON ORIGINAL

REVISIONS

REV	DATE	DESCRIPTION	MADE	CHK'D	APV'D
1	12/06/68	ADDED FLAGG POND SUBSTATION & TAP LINE	JEM		
2	10/28/98	DIGITIZED ON AUTOCAD RELEASE 12 by INFOTECH	BMR		
3	11/05/98	STRUCTURE RELOCATION @ ROUTE 21 PER 08/29/83 FIELD ISSUE	JFH		
4	11/09/99	ADDED MATCH LINES	JFH		
5	08/05/03	ADDED WETLANDS AND NOTES	JE		
6	10/22/09	FI 717 – UPDATED A1/B2, AND SHEET DATA	DRD		
7	05/19/15	CORRECT LINE NAME AND DESIGNATION	TEC		
8					

ORIGINAL
DATE 06/19/1950
DESIGNED / CHECKED / SUPERVISOR / INSPECTED / REVIEWED / REVIEWED / APPROVED / APPROVED

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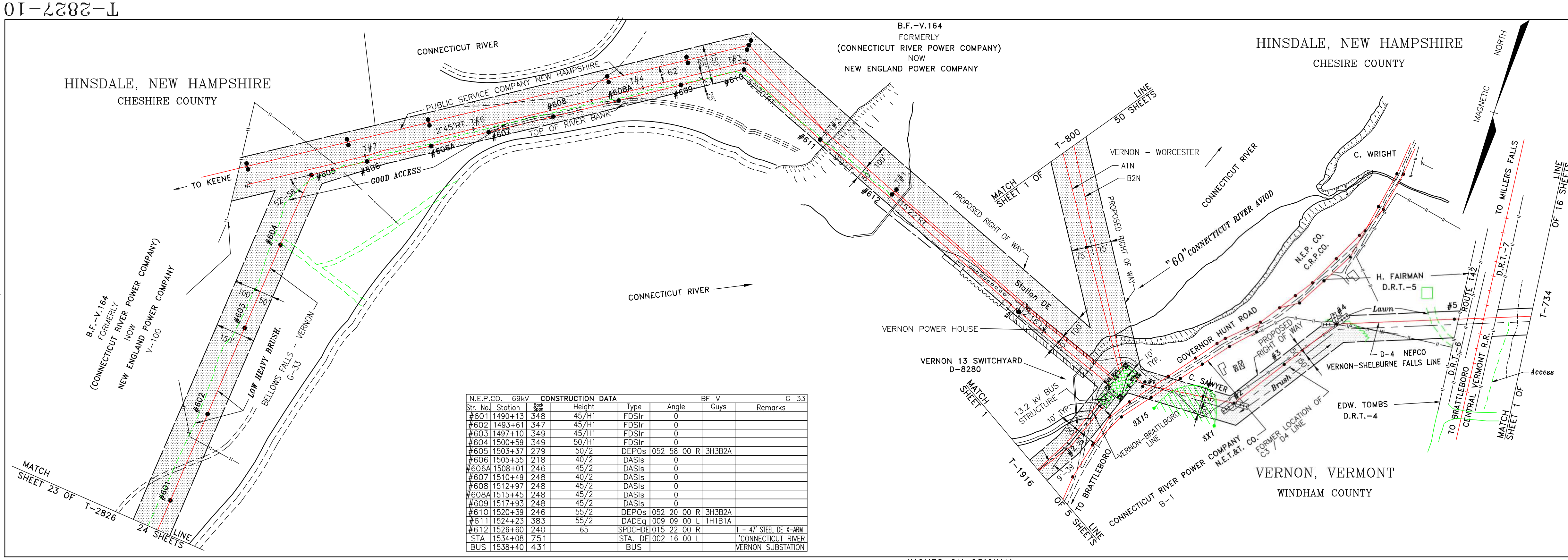
MAP OF
A1 & B2 LINES
VERNON–WORCESTER

SHEET 32 OF 49 SHEETS

SCALE: 1"=200' DATE: 06/19/1950

T–2732–7



N.E.P.CO. 69kV CONSTRUCTION DATA				BF–V			G–33
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#601	1490+13	348	45/H1	FDSIr	0		
#602	1493+61	347	45/H1	FDSIr	0		
#603	1497+10	349	45/H1	FDSIr	0		
#604	1500+59	349	50/H1	FDSIr	0		
#605	1503+37	279	50/2	DEPOs	052 58 00 R	3H3B2A	
#606	1505+55	218	40/2	DASIs	0		
#606A	1508+01	246	45/2	DASIs	0		
#607	1510+49	248	40/2	DASIs	0		
#608	1512+97	248	45/2	DASIs	0		
#608A	1515+45	248	45/2	DASIs	0		
#609	1517+93	248	45/2	DASIs	0		
#610	1520+39	246	55/2	DEPOs	052 20 00 R	3H3B2A	
#611	1524+23	383	55/2	DADEg	009 09 00 L	1H1B1A	
#612	1526+60	240	65	SPDCHDE	015 22 00 R		1 – 47' STEEL DE X-ARM
STA	1534+08	751		STA. DE	002 16 00 L		'CONNECTICUT RIVER
BUS	1538+40	431		BUS			VERNON SUBSTATION

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CONSTRUCTION DATA VERNON–BRATTLEBORO LINE							
STR.NO.	STATION	BACKSPAN	HEIGHT	TYPE	ANGLES	GUYS	REMARKS
BUS	0+00						
2	2+10	210	41' STEEL	TOWER PIN+DISC		9°–39'RT	2 SET AIRBREAK SW.

N.E.P.CO. 69kV CONSTRUCTION DATA				DRT			D–4
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
BUS	0+00				0		Vernon Sub
#1	1+26	72	45,45	SUB LTS	0		
#2	4+79	353	60	DEPO	052 40 00 L		
#3	7+40	261	50	DASI	0		
#4	10+5	265	60	DEPO	032 38 00 R		
#5	14+51	446	60	DASI	0		

NOTES:

1.) THIS PLAN SUPERSEDES T–985.

REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
3	11/07/97	Renumbered G–33 Line.	B.M.R.		
4	07/20/98	Rev'd. Construction Data for G–33 Line Rehibilitation Project.	JFH		
5	01/07/99	Added Access, Wetlands & Wetland, Access Text.	JFH		
6	12/28/00	Removed C3/D4 Line & Installed new D4 Line.	BMR		
7	07/15/03	Added ""60"" Wetland, Access Text.	J.F.H.		
8	05/12/11	CHANGED A1/B2 TO A1N/B2N	TEC		
9	02/01/13	AS BUILT FOR G–33 LINE REFURBISH AND RECONDUCTOR PROJECT	SWF		
10	04/24/18	AS–BUILT: INSTALLED AS SHOWN PER W.O.#'s 90000162309 (VT) & 90000162308 (MA).	CAI/UDB	CAI/SMS	CAI/JJG

ORIGINAL	
DATE	
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

INCHES ON ORIGINAL

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MAP OF

BELLOWS FALLS – VERNON LINE

SHEET 24 OF 24 SHEETS

SCALE: 1"=200' DATE: 04/09/1952

T–2827–10

REVISIONS

REV	DATE	DESCRIPTION	MADE	CHK'D	APP'D
15	02/15/04	ADDED WETLAND 10W			
16	02/15/06	E205 REFURB. FROM #523 TO PRATTS JCT.- ADDED WETLANDS, ACCESS & NOTES	PJ/TEC		
17	10/26/06	F1 632 (12/20/05) - STRUCTURE #193 UPDATED	DRD		
18	11/23/09	F1 780 - J136S TAP REFURBISHMENT	DRD		
19	02/23/10	F1 930 - REPLACE STR #1090 ON E205E LINE	TEC		
20	6/21/10	I-135S & J-136S RECONDUCTORING AND SHIELDWIRE REPLACEMENT - AS-BUILT	TY	PEB	LRG
21	12/30/10	E205 REFURB: From #523 to Pratts Jct.; Design As-Built Updates.	CAI		
22	01/24/13	9000099903, 9000101439 -LINE RELOCATION AT PRATTS JUNCTION SUB, E205E, P142N & 0141N LINES	TEC		

ORIGINAL	
DATE	
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

T-3474-22

MELCO 13.8 KV. P.J.-L. LINE No.S 1 & 2

STR. NO.	STATION	BACK SPAN	HEIGHT	TYPE	ANGLE	GUYS	REMARKS
BUS	3+03±						(Note: Structures
1	5+00	197	2-35	D.E.	10°±Rt.	4H,2A	are wood "K" frame
2	9+35	435	2-40	D.E		4H	construction)

MELCO 13.8 KV. P.J.-L. LINE No. 3

STR. NO.	STATION	BACK SPAN	HEIGHT	TYPE	ANGLE	GUYS	REMARKS
BUS	0+00						(Note: Structures
1	2+28	228	2-35	D.E.	9°35'Lt.	2H,2B,2A	are wood "1/2 K" frame
2	6+73	445	40	D.E.		H,B,A	construction)

N.E.P.Co. 13.8 KV. LINE NO. 225W1

STR. NO.	STATION	BACK SPAN	HEIGHT	TYPE	ANGLE	GUYS	REMARKS
BUS	0+00						Pratts Jct. Sub
1	0+50	50			89°46'Lt.		Installed by others
2	1+00	50					Installed by others
3	1+83	83					Installed by others
4	4+03	220	45	BADE	111°00'Rt.	1H,1B	Start of Construction
5	6+36	233	2-45	Susp.			CONRAIL XING
6	9+53	317	2-45	D.E.	6°11'Lt.	2H,2B,2A	Opp.T.#663(A1/B2)Lines
7	12+85	332	2-45	Susp.	2°35'Lt.	2A	Opp.T.#662(A1/B2)Lines
8	14+51	166	45	SA-Susp.			
9	16+17	166	45	SA-Susp.			Opp.T.#661(A1/B2)Lines
10	18+26	209	50	SA-Susp.			
11	20+35	209	55	DA Susp.			Opp.T.#1090(E-205)Line
12	22+05	170	55	DA Susp.			
13	24+29	224	40	SA Susp.			Opp.T.#659(A1/B2)Lines
14	26+15	186	40	SA Susp.			
15	28+00	185	45	DA Susp.			Opp.T.#658(A1/B2)Lines
16	30+30	230	45	SA Susp.			
17	32+60	230	50	DA Susp.			
18	35+00	240	50	SA Susp.			Dirt Parking Area
19	37+55	255	45	DA Susp.			
20	40+15	260	45	DA Susp.			Opp.T.#655(A1/B2)Lines
21	42+12	197	40	SA Susp.			Opp.T.#1085(E-205)Line
22	43+37	125	40	DADE		1H,1B	Opp.T.#654(A1/B2)Lines End Const.
23	44+89	~152					Str. at Rte.12 to be
							installed by others

M.E.L.Co. 13.8 KV. DISTRIBUTION LINE NO. 225W4

STR. NO.	STATION	BACK SPAN	HEIGHT	TYPE	ANGLE	GUYS	REMARKS
BUS	0+00	0					
1	0+39	39	35	BA	70°±LT.	H,2B	
2	2+01	162	40	BA	67°06'RT.	2H,2B,A	
3	3+11	110	35	PO	40°59'RT.	2A	
4	4+61	150	35	D.E.		H,B,S	
5	5+86	125	60	SA	5°02'		
6	7+08	122	60	D.E.		H,B,S	NEUTRAL TAP FOR 225W3
7	9+83	275	50	SA			
8	12+71	288	60	SA			

N.E.P.CO. 115kV **CONSTRUCTION DATA** PRATTS JUNCTION - MILLBURY O-141N

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#1	2+52	252	65	DA-DE	31° 16' R		STEEL
#2	3+65	113		FA	17° 04' L		STEEL
#3	6+00	152	85	DC-DE	68° 00' R		O-141N/P-142N

N.E.P.CO. 115kV **CONSTRUCTION DATA** PRATTS JUNCTION - MILLBURY P-142N

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#1	2+54	254	65	DA-DE	9° 23' R		STEEL
#2	3+54	100	65	DA-DE	26° 19' R		STEEL
#3	6+00	152	85	DC-DE	68° 00' R		O-141N/P-142N

N.E.P.Co. 115 KV. B.F.-P.J. LINE No.s I-135S & J-136S

372	0+00		60	D.E.(TOWER)			Bellows Falls - Pratts Junction I-135 & J-136 Line.
372A	2+01	201	1-75,1-75	H-DE			J136S (2-75' WOOD)
TAP	2+51	50					
373	3+19	118	M-46	DE(TOWER)			

N.E.P.CO. **CONSTRUCTION DATA** I-135 & J-136

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#368	384+04		60,60	H-SUSP			
#369	393+03		80,80	H-SUSP			
#370	401+36		60,60	H-SUSP			
#371	409+38		70,70	H-SUSP			
#372	418+13	875	60	STEEL K-60	5ø31' R		
#373	427+69	313/J116	46	STEEL M-46	28° L		

N.E.P.CO. **CONSTRUCTION DATA** J-136

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#372A	419+40	127	75/1,75/1	H-DE			

N.E.P.CO. 69kV **CONSTRUCTION DATA** P.J. - L. - AYER Line No. U-21S

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#BUS	0+00		50'	Sub DE			Pratts Junction Substation
#1	3+08	308	60' CL.2	DADI			Railroad
#2	5+73	265	60' CL.2	DADE		1H1B	
#3	9+36	363	60' CL.2	SPO	8°22'LT	3A	
#4	12+37	301	50' CL.2	DASI			
#5	15+37	300	50' CL.2	DASI			
#6	18+53	316	50' CL.2	DASI			
#7	21+65	312	55' CL.2	DADI			Legate Road
#8	24+88	323	50' CL.2	DASI			
#9	27+75	287	50' CL.2	DASI			
#10	31+41	366	50' CL.2	DASI			
#11	35+01	360	50' CL.2	DASI			
#12	38+77	376	45' CL.2	DADE		1B,1H	Last Structure in Sterling.
#13	40+74	197	50' CL.2	DASI			First Structure in Leominster
#14	43+72	298	55' CL.2	DASI			

N.E.P.CO. 69kV **CONSTRUCTION DATA** P.J. - L. - AYER. Line No. V-22S

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#BUS	0+00		50'	Sub DE			Pratts Junction Substation
#1	2+65	265	50'	TOWER			
#2	5+73	265	60'	DADE		1B,1H	
#3	9+36	363	60'	SPO	8°-22'LT	3A	
#4	12+37	301	50'	Br SASI			
#5	15+37	300	50'	SASI			
#6	18+53	316	50'	SASI			
#7	21+65	312	55'	SASI			Legate Road
#8	24+88	323	50'	Br SASI			
#9	27+75	287	50'	Br SASI			
#10	31+41	366	50'	Br DASI			
#11	35+01	360	50'	Br DASI			
#12	38+77	376	45'	Br DASI		1B,1H	Last Structure in Sterling.
#13	40+74	197	50'	DASI			First Structure in Leominster
#14	43+72	298	55'	Br DADE			

N.E.P.CO. 69kV **CONSTRUCTION DATA** VERNON-WORCESTER N-40A

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#1				WOOD			

N.E.P.CO. 69kV **CONSTRUCTION DATA** VERNON-WORCESTER N-40B

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#1				WOOD			

N.E.P.CO. 69kV **CONSTRUCTION DATA** B.F.-P.J- VERNON-W. Line Nos. A1/B2

653	2431+41		50	PIN	1°-57'RT.		
654	2434+51		40	PIN			
655	2437+71		40	PIN			
656	2441+71		40	PIN			
657	2445+71		40	PIN			
658	2449+90		40	PIN			
659	2453+68		40	PIN			
660	2457+28		60	PIN			
661	2461+78		40	PIN			
662	2465+07		40	PIN			
663	2468+43		40	PIN	6°-11'RT.	1A	
664	2471+47		40	PIN			
665	2473+40		40	PIN			
SUB	2477+07		40	PIN			TOWER REMOVED- BUS STRUCTURE

N.E.P.Co. **CONSTRUCTION DATA** N.Y.-P.J. E-205E

STR. NO.	STATION	BACK SPAN	HEIGHT	TYPE	ANGLE	GUYS	REMARKS
#1084	3714+97	271	75,75	SUSP	0		X-Brace
#1085	3718+72	375	75,75	SUSP	0		X-Brace
#1086	3722+09	337	75,75	SUSP	0		X-Brace
#1087	3728+51	642	85,85	SUSP	0		X-Brace
#1088	3733+55	504	70,70	SUSP	0		X-Brace
#1089	3737+81	426	75,75	SUSP	0		X-Brace/Aerial Marker
#1090	3740+39	258	75,75	SUSP	0		X-Brace
#1091	3744+65	426	75,75	SUSP	0		X-Brace
#1092	3747+45	280	75,75,75	3P-DE	009 55 22 R	3H3B4A	
#1093	3751+29	384	75,75	SUSP	0		X-Brace
#1094	3754+68	339	70,70	SUSP	0		X-Brace
#1095	3757+39	271	85,85	SUSP	0		X-Brace/B & M R.R./Aerial Marker
#1096	3760+17	278	70,70,70	3P-DE	021 13 41 L	3H3B4A	
#1097	3767+34	372	80/1,75/1,75/2	DEPO	90° 59" L	5H5B 10	Spcl X-Brace Looped Guys
#1098	3770+47	313	115/2,115/2	H-SU	0		
#1099B			65,65,65	T-DE			STEEL
#1099A	3773+60	350	95,95,95	T-DE			STEEL
BUS	3774+95	135					Pratts Jct Substation

N.E.P.Co. 345kV PRATTS. JCT.-MILLBURY 343

193	1104+55±	320	80',80'	SUSP.			

N.E.P.Co. 115 K.V P.J.- LAUREL CIRCLE LINE No. L-138W

129	777+70	720					
130-A	782+54	469			114°18'08"L		
BUS	783+71	117					

N.E.P.Co. 115 K.V. P.J.- AYER LINE No. K-137W

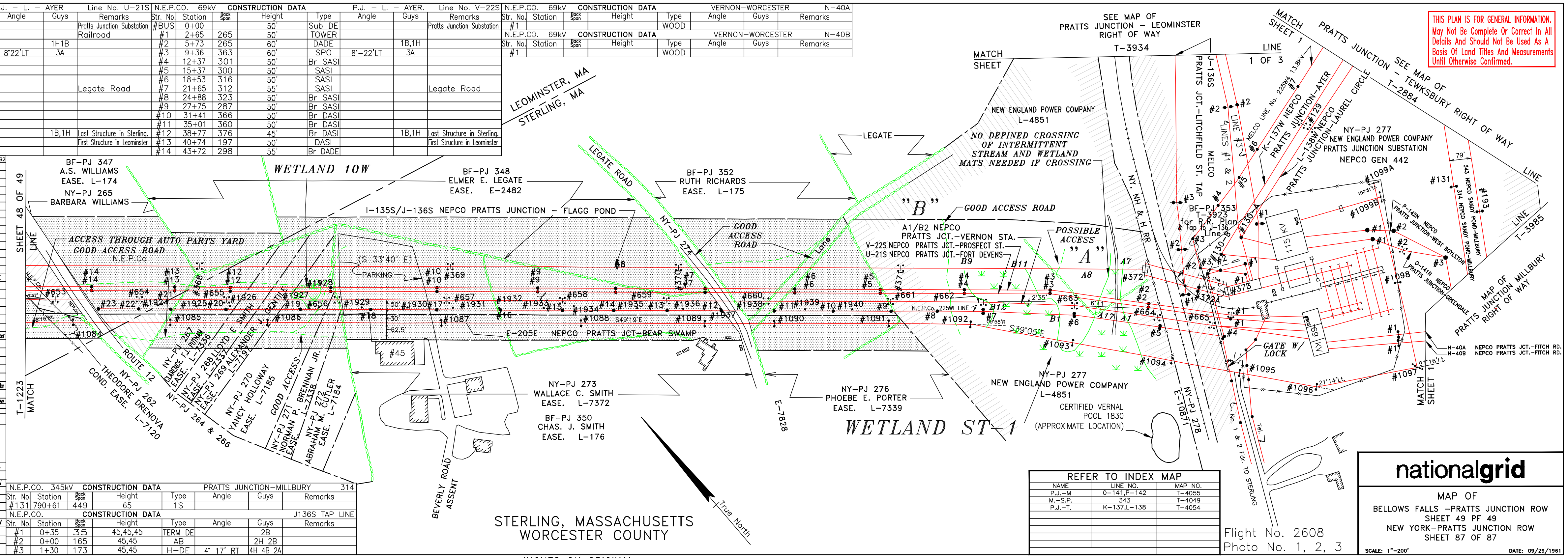
129	777+73	740					
130-B	783+33	559			118°27'38"L		
BUS	785+50	217					

N.E.P.CO. 345kV **CONSTRUCTION DATA** PRATTS JUNCTION-MILLBURY 314

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#131	790+61	449	65	1S			

N.E.P.CO. **CONSTRUCTION DATA** J136S TAP LINE

Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#1	0+35	35	45,45,45	TERM DE		2B	
#2	0+00	165	45,45	AB		2H 2B	
#3	1+30	173	45,45	H-DE	4° 17' RT	4H 4B 2A	



THIS PLAN IS FOR GENERAL INFORMATION. May Not Be Complete Or Correct In All Details And Should Not Be Used As A Basis Of Land Titles And Measurements Until Otherwise Confirmed.

REFER TO INDEX MAP

NAME	LINE NO.	MAP NO.
P.J.-M	O-141,P-142	T-4055
M.-S.P.	343	T-4049
P.J.-T.	K-137,L-138	T-4054

Flight No. 2608
Photo No. 1, 2, 3

INCHES ON ORIGINAL

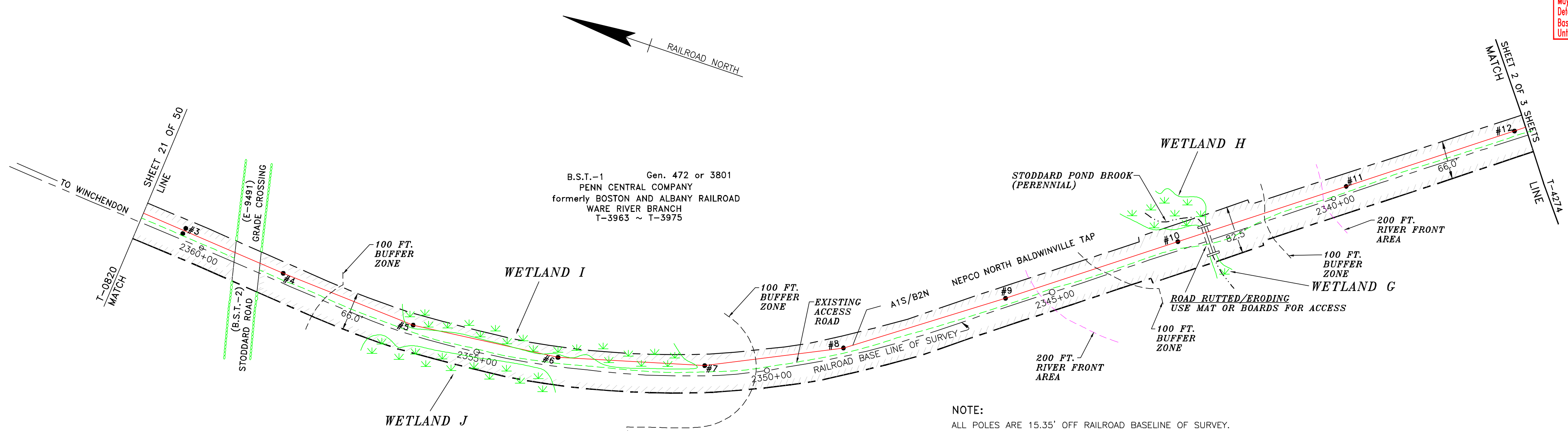
nationalgrid

MAP OF
BELLOWS FALLS -PRATTS JUNCTION ROW
SHEET 49 PF 49
NEW YORK-PRATTS JUNCTION ROW
SHEET 87 OF 87

SCALE: 1"=200' DATE: 09/29/1961

T-3474-22

N.E.P.CO.			CONSTRUCTION DATA			A1S/B2N N. BALDWINVILLE TAP	
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#3	4+63	155	55/3,55/3	HDE		2H	
#4	6+45	182	70/1	DV-SU	1° 25' L	1A,1B/SW	RESTRAINED
#5	8+78	233	65/1	DV-SU	7° 45' LT	1A	RESTRAINED
#6	11+28	250	60/1	DV-SU	10° 15' L	1A	RESTRAINED
#7	13+78	250	65/1	DV-SU	10° 00' L	1A	RESTRAINED
#8	16+28	250	65/1	DV-SU	9° 25' L	1A	RESTRAINED
#9	19+28	300	65/1	DV-SU	1° 30' L	1A	RESTRAINED
#10	22+28	300	65/1	DV-SU			
#11	25+30	302	65/1	DV-SU			
#12	28+30	300	65/1	DV-SU	1° 10' R	1A	RESTRAINED



NOTE:
ALL POLES ARE 15.35' OFF RAILROAD BASELINE OF SURVEY.
RAILROAD VALUATION SHEETS $\frac{V.5}{43}$ Through $\frac{V.5}{50}$
R-2558-1 Through R-2558-8 (NEPCo Plan File Room)

WINCHENDON, MASSACHUSETTS
WORCESTER COUNTY

INCHES ON ORIGINAL

REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
1	07/01/97	DIGITIZED ON AUTOCAD RELEASE 12 by INFOTECH	BMR		
2	10/15/99	ADDED MATCH LINE AND REVISED CONSTRUCTION DATA	BMR		
3	10/19/06	WETLANDS, ACCESS AND BUFFER ZONES ADDED	KPB		
4	01/13/09	FI 863 – UPDATED A1/B2 LINES, AND SHEET DATA	DRD		
5	06/08/11	RENAME A1/B2 TO A1S/B2N	TEC		
6	11/06/15	9000044463 – N. BALDWINVILLE TAP REFURB, AS-BUILT	TEC		
7					
8					

ORIGINAL	
DATE	11/03/1972
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

nationalgrid

MAP OF
NORTH BALDWINSVILLE TAP
RIGHT OF WAY

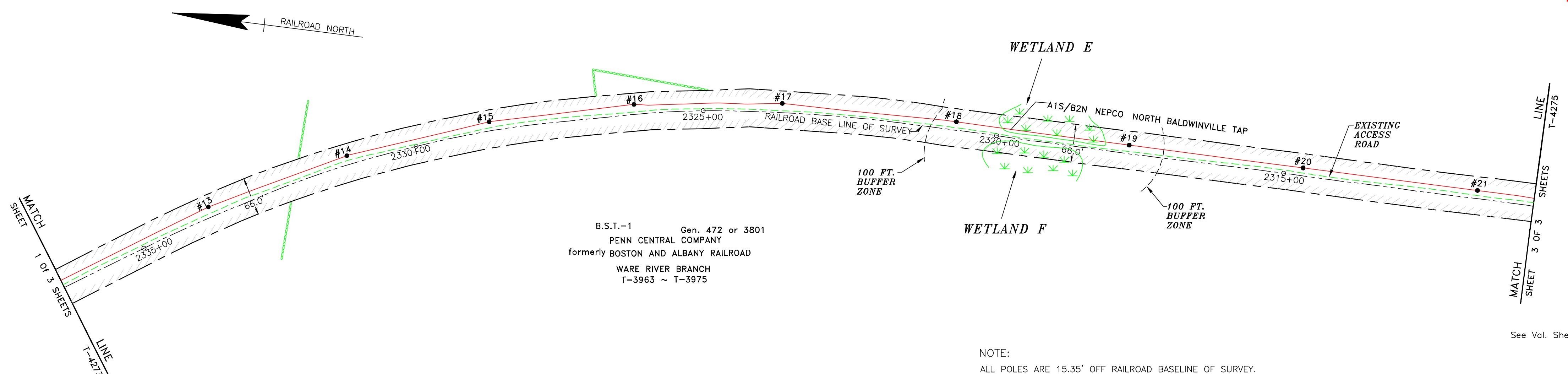
SHEET 1 OF 3 SHEETS

SCALE: 1"=200'
DATE: 11/03/1972

T-4273-6

T-4274-5

N.E.P.CO.			CONSTRUCTION DATA			A1S/B2N N. BALDWINVILLE TAP	
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#13	31+30	275	65/1	DV-SU	5° 10' R	1A	RESTRAINED
#14	33+80	250	65/1	DV-SU	7° 00' R	1A	RESTRAINED
#15	36+30	250	65/1	DV-SU	7° 05' R	1A	RESTRAINED
#16	38+80	250	65/1	DV-SU	5° 50' R	1A	RESTRAINED
#17	41+30	250	65/1	DV-SU	6° 05' R	1A	RESTRAINED
#18	44+30	300	65/1	DV-SU	1° 45' R	1A	RESTRAINED
#19	47+30	300	70/1	DV-SU			
#20	50+30	300	65/1	DV-SU			
#21	53+30	300	65/1	DV-SU			



THIS PLAN IS FOR GENERAL INFORMATION. May Not Be Complete Or Correct In All Details And Should Not Be Used As A Basis Of Land Titles And Measurements Until Otherwise Confirmed.

See Val. Sheets V.5/44 & V.5/45

NOTE:

ALL POLES ARE 15.35' OFF RAILROAD BASELINE OF SURVEY.
RAILROAD VALUATION SHEETS V.5/43 Through V.5/50
R-2558-1 Through R-2558-8 (NEPCo Plan File Room)

WINCHENDON, MASSACHUSETTS

WORCESTER COUNTY

INCHES ON ORIGINAL

nationalgrid

MAP OF
NORTH BALDWINSVILLE TAP
RIGHT OF WAY

SHEET 2 OF 3 SHEETS

SCALE: 1"=200' DATE: 11/03/1972

T-4274-5

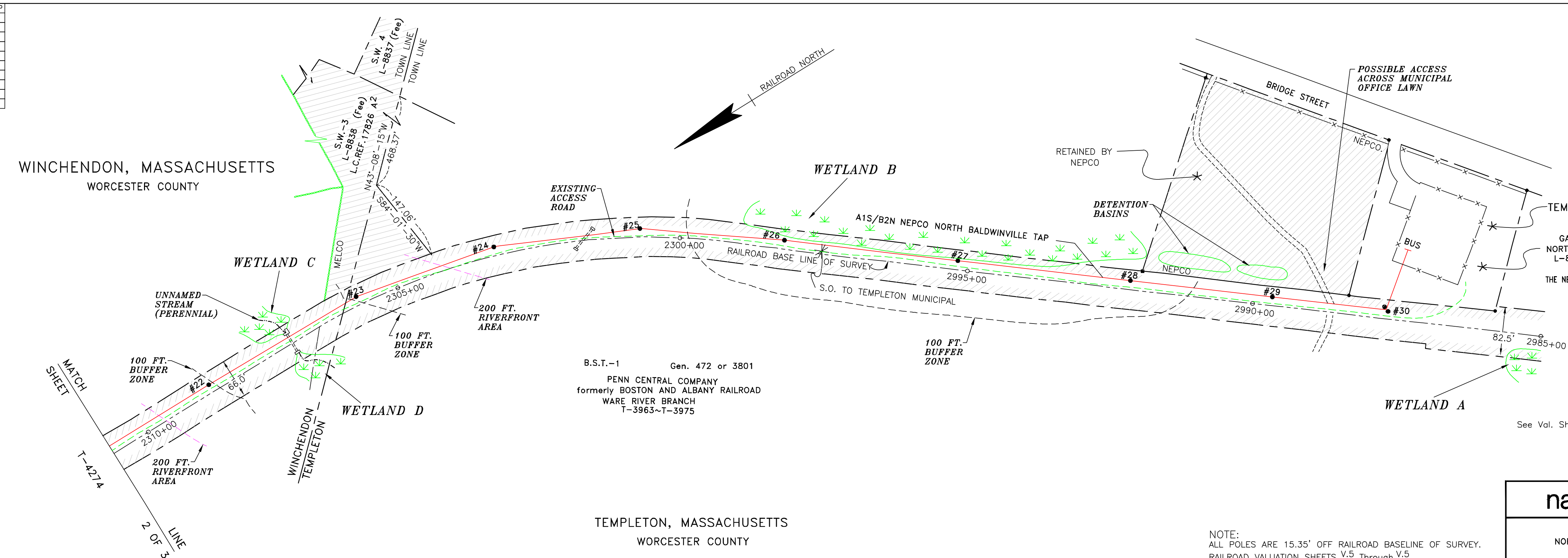
REVISIONS

ORIGINAL	REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
DATE 11/03/1972						
DESIGNED	1	07/14/97	DIGITIZED ON AUTOCAD RELEASE 12 bY INFOTECH	BMR		
CHECKED	2	10/20/06	WETLANDS, ACCESS AND 100 FT BUFFER ZONE ADDED	KPB		
SUPERVISOR	3	01/13/10	FI 863 – UPDATED A1/B2 LINE, AND SHEET DATA	DRD		
INSPECTED	4	06/08/11	RENAME A1/B2 TO A1S/B2N	TEC		
REVIEWED	5	11/06/15	900000044463 – N. BALDWINVILLE TAP REFURB, AS-BUILT	TEC		
REVIEWED	6					
APPROVED	7					
APPROVED	8					

T-4275-6

N.E.P.CO.	CONSTRUCTION DATA					A1S/B2N N. BALDWINVILLE TAP	
Str. No.	Station	Back Span	Height	Type	Angle	Guys	Remarks
#22	56+30	300	65/1	DV-SU	0° 55' R	1A	RESTRAINED
#23	59+30	300	60	DV-SU	10° 20' R	1A	RESTRAINED
#24	61+80	250	60	DV-SU	12° 35' R	1A	RESTRAINED
#25	64+30	250	60	DV-SU	12° 10' R	1A	RESTRAINED
#26	66+80	250	65	DV-SU	3° 05' R	1A	RESTRAINED
#27	69+80	300	65	DV-SU			
#28	72+80	300	65	DV-SU			
#29	75+30	250	65	DV-SU		1B	
#30	77+30	200	60,65	DEPO	77° 00' L	3H,3B,1A	

THIS PLAN IS FOR GENERAL INFORMATION. May Not Be Complete Or Correct In All Details And Should Not Be Used As A Basis Of Land Titles And Measurements Until Otherwise Confirmed.



NOTE:
ALL POLES ARE 15.35' OFF RAILROAD BASELINE OF SURVEY.
RAILROAD VALUATION SHEETS V.5/4.3 Through V.5/50 .
R-2558-1 Through R-2558-8 (NEPCo Plan File Room)

INCHES ON ORIGINAL

REVISIONS

REV	DATE	DESCRIPTION	MADE	CH'K'D.	AP'V'D.
1	07/14/97	DIGITIZED ON AUTOCAD RELEASE 12 by INFOTECH	BMR		
2	10/20/99	NORTH BALDWINVILLE SOLD TO TEMPLETON MUNICIPAL NOV. 1981	BMR		
3	10/20/06	WETLANDS, ACCESS AND BUFFER ZONES ADDED	KPB		
4	01/13/10	FI 863 - UPDATED A1/B2 LINE	DRD		
5	06/08/11	RENAME A1/B2 TO A1S/B2N	TEC		
6	11/06/15	9000044463 - N. BALDWINVILLE TAP REFURB, AS-BUILT	TEC		
7					
8					

ORIGINAL	
DATE 11/03/1972	
DESIGNED	
CHECKED	
SUPERVISOR	
INSPECTED	
REVIEWED	
REVIEWED	
APPROVED	
APPROVED	

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MAP OF
NORTH BALDWINSVILLE TAP
RIGHT OF WAY

SHEET 3 OF 3 SHEETS

SCALE: 1"=200' DATE: 11/03/1972

T-4275-6

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Transmission System Impact Study Report for Group 1 of Distributed Energy Resource (DER) Additions in Western Massachusetts

November 2019

Prepared by:
Dean Latulipe
Raman Somayajulu

nationalgrid

NEW ENGLAND POWER COMPANY
40 Sylvan Rd
Waltham, MA 02451

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List of Figures

1 EXECUTIVE SUMMARY

This document provides the transmission system impact study report for Group 1 of National Grid's Western MA DER interconnection cluster study. Group 1 consists of the first stage of proposed Distributed Energy Resources (DER) additions applying for interconnection into the the National Grid distribution system in Western MA. The total DER applying for interconnetion int the Western MA distribution system is 787 MW. This 787 MW of DER includes all applications which are greater that 1 MW in Western MA which were submitted to transmission for evaluation at time of the commencement of the study . Group 1 of the cluster consists of 320 MW, with 90 MW already getting approval to connect earlier in the year. Group 2 consists of an additional 467 MW of DER in Western Massachusetts. The transmission impact study for Group 2 is planned to be completed by April 1st of 2020.

The interconnection of the remaining 230 MW of Group 1 of the Western MA DER interconnection cluster was found to result in only one criteria violation (steady state high voltage violations, as discussed below).

Steady State Results

No N-1 Thermal and Voltage violations were found for any of the conditions tested.

No N-1-1 Thermal overloads were found for any of the conditions tested.

N-1-1 High Voltages were identified for the following conditions.

- High voltages can occur along the Y-25 69 kV line between Adams, Deerfield 5, Harriman, and Searsburg. These high voltages occur in the existing system, but are made worse by the interconnection of Group 1 of the Western MA DER Cluster. The high voltages can be eliminated by changing the tap settings of the Adams 115/69 kV autotransformer to the following:

  Existing Tap Settings:
    - High Voltage Winding = 113 kV
    - Low Voltage Winding = 69 kV

  Proposed Tap Settings:
    - High Voltage Winding = 111 kV
    - Low Voltage Winding = 66 kV

- High voltages can occur along the B-2 69 kV line at Crystal Lake, Westminster and E Westminster for loss of the D-4E 69 kV line followed by the B2 Breaker Open contingency at Pratts Jct.   This high voltage can be eliminated by implementing the following upgrade:

- Install Direct Transfer Trip (DTT) protection from Pratts Jct to Crystal Lake, that trips the entire B-2S line following the B2 breaker open contingency at Pratts Jct. The DTT scheme will sent a trip signal to Crystal Lake 69 kV anytime the B2S breaker at Pratts Jct opens without a fault.   This action will result in the B2S 69 kV line supplies to Westminster and E Westminster substations, being tripped. The loads and DG at Westminster and E Westminster substation will then be transferred to the A1S 69 kV line via an automatic transfer scheme.

If this transmission solution is not implemented, these high voltages along the B2 line will be eliminated if the 4.99 MW DER unit proposed to be connected to the B-2 line at E Westminster, via Transformer #1, is not connected. It is proposed that this DER unit does not connect until the DTT solution is implemented.

Transient Stability Results

No criteria violations were found for any condition tested, either for N-1 contingencies or N-1-1 Contingencies.

Short Circuit Results

The interconnection of Group 1 of the Western MA Cluster was found to not cause the fault duty to exceed the interrupting capability of any transmission breakers.

PSCAD Results

- *DER Performance.* No DER was found to trip, enter into momentary cessation, or introduce instabilities for all contingencies simulated.   Although significant effort was made to obtain high quality DER models for the most common inverter types being connected into the region, the inverters ultimately modelled may not comply with National Grid's ride-through criteria (per ESB 756 National Grid Document). The DER protection, control, and momentary cessation settings in all installed equipment will be verified for adherence to National Grid's ride-through criteria.

- *Harmonic Distortions.* The SG60 inverter (60 kW, Sungrow) used at several DER installations within the cluster, and the Q660 connected plant (SMA inverters), are sources of harmonic distortions which were found to propagate into the wider system. The light load case showed higher levels of distortion than the peak load case.

The issues noted above are related to incorrect modelling of nearby conventional synchronous generators. The extent to which these generators contributed to the observed issues will be further investigated, and mitigation will be implemented if necessary.

2 INTRODUCTION

This document provides the system impact study for the interconnection of 320 MW of Distributed Energy Resources (DER), greater than 1 MW, into the Western Massachusetts distribution system, owned by National Grid, over the years 2020 to 2021. The 320 MW represents “Group 1” of the total 787 MW DER proposed for the National Grid distribution system in Western MA.

None of the additional DER will be directly connected to the transmission system. All of the DER will be mixed with distribution load. None of the additional DER will control voltage. All DER will be set to a Power Factor of unity.

2.1 Study Objective

The objective of this study was to identify the transmission upgrades, if any, required to integrate the proposed DER without resulting in any significant adverse impact on the reliability, stability, and operating characteristic of the New England bulk power transmission system and National Grid transmission system.

2.2 Project Description

320 MW of Distributed Energy Resources have applied to interconnect to the National Grid distribution system in Western MA by 2021, greater than 1 MW.

Study Area

The transmission system geographic map and one line diagram of the study area are shown in the following figures, with the DER project locations identified.

Figure 1 – Proposed DER Locations - Geographic Map

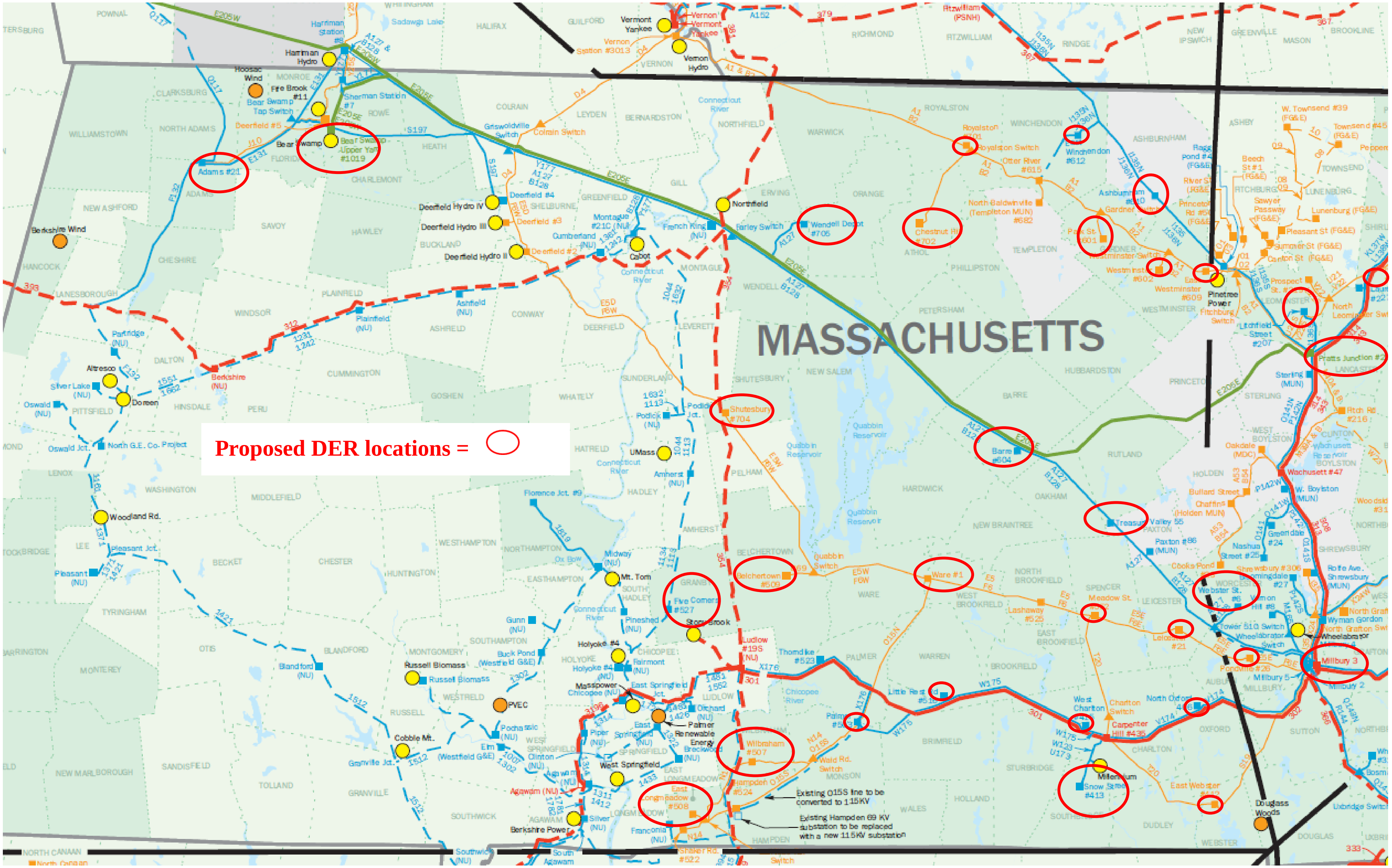


Figure 2 – Proposed DER locations – One Line Diagram

[redacted]

3 STUDY APPROACH

DER additions 1 MW and below, did not need to be added to the base cases for this study. The base cases utilized for this study already include negative loads (with “PD” identifiers) that model the forecasted PV, 1 MW and below, out to year 2022/23. This DER, 1 MW and below, is distributed proportionally across the load busses in Western Massachusetts. Therefore, only that DER additions that exceed 1 MW, will be added to the cases that will be utilized for this study. All 320 MW associated with Group 1 is greater than 1 MW.

3.1 Sequence Groupings of Proposed DER

At the commencement of this study in April 2019, the total volume of DER applications in Western MA was equal to 937 MW. Based on the timeframe range for a level 3 study (3-12 months) in the ISO-NE Planning Procedure 5-3, it was determined that as a function of the complexity of the study it would take 12 months to complete. Considering the length of this timeframe, the Massachuetts Electric Company (“MECo”) provided a prioritization to the list of pending applications based on the MECo application queue position and other factors. With this prioritization, the 937 MW was split into Group 1 and Group 2. Since April 2019, the total of 937 MW has reduced to 787 MW, this attrition has been mainly experienced in Group 2 of the study.

The Group 1 total amounts to 320 MW, and was the first increment of DER to be studied in Western MA. The DER totals for Group 1 are shown in the following table for each substation.

Table 1 – Group 1 DER Totals by Substation

SUBSTATION for GROUP 1	Total kW
ADAMS SUBSTATION	20,810
ASHBURNHAM SUBSTATION	9,516
BARRE SUBSTATION	15,120
BEAR SWAMP UPPER YARD SUBSTATION	2,750
BELCHERTOWN SUBSTATION	12,980
CHESTNUT HILL 702 SUBSTATION	8,940
Crystal Lake SUBSTATION	16,936
E. WEBSTER SUBSTATION	4,980
E. WESTMINSTER SUBSTATION	9,960
E. WINCHENDON SUBSTATION	3,900
EAST LONGMEADOW SUBSTATION	8,990
FIVE CORNERS SUBSTATION	3,000
LASHAWAY SUBSTATION	17,173
LEICESTER SUBSTATION	2,580
LITCHFIELD ST SUBSTATION	4,950
LITTLE REST RD SUBSTATION	15,432
MEADOW STREET 552 SUBSTATION	14,170
MILLBURY SUBSTATION	13,360
N. OXFORD SUBSTATION	8,708
PALMER 503 SUBSTATION	16,820
Pondville SUBSTATION	4,876
SNOW ST. SUBSTATION	14,844
THORNDIKE SUBSTATION	12,448
TREASURE VALLEY SUBSTATION	4,230
W. CHARLTON SUBSTATION	22,519
WARE SUBSTATION	13,140
WENDELL DEPOT SUBSTATION	14,970
West Hampden 139 SUBSTATION	15,673
WESTMINSTER SUBSTATION	4,877
WILBRAHAM SUBSTATION	6,400
Total	**320,052**

3.2 Study Assumptions

- DER was dispatched as follows in both the steady state base cases, as well as the stability base cases:

  - All the new DER in this study, greater than 1 MW, was added to the cases, and dispatched at 100% nameplate, at all load levels. This DER was modeled with negative load[1] at each distribution bus for the substations listed in Table 1. No distribution feeder impedance was assumed.

  - For the purposes of describing the treatment of exisiting and forecasted PV in the study, PV was placed into three categories:

.

    - All existing Category 1 PV (existing or PPA approved PV Facilities greater than or equal to 5 MW) in the 2022/23 basecase representation provided by ISO-NE, was dispatched at 100 % output for all load levels

    - All existing Category 2 PV (existing PV Facilities greater than 1 MW and less than 5 MW) provided by ISO-NE with the 2022/23 base cases, was dispatched at 100 % output at the peak load level only. No Category 2 PV was modeled in the light load and intermediate load cases

    - All existing Category 3 PV (Existing Facilities less than or equal to 1 MW and and all future forecasted solar PV for which locational information is not available) provided by ISO-NE with the 2022/23 base cases, was dispatched at 100 % output at the peak load level only. Note that the “future” solar PV greater than 1 MW and less than 5 MW was carved out of the Category 3 PV so as to avoid double counting of the new DER for which this study is being conducted. No Category 3 PV was modeled in the light load and intermediate load cases

- None of the DER additions were modeled in voltage control mode, since all of the new DER will be mixed with distribution load (i.e. no DER will be installed on dedicated feeders)

- None of the additional DER will be operated in frequency control mode, and therefore the DER additions were modeled that way in the stability study.

- No transmission ring busses are required for any DER additions that are mixed with distribution load. For example, 13 MW of DER is proposed for connection into the existing Belchertown 69/13kV substation. Even though 13 MW is much higher than the Belchertown minimum load (6 MW), no 69 kV ring bus is required to connect the 69 kV PTF line (F-6)

[1] DER was modeled as generators in the stability base cases

- Starting from the original base cases developed for this study, and prior to testing any contingencies, the new DER was dispatched (at 100% output) against existing (and PPA approved) non-DER generation in Connecticut. This maintained the same transfer levels (pre vs post DER additions) of interfaces relevant to this study (i.e. E-W and NY-NE).

- Treatment of transmission overloads above 100 kV in study:

    - For N-0 and N-1 conditions, transmission overloads above 100kV found after dispatching the DER against generation in Connecticut, the DER may be redispatched against existing local non DER generation in western MA, directly connected to the 115 kV system or above, pre-contingency, so as to remove such overloads[2].

    - For N-1-1 conditions, it was assumed that existing generators, connected directly to the 115 kV system and above, can be redispatched, or tripped, between N-1 and N-1-1 contingencies, so as to eliminate a post N-1-1 thermal overloads above 100 kV.

    - No DER generation can be redispatched between contingencies to eliminate N-1-1 overloaded elements above 100 kV.

- Treatment of transmission overloads below 100 kV in study:

    - For N-0 and N-1 conditions, the new DER can't be dispatched against existing generation directly connected to the 69 kV system to eliminate N-0 or N-1 69 kV overloads.

    - For N-1-1 conditions, it was assumed that any generator directly connected to the 69 kV system in Western MA, and under the control National Grid's control center can be redispatched between N-1 and N-1-1 contingencies to prevent post N-1-1 contingency 69 kV overloads from occurring. Also, Bear Swamp generation/pump can be re can be redispatched between N-1 and N-1-1 contingencies to prevent post N-1-1 contingency 69 kV overloads.

        The following generators were assumed to redispatched between contingencies by National Grid operators to prevent post N-1-1 69 kV overloads.

[redacted]

[2] This is consistent with the Mininum Interconnection Standard (MIS) outlined by FERC Order 2003.

[redacted]

- No DER generation can be redispatched between contingencies to eliminate 69 kV N-1-1 overloaded elements.

- The E Winchendon 115 kV Tap line, currently connected to the J-136N line (4/0 Cu), will be swapped to the I-135 line (795 ACSR), by changing the status of the switches at the ROW (e.g. from normally open to normally closed). It is assumed that the additional DER on the E Winchendon will overload the 4/0 Cu on the J-136N line (Bellows Falls to Flagg Pd). This will be accomplished before the additional DER at E Winchendon goes into service.

- It is assumed that N-1-1 contingencies involving 69 kV double circuit towers, or 69 kV breaker failures will not cause a significant adverse impact outside the local area (i.e. NPCC criteria violation), and therefore will not be tested.

- H-134 115 kV project (RSP #951) E Winchendon to Otter River) not in-service

- [redacted]

- New dual pilot schemes for X-176 line (Ludlow to Palmer), in-service (project scheduled for completion by May 2022).

- North Oxford 2nd 115/13 kV transformer, plus 115 kV breaker, in-line with V-174 line, in-service 2022.

- QP660 [redacted]" 20 MW PV unit connecting directly to D-4 69 kV line between Deerfield 4 and Vernon), [redacted]

- QP592 -Bear Swamp Unit 1 and 2 Upgrade In-Service
- QP-508 Alps Berkshire HVDC Project Not In-Service (Withdrawn)
- QP-651 Alps Berkshire Phase Shifting Transformer: Not In-Service (withdrawn).
- QP697 (5.97 MW) and QP698 (8.04 MW), both connected at the [redacted] 13.8 kV., in-service
- QP 535 (Holiday Hill Wind Farm) in-service
- QP 686 ([redacted] – Adams MA, connected to F-132 115 kV line) in-service
- QP 797 [redacted] – Meadow St) in-service
- QP 754 ([redacted] – connected to I-135N 115 kV line) In-service
- QP 779 ([redacted] - Northbridge) In-service – Not relevant for this study
- Hydro Generation that is defined as "Daily Cycle Pondage" or "Weekly Cycle" in the CELT report can be re can be ramped up to nameplate capability, according to the ISO-NE Planning Technical Guide, between N-1 and N-1-1 contingencies to prevent post N-1-1 contingency thermal overloads or voltage violations.

RESOURCE NAME	GEN TYPE ID	PRIM FUEL TYPE	FUEL GEN TYPE DESC	STATE	RSP AREA	NAMEPLATE (MW)	WINTER SCC (MW) Jan 1, 2019	ACTUAL WINTER PEAK SCC (MW) Jan 21, 2019	EXPECTED SUMMER PEAK SCC (MW) JUL 1, 2019
[redacted]	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	VT	VT	45.900	47.216	47.216	47.216
	HW	WAT	HYDRO (WEEKLY CYCLE)	MA	WMA	23.100	27.431	27.431	31.989
	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	MA	WMA	17.550	13.990	13.990	13.965
	HW	WAT	HYDRO (WEEKLY CYCLE)	VT	WMA	33.600	38.471	38.471	40.798
	HW	WAT	HYDRO (WEEKLY CYCLE)	NH	NH	3.200	3.459	3.459	3.600
	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	MA	WMA	9.600	18.667	18.667	18.580
	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	VT	WMA	4.500	4.567	4.567	4.451
	HW	WAT	HYDRO (WEEKLY CYCLE)	MA	WMA	8.100	6.220	6.220	6.154
	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	VT	WMA	34.560	32.000	32.000	32.000
	HW	WAT	HYDRO (WEEKLY CYCLE)	VT	VT	35.640	40.674	40.674	40.920
	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	MA	WMA	61.920	61.800	61.800	61.800
	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	MA	WMA	6.400	6.400	6.400	6.400

However, this generation can't be assumed to ramp up between contingencies post Group 1, if ramping up solves N-1-1 voltage or thermal problems that did not exist prior to Group 1 going in-service (Per ISO-NE PP5-6 document, section 3.4: "No Increase in Conditional Dependence").

- Pumped Storage Generation in the study area (Northfield and Bear Swamp) can be re can be ramped up to 1/2 nameplate capability (two units at Northfield and 1 unit at Bear Swamp) between N-1 and N-1-1 contingencies to prevent post N-1-1 contingency thermal overloads or voltage violations. Note that this can only be assumed if the units are off or in generating mode in the base case (N-0). If units are in pumping mode in the base case, it cannot be assumed that units can be ramped up into generating mode between contingencies.

4 STUDY CRITERIA

This analysis was conducted in accordance with the following criteria.

- NERC Transmission Planning Standards TPL-001-4, "*Transmission System Planning Performance Requirements* ",
- Northeast Power Coordinating Council (NPCC) Directory 1, "*Design and Operation of the Bulk Power System*".
- ISO New England Planning Procedure #3 (PP3) – "*Reliability Standards for the New England Area Bulk Power System*".
- ISO New England Planning Procedure #5 (PP5) – "Proposed Plan Application Procedure".
- National Grid Transmission Group Procedure (TGP) #28 – "*Transmission Planning Guide for the National Grid USA Service Company*".

5 STEADY STATE ANALYSIS

The following tables identify the steady state voltage criteria that were applied in the study:

Table 2 Steady State Voltage Limits

Facility Owner	Voltage Level	Bus Voltage Limits (Per-Unit)	
		Pre-Contingency	Post-Contingency
National Grid	230 kV and above	0.98 to 1.05	0.95 to 1.05
	115 kV and below	0.95 to 1.05	0.90 to 1.05[3]
Eversource	230 kV and above	0.98 to 1.05	0.95 to 1.05
	115 kV and below	0.95 to 1.05	0.95 to 1.05
GMP	115 kV and below	0.95 to 1.05	0.90 to 1.10
VELCO	230 kV and above	0.98 to 1.05	0.95 to 1.05
	115 kV and below	0.95 to 1.05	0.95 to 1.05

[3] National Grid Buses that are part of the bulk power system, and other buses deemed critical by Network Operations, shall meet requirements for 345 kV and 230 kV buses

Table 3 Maximum Percent Voltage Variation at Delivery Points

CONDITION	345 & 230 kV (%)	115 kV[1] & Below (%)
Post Contingency & Automatic Actions	5.0	10.0
Switching of Reactive Sources or Motor Starts (All elements in service)	2.0 *	2.5 *
Switching of Reactive Sources or Motor Starts (One element out of service)	4.0 *	5.0 *

* These limits are maximums which do not include frequency of operation. Actual limits was considered on a case-by-case basis and will include consideration of frequency of operation and impact on customer service in the area.

Notes on two precedingTables:

a. Voltages apply to facilities which are still in service post-contingency.
b. Site specific operating restrictions may override these ranges.
c. These limits do not apply to automatic voltage regulation settings which may be more stringent.

The following table identifies the thermal criteria thata was applied in the study.

Table 4 Thermal Criteria Applied in Study

SYSTEM CONDITION	TIME FRAME	MAXIMUM ALLOWABLE FACILITY LOADING
Pre-contingency (All lines in)	Continuous	Normal Rating
Post-contingency	Less than 15 minutes after contingency occurs	STE Rating
	More than 15 minutes after contingency occurs	LTE Rating

Steady State Solution Parameters

The steady state analysis was performed with pre-contingency solution parameters that allowed adjustment of load tap-changing transformers (LTCs), static VAR devices (SVDs including automatically-switched capacitors. Post-contingency solution parameters were locked and the area interchange control was disabled. The following table shows the pre- and post-contingency solution parameters that were used in this study.

Table 1 Steady State Study Solution Parameters

Case	Area Interchange	Transformer LTCs	Phase Angle Regulators	Switched Shunts
Base	Disabled	Stepping	Locked	Regulating
Contingency	Disabled	Locked	Locked	Locked

5.2 Study Year to be Tested

Since, the in-service date of all DER in this cluster is 2023, the year 2022 and 2023 ISO-NE base cases, released in September 2018, were used for the steady state assessment.

5.3 Load Levels to Test

Four load levels be tested for steady state analysis:

1. Summer Peak Load (2023)
2. Shoulder Peak Load (2022)
3. Light Load (2022)
4. Minimum Load (8000 MW)

5.4 Interface Transfer Levels to Test

For each of the four load levels, it is proposed that two base cases be developed for steady state testing:

1. High East to West Stress (3500 MW), with High NE-NY transfers (1200 MW), High Sandy Pond HVDC Import

2. High West to East Stress (3000 MW), with High NY-NE transfers (1600 MW), Low Sandy Pond HVDC Import

Load Level Assumption

The load levels contained in the following library cases (released by ISO-NE in September of 2018) was assumed for this study. These cases are based on the loads contained in the CELT 2018 forecast.

2023 SUM – Summer Peak load case
2022 SHL – Summer Shoulder peak load case
2022 SL – Spring light load case
ML – Minimum load case

5.6 Steady State Base Case Development

In order to investigate the impact of the proposed projects to the New England transmission system, two base cases was developed for each of the four load levels listed in the previous section. The following table summarizes the interface levels and generation dispatches for the steady state base cases.

Table 6 Steady State Base Case Summaries

Base Case Load Flows (MW)							
Name	23pk-ew	23pk-we	22sh-ew	22sh-we	22ll-ew	22ll-we	Min-load
Year/Load Level	2023 Summer peak		2022 Shoulder peak		2022 Light Load		2022 Min Load
Bias	East-West	West-East	East-West	West-East	East-West	West-East	
Total Load	23828	23768	18132	17958	12615	12514	9034
Total Losses	824	683	566	562	507	322	222
Total Generation	22988	21453	16775	14866	11046	8978	8962
Scaling Load	31563		16768		11453		7898
Non-Scaling Load	466		465		408		408
DR passive	0		0		0		0
DR active	-479		0		0		0
EE	-4262		0		0		0
Station Service	603	543	590	417	443	344	395
NON CELT LOAD	318		318 20		318		318
New England Transmission Interface Transfers (MW)							
Sandy Pd HVDC Import	2000	1000	2000	1000	2000	1000	0
E-W	3532	-3001	3514	-3036	3472	-3002	-5
NY-NE	-1210	1628	-1235	1599	-1204	1602	41
North-South	2831	1683	2546	2841	2787	1584	1830
CT Export	-847	-653	-209	-163	-1299	336	-20
Area Generation (MW)							
Northfield (MA) – 1180 MW (Max)	0	1180	-1100	1180.0	-1100	0	0
Bear Swamp 666 MW (Max)	0	666	-666	666	-666	0	0
Altresco (MA) – 164 MW (Max)	0	164	73	164	164	164	0
Cabot Hydro (MA) – 65 MW (Max)	11* (minimum)	65	11* (minimum)	65	11* (minimum)	65	11* (minimum)
Harriman Hydro (VT) – 41 MW (Max)	5* (minimum)	41	5* (minimum)	41	5* (minimum)	41	5* (minimum)
Vernon Hydro (VT) – 32 MW (Max)	5* (minimum)	32	5* (minimum)	32	5* (minimum)	32	5* (minimum)
Vernon Solar	20	20	20	20	20	20	0
Deerfield Hydro 2+3 +4 (20 MW Max)	5* (minimum)	20	5* (minimum)	20	5* (minimum)	20	5* (minimum)
Harrington St Solar (10 MW Max)	10	10	10	10	10	10	10
Warren Solar (Little Rest Rd) (14 MW Max)	14	14	14	14	14	14	14
Treasure Valley Solar (16 Max)	16	16	16	16	16	16	16
Millenium	0	360	361	0	361	360	0
Stony Brook	0	483	0	483	483	483	0
Bellows Fall	49	49	0	49	0	0	0
WMI	45	45	0	0	0	45	0
QP697&QP698 (14MW PV at E. WInchendon)	14	14	14	14	14	14	14

5.7 Steady State Contingency Analysis

N-1 and N-1-1 contingency conditions was tested in steady state analysis on the load flow base cases with and without the new DER added to the cases.

5.7.1 N-1 Contingency List

The N-1 Contingency list is shown in the Table .

Table 7 N-1 Steady State Contingency List

CONTINGENCY NAME	kV	DESCRIPTION
HVDC Facilities		
Sandy Pond HVDC Phase II	-	Sandy Pond HVDC Converter – 2000 MW Maximum
345 kV Transmission Lines		
301/302	345	Millbury – Carpenter Hill – Ludlow
308	345	Wachusett – Millbury
312	345	Berkshire – Northfield (Post Alps-Berkshire ETU)
393	345	Alps – Berkshire (Post Alps-Berkshire ETU)
313	345	Wachusett – Millbury
314	345	Sandy Pond – Wachusett
326	345	Scobie – Sandy Pond
320	345	Lake Rd – Card St
343	345	Sandy Pond – Wachusett
354	345	Northfield – Ludlow
367	345	Amherst – Fitzwilliam
3195	345	Amherst – Eagle
380	345	Eagle – Scobie Pd
368	345	Manchester – Card St
379	345	Vernon – Fitzwilliam
381	345	Vernon – Northfield
398	345	Long Mt – Pleasant Valley (NY)
3340	345	Vernon – Vermont Yankee
3381	345	Vernon – Vermont Yankee
345 kV Transformers		
Wachusett T5	345/115	Wachusett Transformer #5
Wachusett T6	345/115	Wachusett Transformer #6
Wachusett T7	345/115	Wachusett Transformer #7
Fitzwilliam T1	345/115	Fitzwilliam Transformer #1
Ludlow T2	345/115	Ludlow Transformer #2
Ludlow T3	345/115	Ludlow Transformer #3
Northfield T1	345/115	Northfield Transformer #1 (post Pittsfield-Greenfield upgrades)
Berkshire T1	345/115	Berkshire Transformer #1
Carpenter Hill T1	345/115	Carpenter Hill Transformer #1
Agawam T1	345/115	Agawam T1
Agawam T2	345/115	Agawam T2
345 kV Breaker Failures		
Berkshire F BF	345	312 + Berkshire Auto (Post Alps-Berkshire ETU)
Berkshire E BF	345	393 + Berkshire Auto (Post Alps-Berkshire ETU)
Alps BF	345	ETU + 393 (Post Alps-Berkshire ETU)
Fitzwilliam 3791 BF	345	379 + Fitz T1
Fitzwilliam 671 BF	345	367 + Fitz T1
Wachusett 7T BF	345	308 + Wachusett T7
Wachusett 6T BF	345	313 + Wachusett T6
Wachusett43-6T BF	345	343 + Wachusett T6
Wachusett 14-7T BF	345	314 + Wachusett T7
Ludlow 1T BF	345	334 + Ludlow T2
Ludlow 2T BF	345	334 + Ludlow T3
Ludlow 3T BF	345	Ludlow T3
Ludlow 4T BF	345	354 + Ludlow T2
Ludlow 5T BF3t19	345	3196 + 354
Ludlow 6T BF	345	3196
Ludlow 7T BF	345	301/302 + Ludlow T2+ Carpenter Hill Auto
Ludlow 8T BF	345	3419 + 301/302 + Ludlow T2+ Carpenter Hill Auto
Ludlow 9T BF	345	3419
Millbury 308+302 BF	345	301/302 + 308
Northfield 2T BF	345	312 + Northfield G1 + G2 (post Pittsfield-Greenfield upgrades)

CONTINGENCY NAME	kV	DESCRIPTION
Northfield 5T BF	345	354 + Northfield G3 + G4 (post Pittsfield-Greenfield upgrades)
Vernon 3TB4-B1 BF	345	381 + Vernon Reactor
Vernon 3TB3-B1 BF	345	379 + 3381
Vernon 3TB1-B1 BF	345	3320 + 3340
Vernon 3TB2-B1 BF	345	340 + Vernon T1
Vermont Yankee 1T	345	Vermont Yankee GSU
Vermont Yankee 381	345	3381 + Vermont Yankee Auto
Vermont Yankee 81-1T	345	3381 + Vermont Yankee GSU
Vermont Yankee 79-40	345	3340 + Vermont Yankee Auto
345 kV Double Ckt Towers		
-	-	-
230 kV Transmission Lines		
E-205E	230	Bear Swamp – Pratts Jct.
E-205W	230	Bear Swamp – Eastover Rd (NY)
38	230	Rotterdam (NY) – Eastover Rd (NY)
230 kV Double Ckt Towers		
-	-	-
230/115 kV Transformers		
Bear Swamp T4	230/115	Bear Swamp Transformer #4
Bear Swamp T5	230/115	Bear Swamp Transformer #5
PrattsJct T8 + T8A	230/115	PrattsJct Transformer #8 + 8A
Eastover Rd T1	230/115	Eastover Rd Transformer #1
Eastover Rd T2	230/115	Eastover Rd Transformer #2
230 kV Breaker Failures		
Bear Swamp 2205E BF	230	Bear Swamp G2 + T4 (230-115 kV) + E-205E
Bear Swamp 2205W BF	230	Bear Swamp G2 + T4 (230-115 kV) + E-205W
Bear Swamp 1205E BF	230	Bear Swamp G1 + T5 (230-115 kV) + E-205E + 115 kV Cap
Bear Swamp 1205W BF	230	Bear Swamp G1 + T5 (230-115 kV) + E-205W + 115 kV Cap
Eastover Rd RE205 BF	230	E-205W + Eastover Rd T1
Eastover Rd RE215 BF	230	E-205W + Eastover Rd T2
Eastover Rd R38 BF	230	38 + Eastover Rd T1
Eastover Rd R48 BF	230	38 + Eastover Rd T2
115 kV Transmission Lines		
1242	115	Montague – Berkshire
1361	115	Montague – Cumberland (post Pittsfield-Greenfield upgrades)
1231	115	Berkshire – Cumberland
1551	115	Doreen – Berkshire
1662	115	Doreen – Berkshire
PV20	115	Plattsburg – South Hero
K6	115	Bennington – Hoosick (NY)
K7	115	Whitehall – Bliss Ville
A-127E	115	Millbury- Webster St – Erving (post Erving substation)
A-127W	115	Erving – Harriman (post Erving substation)
B-128	115	Harriman – Millbury
E-131	115	Bear Swamp – Harriman – Adams
F-132	115	Adams – Doreen
I-135	115	Fitzwilliam – Flagg Pd
I-135S	115	Flagg Pd – PrattsJct
J-136S	115	Flagg Pd – Litchfield Tap – PrattsJct
O-141	115	Greendale – Nashua St
O-141N	115	PrattsJct – Wachussett
O-141S	115	Nashua St – Millbury
O-141W	115	Wachusett– Greendale
P-142	115	W Boylston – Rolfe Ave
P-142N	115	PrattsJct – Wachusett
P-142S	115	Rolfe Ave – Millbury
P142W	115	Wachusett – W Boylston
Q-117	115	Adams – Bennington
R-170	115	Palmer – W Hampden
1205	115	W Hampden - Ludlow
1976	115	W Hampden - Scitico
S-197	115	Bear Swamp – Deerfield
V-174W	115	Carpenter Hill – N Oxford
V-174	115	N Oxford – Millbury
W-175	115	Carpenter Hill – Palmer
X-176	115	Palmer – Ludlow
Y-177	115	Harriman – Montague (NU)

CONTINGENCY NAME	kV	DESCRIPTION
Z-126	115	Millbury – Tower 510 – Webster St
115 kV Double Ckt Towers		
1161+1211 DCT	115	1161 + 1211 + 1662
1231+1242 DCT	115	1231 + 1242
1551+1662 DCT	115	1551 + 1662 + 1211
1715+1816 DCT	115	1715 + 1816 + Altresco Gen
A127E+B128 DCT	115	A-127E + B-128 (Millbury – Erving) (post Erving substation)
A127W+B128 DCT	115	A-127W + B-128 (Erving – Harriman) (post Erving substation)
141W+142 DCT	115	O-141W + P-142
O141S+P142 DCT	115	O-141S + P-142
O141N+P142N DCT	115	O-141N + P-142N
O141S+142S DCT	115	O-141S + P-142S
O141W+P142W DCT	115	O-141W + P-142W
I135S+J136S DCT	115	I-135S + J-136S
I135N+J136N DCT		I-135N + J-136N
I135+J136N DCT		I-135 + J-136N
115/69 kV Transformers		
Millbury T1	115/69	Millbury Transformer #1 (56 MVA)
Millbury T2	115/69	Millbury Transformer #2 (56 MVA)
Millbury T3	115/69	Millbury Transformer #3 (45 MVA) + 63 Mvar Cap Bank
Pratts Jct T5 +T6 + T7	115/69	PrattsJct Transformer bank #1
PrattsJct T3+T4	115/69	PrattsJct Transformer bank #2
Deerfield 4 T3 + T4	115/69	Deerfield4 transformer #3 + T4
Adams Autotransformer	115/69	Adams Autotransformer
Bennington T69	115/69	Bennington VT 115-69 kV transformer
Harriman Autotransformer	115/69	Harriman Autotransformer
Palmer Transformer bank #1	115/69	Palmer T3 + T5
Palmer Transformer bank #1	115/69	Palmer T4 + T6
W Hampden T1	115-69	West Hampden T1
115 kV Breaker Failures		
Adams 731 BF	115	E-131 + Q-117 (Post Adams Upgrade)
Adams 217 BF	115	F-132 + Q-117 (Post Adams Upgrade)
Adams T3T BF	115	F-132 + Adams Auto (Post Adams Upgrade)
Adams T5T BF	115	E-131 + Adams Auto (Post Adams Upgrade)
Bear Swamp 131 BF	115	E-131 + Bear Swamp T4 + Bear Swamp GSU #1
Bear Swamp 197 BF	115	S-197 + Bear Swamp T4 + Bear Swamp GSU #1
Bear Swamp T31 BF	115	E-131 + Bear Swamp Fut Xfmr + Bear Swamp 115 kV Cap + Bear Swamp GSU #2 (Post Bear Swamp Upgrade)
Bear Swamp T97 BF	115	S-197 + Bear Swamp Fut Xfmr + Bear Swamp 115 kV Cap + Bear Swamp GSU #2 (Post Bear Swamp Upgrade)
Bennington K4 BF	115	Q-117 + Bennington 115 kV Cap #1
Bennington KT1 BF	115	Bennington Auto + Bennington 115 kV Cap #2
Berkshire 12T BF	115	1551 + Berkshire T2
Berkshire 13T BF	115	1551 + 1231
Berkshire 16T BF	115	1662 +1242
Doreen 6T BF	115	1161 + 1662
Doreen 7T BF	115	1211 + 1662
Doreen 8T BF	115	1211 + 1551
Doreen 9T BF	115	1551 + 1816
Doreen 12T BF	115	1715 + F-132
Erving A BF	115	A-127W + A-127E open ended + Northfield T1
Erving B BF	115	A-127E + A-127W open ended + Northfield T1
Erving C BF	115	A-127E + A-127W + Northfield T1
Harriman A127 BF	115	A-127W + B-128 open ended
Harriman B128 BF	115	A-127W open ended + B-128
Harriman E131 BF	115	E-131 + Y177 open ended + Harriman G1 + G2 +G3
Harriman Y177 BF	115	E-131 open ended + Y177 + Harriman G1 + G2 +G3
Harriman TIE BF	115	A-127W open ended + B-128 open ended + E-131 open ended + Y177 open ended + Harriman G1 + G2 +G3
Montague 1T BF	115	1632 + Cabot Gen
Montague 3T BF	115	1044 + Y-177 open ended
Montague 7T BF	115	1361 + A-127W open ended
Montague 8T BF	115	1361 + 1242
Montague 10T BF	115	1242 + Cabot Gen
PrattsJct O141 BF	115	Pratts T3 + T4 115-69 kV autos + O-141N + Pratts 63 MVAR capacitor
PrattsJct 801 BF	115	Pratts T3 + T4 115-69 kV autos + E-205E + Pratts 63 MVAR capacitor
PrattsJct I135 BF	115	Pratts T3 + T4 115-69 kV autos + I-135S + Pratts 63 MVAR capacitor
PrattsJct 1110 BF	115	Pratts T3 + T4 115-69 kV autos + Pratts 63 MVAR capacitor
PrattsJct P142 BF	115	Pratts T3 + T4 115-69 kV autos + P-142N + Pratts 63 MVAR capacitor

CONTINGENCY NAME	kV	DESCRIPTION
PrattsJct 802 BF	115	Pratts T5 + T6 + T7 115-69 kV autos + E-205E + J-136 (PJ – Litch Tap)
PrattsJct L138 BF	115	Pratts T5 + T6 + T7 115-69 kV autos + L-138 + J-136 (PJ – Litch Tap)
PrattsJct K137 BF	115	Pratts T5 + T6 + T7 115-69 kV autos + K-137 + J-136 (PJ – Litch Tap)
PrattsJct J136 BF	115	Pratts T5 + T6 + T7 115-69 kV autos + J-136S
PrattsJct 2110 BF	115	Pratts T5 + T6 + T7 115-69 kV autos + J-136 (PJ – Litch Tap)
PrattsJct 38-42 BF	115	L-138W + P-142N
PrattsJct 37-41 BF	115	K-137W + O-141N
115 kV Capacitor Banks		
Bear Swamp Cap #1	115	Bear Swamp 50 Mvar Cap Bank (Post Bear Swamp project)
115 kV Line-End Open Contingencies		
1242 Mont-open	115	Montague – Berkshire
1242 Berk-open	115	Montague – Berkshire
1231 Berk-open	115	Berkshire – Cumberland
1231 Cumb-open	115	Berkshire – Cumberland
A-127 Harr-open	115	A-127 (Harriman – Cabot Tap)
A-127 Millb-open	115	A-127 (Millbury – Tower 510)
B-128 Harr-open	115	B-128 (Harriman – Cabot Tap)
B-128 Millb-open	115	B-128 (Millbury – Tower 510)
I135 Flagg-open	115	I-135 (Flagg Pd – Ashburnham)
I-135 Fitz-open	115	I-135 (Fitzwilliam – Ashburnham)
J136S Pratts-open	115	J-136S (PrattsJct – Litchfield St Tap)
J136S Flagg-open	115	J-136S (Flagg Pd – Litchfield St Tap)
O141N Wach-open	115	O-141N (Wachusett – Sterling)
O141N Pratts-open	115	O-141N (PrattsJct – Sterling)
P142N Wach-open	115	P-142N (Wachusett – Sterling)
P142N Pratts-open	115	P-142N (PrattsJct – Sterling)
P142S Milb-open	115	P-142S (Millbury – Wyman Gordon)
P142S Bloom-open	115	P-142S (Rolfe Ave. – Bloomingdale Tap)
P142S Rolfe-open	115	P-142S (Rolfe Ave – Bloomingdale Tap)
E131 Harr-open	115	E-131 (Harriman – Bear Swamp Jct)
E131 Bear-open	115	E-131 (Bear Swamp – Bear Swamp Jct)
E131 Adams-open	115	E-131 (Adams – Bear Swamp Jct)
F132 Doreen-open	115	F-132 (Doreen – Partridere)
W-175 Carp-open	115	W-175 (Carpenter Hill – W Charlton)
W-175 Palm-open	115	W-175 (Palmer – Little Rest Rd)
X-176 Palm-open	115	X-176 (Palmer – Thorndike)
X-176 Ludlow-open	115	X-176 (Ludlow – Thorndike)
115 kV Bus Faults		
Harriman Bus #1	115	A-127 open ended + B128 open ended + GSU # 1 + #2 (Post-Harriman Tie breaker)
Harriman Bus #2	115	E-131 open ended + Y-177 open ended + T3 open ended (Post-Harriman Tie breaker)
Pratts Bus #1	115	
Pratts Bus #2	115	
69 kV Transmission Lines		
A-1	69	Otter River – Chestnut Hill
A-1N	69	Chestnut Hill – Vernon
A-1S	69	PrattsJct – Otter River
B-2N	69	Park St – Vernon
B-2S	69	PrattsJct – Park St (Gardner)
D-4N	69	Vernon – QP660
D-4S	69	QP660- Deerfield 4
E-5	69	Meadow St. – Ware
E-5D	69	Shutesbury – Deerfield 4
E-5E	69	Millbury – Meadow St
E-5W	69	Ware – Shutesbury
F-6	69	Meadow St. – Ware
F-6E	69	Millbury – Meadow St
F-6W	69	Ware – Deerfield 4
J-10	69	Adams – Deerfield 5
M-39	69	Fitch Rd – Wachusett
N-40	69	Fitch Rd – PrattsJct
N-14	69	Palmer – E Longmeadow
O-15N	69	Palmer – Ware
O-15S	69	W hampden - E Longmeadow
Y-25N-1	69	Searsburg – Searsburg Wind
Y-25N-2	69	Bennington – Deerfield Wind
Y-25S	69	Deerfield 5 – Harriman – Searsburg

CONTINGENCY NAME	kV	DESCRIPTION
		69 kV Breaker Failures
Pratts A1S BF	69	A-1S + U-21S + N-40 + open end 69 kV side of Pratts 115/69 kV transformer bank #1
Pratts B2S BF	69	B-2S + V-22S + open 69 kV side of Pratts 115/69 kV transformer bank #2
Pratts 160 BF	69	Pratts 115/69 kV transformer bank #2 + Open end A-1S + N-40 + U-21S
Pratts 260 BF	69	Pratts 115/69 kV transformer bank #2 + Open end B-2S + V-22S
Pratts Tie BF	69	PrattsJct 69 kV busses #1 and #2 (open all lines and transformers at PrattsJct 69 kV)
Pratts U21 BF	69	U-21S + N-40 + open end 69 kV side of Pratts 115/69 kV transformer bank #1 + open end A-1S
Pratts V22 BF	69	V-22S + open end B-2S + open 69 kV side of Pratts 115/69 kV transformer bank #2
Deerfield #4 540	69	E-5D + Deerfield 69 kV bus (open end all other facilities out of Deerfield 69 kV)
Deerfield #4 640	69	F-6W + Deerfield 69 kV bus (open end all other facilities out of Deerfield 69 kV)
Crystal Lake B2S BF	69	B-2S + Crystal Lake T1 (69/13kV)
Crystal Lake B2N BF	69	B-2N + Crystal Lake T2 (69/13kV)
Searsburg Y25 BF	69	Y-25N-1 + Y25S
Deerfield Wind Y25-1 BF	69	Searsburg Wind + Y-25N-1 + Y-25N-2 open ended
Deerfield Wind Y25-2 BF	69	Searsburg Wind + Y-25N-2 + Y-25N-1 open ended
Deerfield Wind Y25-Tie BF	69	Searsburg Wind + Y-25N-1 + Y-25N-2
Adams 360 BF	69	Adams 115/69kV Autotransformer + J-10
Chestnut Hill 230 BF	69	A-1N + A-1 open ended + T2
Chestnut Hill 130 BF	69	A-1 + A-1N open ended + T1
Otter River A1 BF	69	A-1 + A-1S open ended
Otter River A1S BF	69	A-1S + A-1 open ended
Harriman 3810 BF	69	Y-25S + Harriman G3 + Harriman 115/69kV Autotransformer
Vernon A1 BF	69	A-1N + GSU #1
Vernon B2 BF	69	B-2N + D-4 open ended + GSU #2
Vernon D4 BF	69	B-2N + D-4 open ended + GSU #2
Vernon Tie BF	69	All lines (A-1N, B-2N, D-4) open ended + GSU #1 & #2
Bennington Y25 BF	69	Y-25N-2 + Benn 115/69kV Autotransformer + Benn Cap #2
		69 kV Line-End Open Contingencies
A-1 Chest-open	69	Chestnut Hill – Roylston
A-1 Ott-open	69	Royalston – Otter River
A-1S Ott-open	69	Otter River – E Westminster
A-1S Pratts-open	69	E Westminster – PrattsJct
B-2S Park open	69	Park St (Gardner) – Westminster
B-2S Pratts-open	69	E Westminster – PrattsJct
E-5E Mill-open	69	Millbury – Pondville
E-5 Meadow-open	69	Meadow St – Harrington St
E-5W Ware-open	69	Ware - Shutesbury
E-5D Deer4-open	69	Deerfield 4 – Deerfield 3
F-6E Mill-open	69	Millbury - Pondville
F-6 Meadow-open	69	Meadow St. – Lashaway
F-6W Deer4-open	69	Deerfield 4 – Deerfield 3
F-6W Ware-open	69	Ware – Belchertown
Y-25N Sears-open	69	Searsburg – Bennington
Y-25S Deer5-open	69	Deerfield 5 – Harriman – Searsburg
Y-25S Harr-open	69	Deerfield 5 – Harriman – Searsburg
Y-25S Hoos-open	69	Deerfield 5 – Harriman – Searsburg
		69 kV Bus Faults
Pratts Bus #1	69	
Pratts Bus #2	69	
Vernon #1	69	A-1 open ended at Vernon + GSU #1
Vernon #2	69	B-2 and D-4 open ended at Vernon + GSU #2
Deerfield #4	69	All lines open ended at Deerfield 4 (E-5, F-6, D-4)
		69 kV Double Ckt Towers
A1S+B2S	69	
A1S+B2N	69	
A1+B2N	69	
A1N+B2N	69	
E5E+F6E DCT	69	
E5+F6 DCT	69	
E5W+F6W DCT	69	
E5D+F6W DCT	69	
		Generators/GSU
Harriman Hydro (VT)	115/6.9	GSU 1
Harriman Hydro (VT)	115/6.9	GSU 2
Harriman Hydro (VT)	115/6.9	GSU 3
Cabot Hydro (MA)	115/13.8	Cabot GSU

CONTINGENCY NAME	kV	DESCRIPTION
Northfield (MA)	345/13.8	GSU #1 Unit 1 + Unit 2
Northfield (MA)	345/13.8	GSU #2 Unit 3 + Unit 4
Altresco (MA)	115/13.8	Unit 1 + Unit 2
Altresco (MA)	115/13.8	Unit 3 + Unit 4
Vernon Hydro #1 (VT)	69/13.8	GSU #1
Vernon Hydro #2 (VT)	69/13.8	GSU #2
Seabrook	345	
Bear Swamp G1/P1	230 kV	Bear Swamp Generator/Pump #1
Bear Swamp G2/P2	230 kV	Bear Swamp Generator/Pump #2
Millenium GT + ST	115 kV	Millennium Gas Turbine + Steam Turbine Unit

5.7.2 N-1-1 Contingency List

The following table lists the contingencies that was tested as the first line out in N-1-1 contingency analysis. In each line-out case, all contingencies described in previous section was tested as the second contingency.

Table 8 **N-1-1 Contingency List**

Initial facility out (N-1), one at a time	Second Contingency (N-1-1)
[redacted]	

5.8 Steady State Results

N-1 Thermal Results

Simulation results indicate that no transmission facility overloads following N-1 contingencies as result of Group 1 of the DER interconnections. Appendix D provides the full N-1 thermal results.

N-1 Voltage Results

With the addition of the Group 1 DER interconnections, many transmission substations were found to experience high voltage conditions at light load and minimum load conditions, following N-1 contingencies. These high voltage conditions did not exist before the addition of Group 1 (full N-1 voltage results are provided in Appendix D).

To eliminate these high voltage problems at light load and minimum load conditions, an automatic switching scheme will be employed to switch off distribution feeder capacitors during light load and/or high voltage conditions on the feeders themselves. These "smart capacitor" automation schemes are itemized in the following table.

Table 9 "Smart Capacitor" Control Additions in Western Massachusetts

Substation Bus	**Feeder Capacitor MVAR**
E WINCHENDON1 13.8	0.6
CRYSTAL LK1 13.8	2.7
CRYSTAL LK2 13.8	3.8
E WSTMSTR T1 13.8	0.6
E WSTMSTR T2 13.8	0.6
E LONGMEADOW 1 13.2	0.9
N HAMPDEN T1 13.2	1.2
PALMER 13.2	1.5
WILBRAHAM 13.2	0.3
LASHAWAY 13.2	1.5
W CHARLTON 13.2	0.9
LITL REST RD 13.2	0.9
THORNDIKE 13.2	0.8
TREASURE VLY 13.8	1.8
CHESNUT HL T1 13.8	1.5
CHESNUT HL T2 13.8	1.2
Total	**20.8**

Presently, the feeder capacitors listed in the preceding table are fixed capacitors; meaning that they are not switched automatically, and are in service all the time unless switched out manually in the field. After the automatic switching schemes are installed, these feeder capacitors will be switched out if the feeder loading becomes less than 45% of peak feeder load. From a loadflow perspective, switching out these capacitors during light load conditions was modeled as MVAR lagging load at each the substation busses listed in the table.

With the "Smart Capacitor" automatic switching controls modeled, the loadflow simulations were re-run on the two light load cases, and the minimum load case. The high voltage problems were eliminated for all N-1 contingencies tested.

N-1-1 Thermal Results

Simulation results indicate that no transmission facility overloads following N-1-1 contingencies as result of Group 1 of the DER interconnections.

N-1-1 simulations were first run for 69 kV facilities taken out of service, one at a time, followed by all second contingencies listed in Table 8. During these simulations, only 69 kV connected generation, and Bear Swamp, was allowed to be redispatched in between contingencies to eliminate post N-1-1 contingency overloads. This methodology accurately reflects how the 69 kV transmission system in Western MA is secured for N-1-1 contingencies involving 69 kV facilities as the first contingency. All SMART capacitors discussed in the previous section were assumed in-service at minimum load and light load conditions. The thermal results for these simulations are shown in the following table.

Note the following table provides results for both N-2 and N-1-1 contingencies. N-2 results do not involve any redispatching or system adjustments between contingencies. The N-1-1 results do include redispatching and system adjustments between contingencies. No more than 1200 MW of generation redispatching was allowed between contingencies to secure each post N-1-1 configuration. The 1200 MW limit includes any generation that is lost as part of the first contingency.

Note also that all base cases utilized for the N-1-1 analysis were secure for all N-1 contingencies. Please refer to Appendix D for all N-1 results.

Table 10:

69 kV N-1-1 Thermal Results allowing only 69 kV Generators and Bear Swamp to Adjust between contingencies

	22ll-ew-pump+grp1-69kV+smart-cap21		22ll-we+grp1-69kV+smart-cap21		22sh-ew-pump+grp1-69kV		22sh-we+grp1-69kV		23pk-ew+grp1-69kV		23pk-we+grp1-69kV	
Monitored Facility	N2 %	N11 %	N2 %	N11 %	N2 %	N11 %	N2 %	N11 %	N2 %	N11 %	N2 %	N11 %
104143 SCOBIE POND 345 104162 EAGLE 345 1	92	91			100	99			96	96		
104162 EAGLE 345 104167 AMHERST 345 1	90	89			97	95						
104167 AMHERST 345 104175 FITZWILLIAM 345 1					91	90						
104175 FITZWILLIAM 345 104183 NU_379_VEL 345 1					91	89						
104900 NORTH KEENE 115 104902 KEENE 115 1	99	99			99	99						
109528 VERNON VT 69.0 113041 CHESNUT HILL 69.0 1			121	75			107	84			116	82
109528 VERNON VT 69.0 113055 N BLDWNVL_B2 69.0 1			103	73			100	92			103	89
113001 BEAR SWAMP 230 113266 PRATTS JCT 230 1	99	93			105	95						
113008 BEAR SWAMP 115 113010 E131 TAP 115 1	109	100			116	100	92	92			92	92
113010 E131 TAP 115 113146 HARRIMAN 2 115 1					95	83						
113021 DEERFIELD 5 69.0 113058 HOOSAC WIND 69.0 1					91	91						

Monitored Facility	22ll-ew-pump+grp1-69kV+smart-cap21		22ll-we+grp1-69kV+smart-cap21		22sh-ew-pump+grp1-69kV		22sh-we+grp1-69kV		23pk-ew+grp1-69kV		23pk-we+grp1-69kV	
	N2 %	N11 %	N2 %	N11 %	N2 %	N11 %	N2 %	N11 %	N2 %	N11 %	N2 %	N11 %
113032 N BLDWNVL_A1 69.0 113038 ROYALSTON 69.0 1	106	100	158	100			129	101	92	92	141	100
113032 N BLDWNVL_A1 69.0 113351 WESTMNSTR_A1 69.0 1			123	75			97	73			106	73
113037 LASHAWAY_E5 69.0 113136 HARRINGTN ST 69.0 1											95	97
113038 ROYALSTON 69.0 113041 CHESNUT HILL 69.0 1			129	82			106	83			116	82
113039 MEADOW ST_F6 69.0 113052 LASHAWAY_F6 69.0 1							93	93			98	98
113039 MEADOW ST_F6 69.0 113318 LEICESTER_F6 69.0 1			94	94			104	100			109	100
113046 DEERFIELD 4 69.0 909528 VERNON SOLAR 69.0 1	98	98			98	98						
113054 MEADOW ST 69.0 113136 HARRINGTN ST 69.0 1							99	99			104	100
113054 MEADOW ST 69.0 113337 LEICESTER_E5 69.0 1			94	94			104	100			109	100
113055 N BLDWNVL_B2 69.0 113342 CRYSTAL LAKE 69.0 1			103	72			100	91			102	89
113263 CARPENTER HL 345 113264 MILLBURY 345 1	90	90							100	100		
113263 CARPENTER HL 345 116059 NU_301_NGR 345 1									92	92		
113265 WACHUSETT 345 113950 SANDY POND 345 1					91	91			92	92		
113286 MILLBURY 115 113287 NORTH OXFORD 115 1			99	99							97	97
113318 LEICESTER_F6 69.0 113345 PONDVILLE_F6 69.0 1			91	91			97	93			106	97
113329 E WSTNSTR_A1 69.0 113346 PRATTS JCT 69.0 1			126	85			96	73				
113329 E WSTNSTR_A1 69.0 113351 WESTMNSTR_A1 69.0 1			123	76			96	73				
113329 E.WESTMIN A1 69.0 113346 PRATTS JCT 69.0 1											105	78
113329 E.WESTMIN A1 69.0 113351 WESTMNSTR_A1 69.0 1											106	72
113330 E WSTNSTR_B2 69.0 113346 PRATTS JCT 69.0 1	90	85	131	100			110	101				
113330 E WSTNSTR_B2 69.0 113352 WESTMNSTR_B2 69.0 1			126	95			107	98				
113330 E.WESTMIN B2 69.0 113346 PRATTS JCT 69.0 1											116	101
113330 E.WESTMIN B2 69.0 113352 WESTMNSTR_B2 69.0 1											112	99
113337 LEICESTER_E5 69.0 113344 PONDVILLE_E5 69.0 1			91	91			97	93			106	97
113338 MILLBURY 69.0 113344 PONDVILLE_E5 69.0 1											92	82
113338 MILLBURY 69.0 113345 PONDVILLE_F6 69.0 1											91	81
113342 CRYSTAL LAKE 69.0 113352 WESTMNSTR_B2 69.0 1			125	94			109	100			109	96
116009 NORTHFLD MT 345 116013 NORTHFLD-34 345 1					91	90	97	95				
116107 ERVING 115 116109 NGR_A127W_NU 115 1	94	91			94	88						
119259 LONG MTN 345 119272 NE_398_NY 345 1					91	91						

As can be seen, all post adjustment N-1-1 branch loadings are below 102% of the branch's Long Time Emergency Rating (LTE). 102% is ISO-NE criteria regarding significant negative impact of a project on branch loadings.

N-1-1 simulations were then run for all 345 kV, 115 kV, and 230 kV facilities taken out of service as the first contingency, one at a time, followed by all second contingencies listed in Table 8. During these simulations, all generation in the study area, including generation connected to the 69 kV transmission system, was allowed to be redispatched in between contingencies to eliminate post N-1-1 contingency overloads, including 69 kV overloads. This assumption reflects the fact that the National Grid Control Center will attempt to secure the 69 kV transmission system prior to the second contingency, after any 345, 230, or 115 kV facility is lost. All SMART capacitors discussed in the previous section were assumed in-service at minimum load and light load conditions. The thermal results for these simulations are shown in the following table.

Table 11:

N-1-1 Thermal Results for all contingencies, allowing all generators to adjust between contingencies

	22ll-ew-pump+grp1		22ll-we+grp1		22sh-ew-pump		22sh-we+grp1		23pk-ew+grp1-		23pk-we+grp1	
Monitored Facility	N2 %	N11 %	N2 %	N11 %	N2 %	N11 %	N2 %	N11 %	N2 %	N11 %	N2 %	N11 %
99994 CHINOOK_POI 115 113297 E.WNCH_I135 115 1					91	58						
104079 NEWINGTON 345 104080 NEWINGTON EN 345 1									83	91		
104095 DEERFIELD 345 104097 DFLD_SVCLAG 345 1									95	95		
104095 DEERFIELD 345 104143 SCOBIE POND 345 2									104	100		
104143 SCOBIE POND 345 104162 EAGLE 345 1	108	98			120	100			111	100		
104162 EAGLE 345 104167 AMHERST 345 1	107	97			117	96			102	92		
104167 AMHERST 345 104175 FITZWILLIAM 345 1	103	93			112	91			93	83		
104175 FITZWILLIAM 345 104183 NU_379_VEL 345 1	107	95			113	93			93	82		
104183 NU_379_VEL 345 107040 VERNON VT 345 1	101	90			107	88						
104191 NU_381_VEL 345 107040 VERNON VT 345 1	91	82										
104900 NORTH KEENE 115 104902 KEENE 115 1	147	100			150	100	99	95	118	100	130	100
104902 KEENE 115 104957 MONADNOCK 115 1	130	100			136	100	95	86	113	100		
104913 A152_T 115 104924 WESTPORT 115 1	126	97			125	90	107	97	91	71	116	95
104924 WESTPORT 115 104935 CHESTNUT HIL 115 1	126	97			124	89	107	97	91	71	116	95
104935 CHESTNUT HIL 115 104946 VERNONROAD_T 115 1	121	92			121	87	110	100			122	100
104979 NU_I135N_NGR 115 104990 FITZWILLIAM 115 1					98	98			93	93		
104990 FITZWILLIAM 115 105001 NU_I135_NGR 115 1	98	63			103	69						
109501 HARRIMAN 69.0 109502 HARRIMAN T3 99.0 1	96	92			107	101						
109528 VERNON VT 69.0 113041 CHESNUT HILL 69.0 1							96	83			99	81
109528 VERNON VT 69.0 113055 N BLDWNVL_B2 69.0 1	94	88			95	90	107	91			108	87

Monitored Facility	22ll-ew-pump+grp1		22ll-we+grp1		22sh-ew-pump		22sh-we+grp1		23pk-ew+grp1-		23pk-we+grp1	
	N2 %	N11 %	N2 %	N11 %	N2 %	N11 %	N2 %	N11 %	N2 %	N11 %	N2 %	N11 %
109528 VERNON VT 69.0 909528 VERNON SOLAR 69.0 1	112	100			113	100	91	100			95	100
113001 BEAR SWAMP 230 113266 PRATTS JCT 230 1	112	100			114	100	104	100			109	100
113001 BEAR SWAMP 230 115005 NE_E205W_NY 230 1											92	87
113005 ADAMS 115 113010 E131 TAP 115 1					93	74						
113006 BARRE A127 115 113016 WENDELL A127 115 1	99	82			95	75	117	88			113	88
113006 BARRE A127 115 113291 PAXTON 115 1	97	80			93	74	118	90			116	90
113008 BEAR SWAMP 115 113010 E131 TAP 115 1	138	100			131	100	117	100			120	100
113009 DEERFIELD 4 115 113046 DEERFIELD 4 69.0 1	117	96			120	98	86	91			85	94
113010 E131 TAP 115 113146 HARRIMAN 2 115 1	101	85			102	96						
113016 WENDELL A127 115 116106 NU_A127E_NGR 115 1	104	85			98	78	114	85			110	85
113021 DEERFIELD 5 69.0 113058 HOOSAC WIND 69.0 1	95	91			108	98						
113031 WARE 69.0 113057 PALMER 69.0 1			96	96								
113032 N BLDWNVL_A1 69.0 113038 ROYALSTON 69.0 1					91	85	115	99			121	100
113038 ROYALSTON 69.0 113041 CHESNUT HILL 69.0 1							94	81			99	80
113039 MEADOW ST_F6 69.0 113052 LASHAWAY_F6 69.0 1											92	91
113039 MEADOW ST_F6 69.0 113318 LEICESTER_F6 69.0 1			91	90			100	100			104	100
113046 DEERFIELD 4 69.0 909528 VERNON SOLAR 69.0 1	133	100			134	100	73	95			72	100
113054 MEADOW ST 69.0 113136 HARRINGTN ST 69.0 1							94	94			98	93
113054 MEADOW ST 69.0 113337 LEICESTER_E5 69.0 1			91	90			100	100			104	100
113055 N BLDWNVL_B2 69.0 113342 CRYSTAL LAKE 69.0 1	94	88			95	90	106	90			108	86
113116 CABOT_T A127 115 113117 FRENCH KG 27 115 1	90	68			93	68						
113117 FRENCH KG 27 115 116109 NGR_A127W_NU 115 1	91	68			94	68						
113146 HARRIMAN 2 115 109502 HARRIMAN T3 99.0 1	94	86			105	99	100	93			96	92
113263 CARPENTER HL 345 113264 MILLBURY 345 1	105	100	91	89	94	90	98	91	130	100	100	83
113263 CARPENTER HL 345 116059 NU_301_NGR 345 1	102	96			103	99	101	95	123	98		
113264 MILLBURY 345 113265 WACHUSETT 345 1	92	90							90	73		
113265 WACHUSETT 345 113950 SANDY POND 345 1	113	100			121	100			119	100		
113265 WACHUSETT 345 113950 SANDY POND 345 2					92	76			90	75		
113266 PRATTS JCT 230 113292 PRATTS JCT 115 2	92	85			95	84					91	78
113279 CARPENTER HL 115 113287 NORTH OXFORD 115 1			103	88							110	88
113282 FLAGG POND 115 115001 NG_I135_FGE 115 1					95	60	101	97				
113286 MILLBURY 115 113287 NORTH OXFORD 115 1			116	100							125	100
113291 PAXTON 115 113408 TWR510-A127 115 1	98	80			94	74	117	89			115	89
113297 E.WNCH_I135 115 113305 ASHBRNHM 135 115 1							92	89				
113305 ASHBRNHM 135 115 115001 NG_I135_FGE 115 1							91	88				
113318 LEICESTER_F6 69.0 113345 PONDVILLE_F6 69.0 1							93	93			101	97
113329 E.WESTMIN A1 69.0 113346 PRATTS JCT 69.0 1											92	73
113330 E WSTNSTR_B2 69.0 113346 PRATTS JCT 69.0 1			94	94			116	100				

Monitored Facility	22ll-ew-pump+grp1 N2 %	N11 %	22ll-we+grp1 N2 %	N11 %	22sh-ew-pump N2 %	N11 %	22sh-we+grp1 N2 %	N11 %	23pk-ew+grp1- N2 %	N11 %	23pk-we+grp1 N2 %	N11 %
113330 E WSTNSTR_B2 69.0 113352 WESTMNSTR_B2 69.0 1							113	97				
113330 E.WESTMIN B2 69.0 113346 PRATTS JCT 69.0 1											122	100
113330 E.WESTMIN B2 69.0 113352 WESTMNSTR_B2 69.0 1											118	96
113337 LEICESTER_E5 69.0 113344 PONDVILLE_E5 69.0 1							92	92			101	97
113342 CRYSTAL LAKE 69.0 113352 WESTMNSTR_B2 69.0 1							115	99			115	93
115005 NE_E205W_NY 230 137562 EASTOVER RD 230 1											95	90
116009 NORTHFLD MT 345 116013 NORTHFLD-34 345 1	91	95			91	95	97	98				
116009 NORTHFLD MT 345 116045 LUDLOW 345 1	90	75			90	74	90	72			92	75
116011 NORTHFLD-12 345 116012 NORTHFIELD1X 99.0 1							89	92	0	92		
116013 NORTHFLD-34 345 116014 NORTHFIELD3X 99.0 3							89	92				
116045 LUDLOW 345 116059 NU_301_NGR 345 1					92	80			109	83		
116107 ERVING 115 116109 NGR_A127W_NU 115 1	133	100			137	100	119	95			131	96
116356 WOODLAND 115 116360 PLEASANT 115 1	101	80			97	75	134	100			128	100
116360 PLEASANT 115 116364 BLANDFORD 115 1	123	100			127	100	126	90			119	90
116364 BLANDFORD 115 116368 GRANVILLE_J 115 1	117	95			122	97	113	79			108	80

As can be seen, all post adjustment, N-1-1 branch loadings are below 102% of the branch's Long Time Emergency Rating (LTE). 102% is ISO-NE criteria regarding significant negative impact of a project on branch loadings.

N-1-1 simulations were then repeated for all 345 kV, 115 kV, and 230 kV facilities taken out of service as the first contingency, one at a time, followed by all second contingencies, except that 69 kV generation was not allowed to adjust between contingencies, and generation connected to the 345 kV, 115 kV, and 230 kV transmission system was not allowed to be adjusted to eliminate post N-1-1 69 kV overloads. The purpose of these simulations was to indicate whether any ISO-NE control room generation maneuvers following 345, 230, or 115 kV N-1 contingencies, would make any post N-1-1 overloads on 69 kV system worse. If these maneuvers were found to not increase any N-1-1 69 kV overloads, then it can be assumed that 69 kV generation maneuvers can be made independently to prevent post N-1-1 thermal problems.

Results of these simulations showed no increase in post N-1-1 69 kV thermal overloads. Therefore, the results provided in the previous table are valid.

N-1-1 Voltage Results

N-1-1 voltage results are provided in Table E1 in Appendix E for N-1-1 contingencies involving a 69 kV element only as the first contingency. All 345, 230, 115 and 69 kV contingencies 2nd contingencies were tested.

N-1-1 voltage results shown in Table E1 in Appendix E indicate the following:

- High voltages can occur along the Y-25 69 kV line between Adams, Deerfield 5, Harriman, and Searsburg. These high voltages occur in the existing system, but are made worse by the interconnection of Group 1 of the Western MA DER Cluster. The high voltages can be eliminated by changing the tap settings of the Adams 115/69 kV autotransformer to the following:

  Existing Tap Settings:
    - High Voltage Winding = 113 kV
    - Low Voltage Winding = 69 kV

  Proposed Tap Settings:
    - High Voltage Winding = 111 kV
    - Low Voltage Winding = 66 kV

- High voltages can occur along the F-6 69 kV line at Deerfield 2 substation for loss of the O-15N 9 kV line following by the F6W 69 kV breaker open contingency at Deerfield 4. This high voltage problem can be eliminated by ramping down existing synchronous generation at Deerfield 2 and 3 between contingencies.

- High voltages can occur along the B-2 69 kV line at Crystal Lake, Westminster and E Westminster for loss of the D-4E 69 kV line followed by the B2 Breaker Open contingency at Pratts Jct. This high voltage can be eliminated by implementing the following upgrade:

    - Install Direct Transfer Trip (DTT) protection from Pratts Jct to Crystal Lake, that trips the entire B-2S line following the B2 breaker open contingency at Pratts Jct. The DTT scheme will sent a trip signal to Crystal Lake 69 kV anytime the B2S breaker at Pratts Jct opens without a fault. This action will result in the B2S 69 kV line supplies to Westminster and E Westminster substations, being tripped. The loads and DG at Westminster and E Westminster substation will then be transferred to the A1S 69 kV line via an automatic transfer scheme.

  If this transmission solution is not implemented, these high voltages along the B2 line will be eliminated if the 4.99 MW DER unit proposed to be connected to the B-2 line at E Westminster, via Transformer #1, is not connected. It is proposed that this DER unit does not connect until the DTT solution is implemented.

Additional N-1-1 voltage results are provided Table E2 in Appendix E for N-1-1 contingencies involving 345, 230, and 115kV elements as the first contingency. All 345, 230, 115 and 69 kV contingencies 2nd contingencies were tested. The Adams 115/69 kV tap change was assumed in-service for these simulations. The SMART Capacitors were also modeled for the light load and minimum load cases.

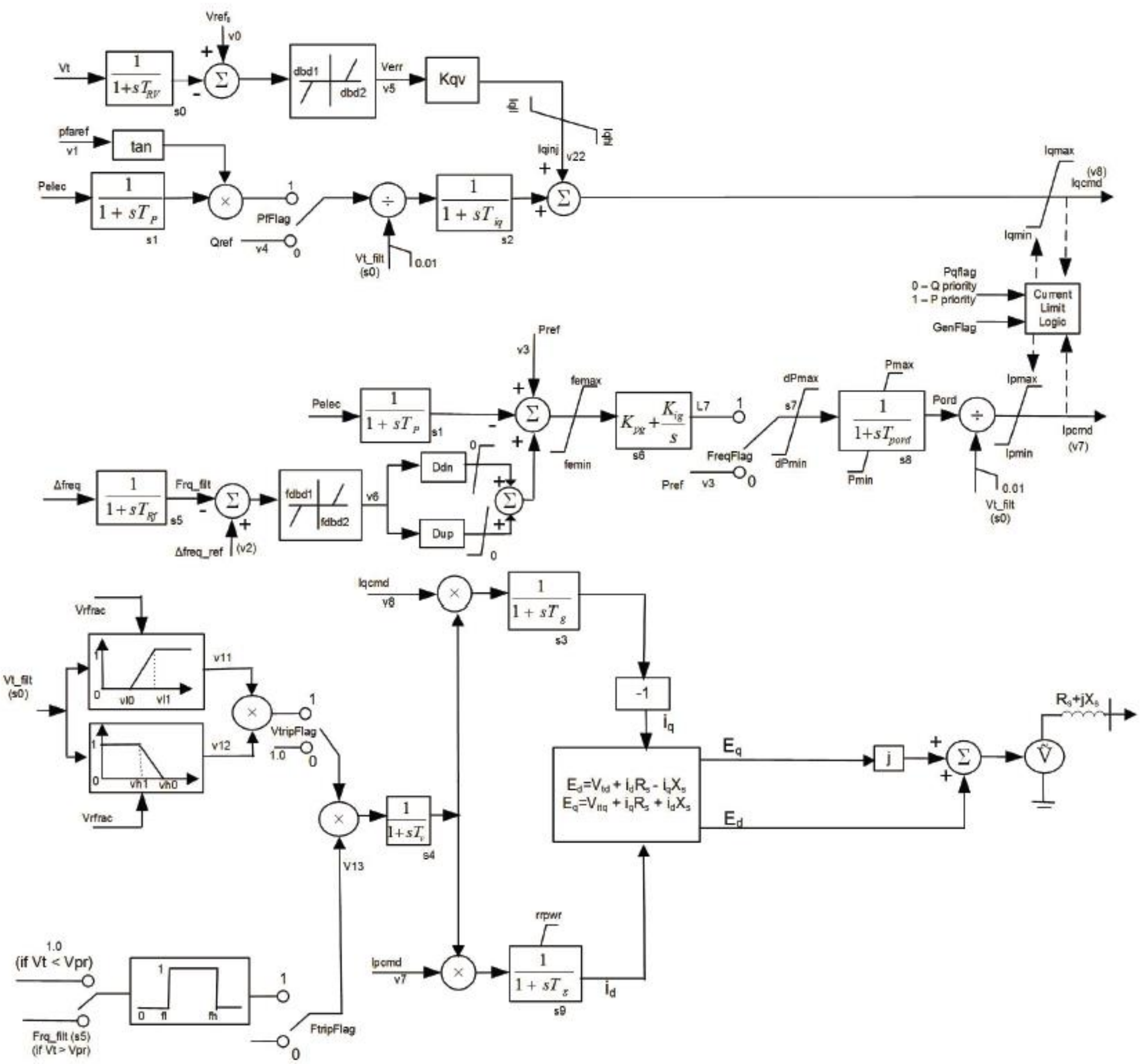
As can be seen from Table E1, no high voltage problems were found for these contingency combinations.

6 STABILITY ANALYSIS

Transient stability testing was conducted for the additional DER.

Stability Modeling of new DER greater than 1 MW and less than 5 MW

For the additional DER that is greater than 1 MW, and less than 5 MW, this generation will modeled with the new DER_A model. The block diagram of the DER_A model is shown in the following figure.


Vref0
v0
Vt
s0
dbd1
dbd2
Verr
v5
Kqv
Iqh
Iql
pfaref
v1
tan
Pelec
s1
PfFlag
Qref
v4
Vt_filt
(s0)
0.01
s2
Iqinj
v22
Iqmax
(v8)
Iqcmd
Iqmin
Pqflag
0 – Q priority
1 – P priority
GenFlag
Current
Limit
Logic
Pref
v3
femax
femin
L7
s6
dPmax
dPmin
s7
FreqFlag
Pmax
Pmin
Pord
s8
Ipmax
Ipmin
Ipcmd
(v7)
Δfreq
Frq_filt
s5
Δfreq_ref
(v2)
fdbd1
fdbd2
v6
Ddn
Dup
Iqcmd
v8
s3
-1
iq
Eq
Ed
j
Rs+jXs
Ed=Vtd + idRs - iqXs
Eq=Vttq + iqRs + idXs
Vrfrac
Vt_filt
(s0)
vl0
vl1
v11
vh1
vh0
v12
VtripFlag
1.0
V13
s4
rrpwr
Ipcmd
v7
s9
id
1.0
(if Vt < Vpr)
fl
fh
Frq_filt (s5)
(if Vt > Vpr)
FtripFlag

The input data that was used for the DER_A model is shown below.

Table 12: DER_A Model Parameters Assumed for Study

Param	Value	Notes
trv	0.02	
dbd1	-99	No voltage control was modeled
dbd2	99	No voltage control was modeled
kqv	0	No voltage control was modeled
vref0	0	No voltage control was modeled
tp	0.02	
tiq	0.02	
ddn	0	
dup	0	
fdbd1	-99	
fdbd2	99	
femax	0	
femin	0	
pmax	1	
pmin	0	
dpmax	99	
dpmin	-99	
tpord	0.02	
imax	1.2	
vl0	0.5	Voltage at head of feeder at which DER at head of feeder starts tripping.
vl1	0.55	Voltage at head of feeder at which DER at tail of feeder trips. Assume 5% voltage drop across feeder
vh0	1.25	Voltage at head of feeder at which DER at tail of feeder trips. Assume 5% voltage drop across feeder
vh1	1.2	Voltage at head of feeder at which DER at head of feeder starts tripping.
tvl0	1.1	shall trip region for undervoltage
tvl1	1.1	shall trip region for undervoltage
tvh0	0.01	May trip region for overvoltage
tvh1	0.01	May trip region for overvoltage
vrfrac	1	No der comes back after tripping
fltrp	57	Frequency ride through per ISO NE SRD: may trip region
fhtrp	61.8	
tfl	0.10	
tfh	0.10	
tg	0.02	†
rrpwr	2.0	
tv	0.02	

Param	Value	Notes
kpg	0	
kig	0	
xe	0.25	
vpr	0.7	
iqh1	0	No voltage control
iql1	0	No voltage control
pfflag	1	
frqflag	0	Freq control disabled
pqflag	P priority	No voltage control
typeflag	1	Generator

All DER greater than 1 MW, but less than 5 MW, was modeled aggregately as a single equivalent generator, at the distribution bus of each substation to which they was connected. The MW size of the single equivalent generator, at a specific substation, was equal the total amount of DER (greater than 1 MW but less than 5 MW) to be connected to that substation. No distribution feeder impedance was modeled between the equivalent generator, and the distribution bus to which it is connected.

Stability Modeling of new DER equal to 5 MW and Greater

For the additional DER that is equal to, or greater than 5 MW , these units were modeled with standard PSS/E library models, approved by ISO-NE, utilizing specific modeling data provided by the developer.

These models were tested individually for reasonableness, before conducting the overall stability study.

These generators were modeled as individual generators at the low side of the substation to which they were connected.

The following two generators exceeded 5 MW for Group 1:

1. Snow St – 11.1 MW
2. Belchertown – 8.0 MW

These generators were modeled with a standard PSS/E library model set:

REGCA – **Renewable Energy Generator/Converter Model**
REECA – Renewable Energy Electrical Model
REPCA --. Plant Controller model

The REECA model type was utilized for these units because the REECA has the ability to model momentary cessation, and the ISO-NE SRD requires DER to go into momentary cessation for terminal voltages below 0.50 pu.

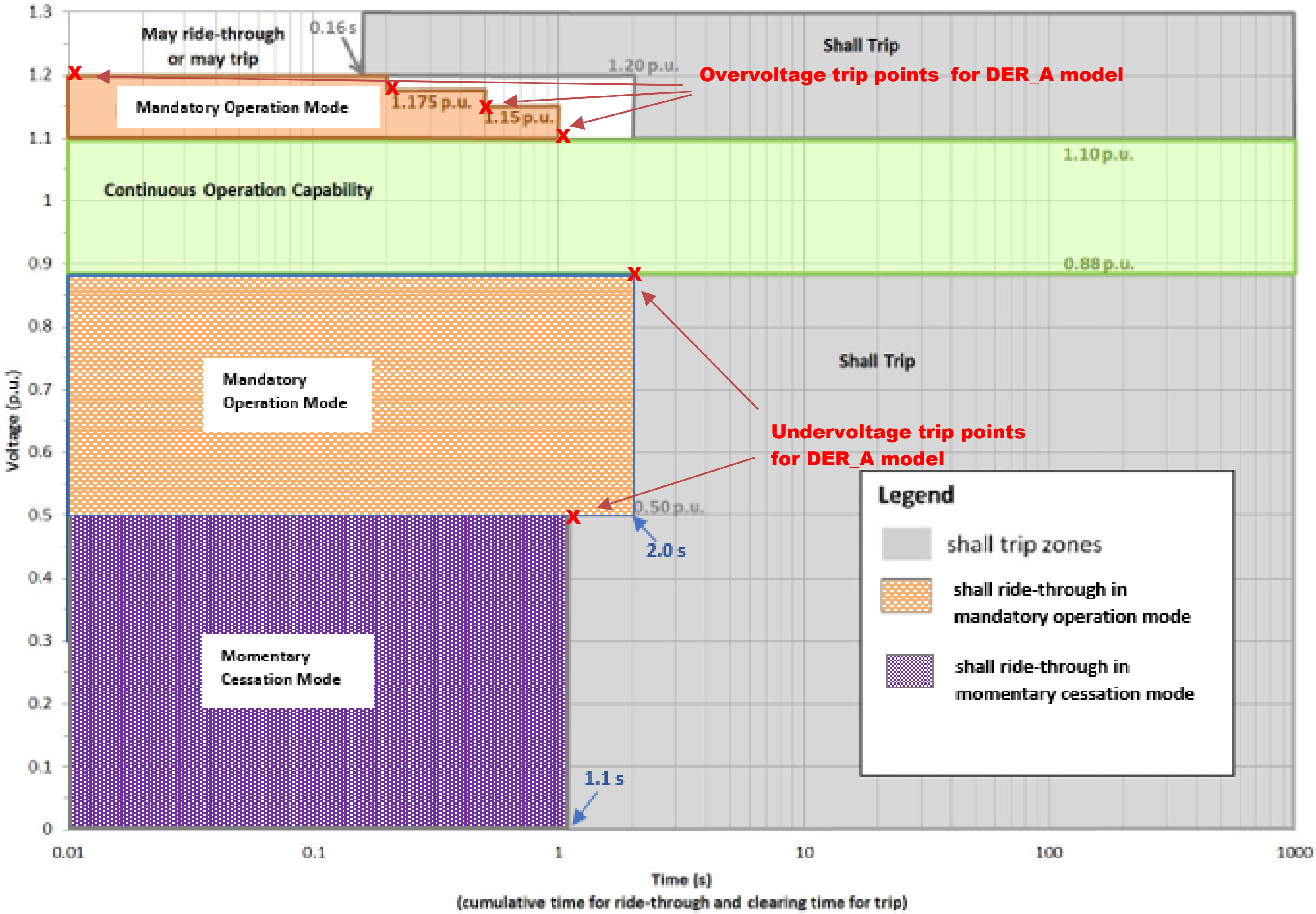
The block diagram for model REECA, and accompanying input parameters for both Snow St and Belchertown, are provide in Appendix C

Ride-Through Capability of Additional DER

It was assumed that all additional DER modeled for this study (all DER > 1MW) will meet the revised Energy Service Bulletin (ESB) for National Grid, for both frequency and voltage.

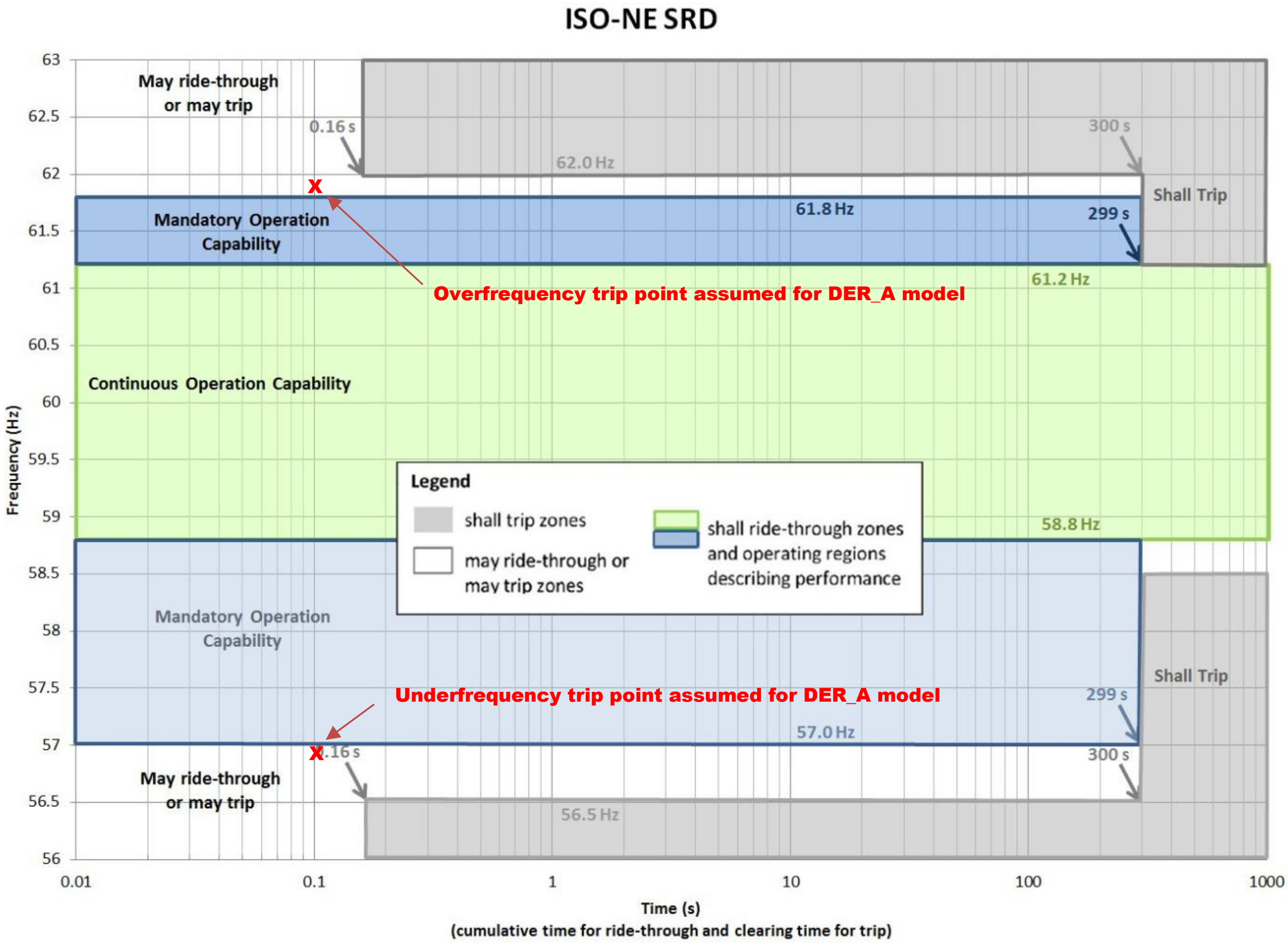
Further, it was assumed that the additional DER will only ride through the "Continuous Operation Capability", "Mandatory Operation Capability", and "Momentary Cessation" regions of the ESB curves for both frequency and voltage. The DER was assumed to tripped permanently for frequencies and voltages outside those regions.

The voltage ride-through capability curve for the revised National Grid ESB is shown below.



The 6 undervoltage trip points was modeled for the VTGTPAT model. The momentary cessation regions of the SRD was modeled using the built-in under/over voltage function of the DER_A model.

The frequency ride-through capability curve is shown below.



The under/over frequency trip points of the ESB was modeled using the built-in under/over frequency function of the DER_A model.

6.2 Study Year Tested

Since the in-service date of the entire 787 MW DER in this cluster ranges from 2020 to 2023, the year 2023 ISO-NE base cases, released in 2019, were used for this transient stability assessment.

Note that there are no planned network changes to the transmission in the western MA area, between 2021 and 2023, which would make the 2023 cases unsutible for the assessment of Group 1 DER (in-service date of 2021).

6.3 Load Levels Tested

Two load levels be tested for stability analysis:

1. Summer Peak Load
2. Light Load

6.4 Stability Base Case Summaries

In order to investigate the impact of the proposed projects to the New England transmission system, one base case representing the 2023 summer peak load levels and two base cases representing the 2023 light load levels, were developed in this study. The following table summarizes the interface levels and generation dispatches for the steady state base cases.

Table 13 Stability Base Case Summaries for Design Contingency Testing

Interface Name	Peak Load Case	Light Load Cases	
	23pk-ew	23ll-ew	23ll-we
NB-NE	1051	1050	1050
ORR_SOUTH	1386	1375	1378
SURW_SOUTH	1600	1600	1611
ME-NH	2004	2000	2044
EAST-WEST	3579	3500	-2975
NE-NY	1210	1200	-1610
NNE-SCOB+394	3629	3343	1658
NORTH-SOUTH	3480	3105	1739
SEMA/RI – NE	1361	1321	-1607
SBRK_SOUTH	1885	1737	539
HIGHGATE_IMP	218	223	344
SNDYPD_IMP	2000	2000	0
CT IMPORT	2900	1944	*390
Cross sound cable Export to NY	101	344	344
Bear Swamp	666	-666	0
Northfield	1080	-1000	0

Altresco	0	197	197
Millrmium	412	412	412

Table 24 Stability Base Case Summaries for BPS Simulations

Interface Name	**Interface Flows (MW)**			
	WMAVT	**BOS**	**ME_C**	**SEMA**
NB-NE	921	921	1052	921
SURW_SOUTH	1356	1355	1605	1355
ME-NH	1556	1781	2004	1718
EAST-WEST	-1371	3445	3018	3457
NE-NY	1223	1221	1192	1221
NNE-SCOB+394	3211	3216	3671	3210
NORTH-SOUTH	3007	2884	3480	2882
SEMA/RI - NE	-1131	2919	2291	3503
SBRK_SOUTH	1794	1722	1914	1734
HIGHGATE_IMP	223	223	223	223
SNDYPD_IMP	0	0	0	0
CT IMPORT	490	501	97	508
Cross sound cable Export to NY	346	345	346	345
Bear Swamp	666	-600	-600	-600
Northfield	1180	-1100	-1100	-1100
Alresco	197	0	0	0
Millenium	412	0	0	0

6.5 BPS Test Results

The following simulations were conducted to determine if any new substations become Bulk Power System (BPS) substations as a result of the additional of Group 1 DER. Results indicate that the addition of Group 1 DER introduces no new BPS stations.

Table 15: Bulk Power System (BPS) Contingency Results (tested on BPS cases)

Contingency Name	Type	kV	Location	Clearing Times (cycles)	Protection Groups	Light Load Results			
						BOS	ME_C	SEMA	WMAVT
BS-230-BPS	BPS	230	Bear Swamp	E205E 35 at Pratts Junction (Z2) E205W 23.5 at Eastover Rd (Z2) Bear Swamp 230/115 kV autotransformer: uncleared	E205E S1: Step Distance S2: Step Distance E205W S1:Step Distance S2: POTT	Stable. No system separation Bear Swamp two units tripped. Bear Swamp units are pumping at 666MW in BOS, ME_C, and SEMA cases. [Total Source loss = -666MW]			Stable. No system separation Bear Swamp two units tripped. The units are generating at 666MW [Total Source loss = 666MW]
BS-115-BPS	BPS	115	Bear Swamp	S-197 25 at Deerfield 4 (Z2) E-131 52 at Harriman (Z2, sequential clearing) 52 at Adams (Z2, sequential clearing) Bear Swamp 230/115 kV autotransformer: uncleared	S197 S1: Step Distance S2: Step Distance E131 S1: Step Distance S2: POTT	Stable. No system separation Bear Swamp two units tripped. Bear Swamp units are pumping at 666MW in BOS, ME_C, and SEMA cases. Harriman three units (39MW) tripped. [Total Source loss = -627MW]			Stable. No system separation Bear Swamp two units tripped. The units are generating at 666MW Harriman three units (39MW) tripped. [Total Source loss = 705MW]
PJ-115-BPS	BPS	115	Pratts Jct	[redacted] I135S/J136S: 34 at Flagg Pd (Z2) K137W: 29 at Ayer (Z2) [redacted]	[redacted] SYS1:STEP DIST SYS2:STEP DIST SYS1:STEP DIST [redacted] SYS1:DIFF	Stable. No system separation Bear Swamp two units tripped. Bear Swamp units are pumping at 666MW in BOS, ME_C, and SEMA cases. 5MW of DG tripped [Total Source loss = -661MW]			Stable. No system separation 5MW of DG tripped [Total Source loss = 5MW]

Contingency Name	Type	kV	Location	Clearing Times (cycles)	Protection Groups	Light Load Results			
						BOS	ME_C	SEMA	WMAVT
				Pratts Jct 230-115kV and 115-69 kV autos: Uncleared	SYS2:DOC				
PJ-230-BPS	BPS	230	Pratts Jct	E-205E: 29 at Bear Swamp (z2) Pratts 230-115 kV autos: Uncleared	S1: Step Distance S2: Step Distance SYS1:DIFF SYS2:DOC	Stable. No system separation [Total Source loss = 0MW]			
Palmer-115-BPS	BPS	115	Palmer	W175: 47 at Carpenter Hill (Z2) [redacted] R-170: 29 cy at W Hampden (Z2)	[redacted] W-175 & R-170: S1 = Step Distance S2 = Step Distance	Stable. No system separation 50MW of DG tripped [Total Source loss = 50MW]			
Carp-115-BPS	BPS	115	Carpenter Hill	V174W: 29 at N Oxford (Z2) W175: 29 at Palmer (Z2) Carpenter Hill T1: uncleared	V-174W & W-175: S1 = Step Distance S2 = Step Distance Carpenter Hill T1: S1 = Diff S2 = Diff	Stable. No system separation Millennium units are offline. 46MW of DG tripped [Total Source loss = 46MW]			Stable. No system separation Millennium units tripped as part of fault clearing 53MW of DG tripped [Total Source loss = 465MW]
Flagg-115-BPS	BPS	115	Flagg Pd	I-135S/J-135S: 29 at Pratts Jct (Z2) I-135: 30 at Whitmanville(Z2) J-136N: 42 at Bellows (Z2)	I-135S, I-135, J-136S & J136N: S1 = Step Distance S2 = Step Distance	Stable. No system separation 15MW of DG tripped [Total Source loss = 15MW]			
[redacted]	BPS	115	[redacted]	[redacted]	[redacted]	Stable. No system separation 6MW of DG tripped [Total Source loss = 6MW]			

6.6 N-1 Stability Test Results

Several Breaker Failure Contingencies were tested. These Breaker Failures were first tested with assuming a 3-phase initiating fault, which is categorized as an Extreme Contingency. If this test failed the Performance requirements outlined in ISO-NE PP3, a corresponding Design Contingency was tested (Breaker failure with Single line to Ground imitating fault); otherwise, no corresponding design contingency was tested.

Table 16 N-1 Breaker Failure Contingency List (tested on Design Contingency Cases)

-

Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)	Protection Groups	Light Load Results		Peak Load Results
						EW	WE	EW
BS-1205E-BF	EC	230	3PH fault at Bear Swamp 230 kV #1 bus with failure of 1205E breaker at Bear Swamp	5 at BS G1 5 at BS T5 auto 15 at BS (BF) 17 at Pratts Junction 230 kV (DTT)	E-205E S1: Step Distance S2: Step Distance	Stable. Bear Swamp P1 tripped as part of fault clearing. Bear Swamp P2 tripped by out of step relay. Non-consequential source loss = -333MW	Stable. Bear Swamp units are offline. No non-consequential source loss	Stable. Bear Swamp G1 tripped as part of fault clearing. Bear Swamp G2 tripped by out of step relay. Non-consequential source loss = 333MW
BS-T97-BF	EC	115	3PH fault at Bear Swamp 115 kV #1 bus with failure of T97 breaker at Bear Swamp	5 at BS G1 5 at BS #5 auto 5 cy at BS cap 19 at Bear Swamp (BF) 25 at Deerfield (Z2)	S-197 S1: Step Distance S2: Step Distance	Stable. Bear Swamp P1 tripped as part of fault clearing. Bear Swamp P2 tripped by underspeed relay. Non-consequential source loss = -333MW	Stable. Fife brook unit tripped by overspeed relay Non-Consequential source loss = 10MW	Stable. Bear Swamp G1 tripped as part of fault clearing. Fife Brook tripped by underspeed relay. Non-consequential source loss = 10 MW
[redacted]	EC	345	[redacted]	[redacted]	[redacted]	Stable. No non-consequential source loss	Stable. No non-consequential source loss	Stable. No non-consequential source loss
[redacted]	EC	345	[redacted]	[redacted]	[redacted]	Stable. No non-consequential source loss	Stable. No non-consequential source loss	Stable. No non-consequential source loss
[redacted]	EC	345	[redacted]	[redacted]	[redacted]	Stable. No non-consequential source loss	Stable. No non-consequential source loss	Stable. No non-consequential source loss
[redacted]	EC	345	[redacted]	[redacted]	[redacted]	Stable. No non-consequential source loss	Stable. No non-consequential source loss	Stable. No non-consequential source loss
[redacted]	EC	115	[redacted]	[redacted]	[redacted]	Stable. Millennium units tripped as part of fault clearing No non-consequential source loss	Stable. Millennium units tripped as part of fault clearing No non-consequential source loss	Stable. Millennium units tripped as part of fault clearing No non-consequential source loss
[redacted]	EC	115	[redacted]	[redacted]	[redacted]	Stable.	Stable.	Stable.

			[redacted]			Millennium units tripped as part of fault clearing No non-consequential source loss	Millennium units tripped as part of fault clearing No non-consequential source loss	Millennium units tripped as part of fault clearing No non-consequential source loss
PJ-69kV-TIE-BF	EC	69`	3-phase fault on 69kV bus #1 with Failure of 69 kV breaker 320 (non-ipt) at Pratts Jct	6 at Breakers A1,N40,U21,xfmr bank 1 18 at Breakers B2,V22,xfmr bank 1	Pratts 69 kV Bus: S1: Diff S2: Diff	Stable. No non-consequential source loss	Stable. No non-consequential source loss	Stable. No non-consequential source loss
[redacted]	EC	345	[redacted]			Stable. Northfield P1, P2 tripped as part of fault clearing No non-consequential source loss	Stable. Northfield units are offline No non-consequential source loss	Stable. Northfield G1, G2 tripped as part of fault clearing No non-consequential source loss
	EC	115				Stable. No non-consequential source loss	Stable. No non-consequential source loss	Stable. No non-consequential source loss
AD-3T5T-BF	EC	115	3-phase fault on E-131 line at Adams. Failure of 3T5T breaker at Adams	6 cycles at Harriman, Bear Swamp (POTT) 14 cycles at Adams T3 Xfmr (BF)	E-131 S1: POTT S2: Step Distance	Stable. No non-consequential source loss	Stable. Fife Brook tripped by underspeed relay. Non-consequential source loss = 10 MW	Stable. Fife Brook tripped by underspeed relay. Non-consequential source loss = 10 MW

Table 17 N-1 Stability Design Contingency Results (tested on Design Contingency Cases)

Contingency Name	Type	kV	Location/ Description	Clearing times (cycles)	Protection Groups	Light Load Results				Peak Load
						EW		WE		EW
						Pre-SRD Change	Post-SRD Change	Pre-SRD Change	Post-SRD Change	Post-SRD Change
[redacted]	NC	115	[redacted]			63MW of Non-consequential DG tripped	Stable. No non-consequential source loss	63MW of Non-consequential DG tripped	Stable. No non-consequential source loss	Stable. No non-consequential source loss
	NC	115				10MW of Non-consequential DG tripped	Stable. No non-consequential source loss	10MW of Non-consequential DG tripped	Stable. No non-consequential source loss	Stable. No non-consequential source loss
E205E-PJ	NC	230	3-phase fault on E-205E at 20% from Pratts Jct to Bear Swamo	6 @ Pratts Jct (Z1) 29 @ Bear Swp (Z2)	E-205E Line: S1 = Step Distance S2 = Step Distance	0MW of Non-consequential DG tripped	Stable. No non-consequential source loss	0MW of Non-consequential DG tripped	Stable. No non-consequential source loss	Stable. No non-consequential source loss
E205W-BS	NC	230	3-phase fault on E-205W line at Bear Swamp	5 at Eastover Road 5 at Bear Swamp	E-205W Line: S1 = POTT S2 = Step Distance	-	Stable. No non-consequential source loss	-	Stable. No non-consequential source loss	Stable. No non-consequential source loss
[redacted]	NC	345	[redacted]			0MW of Non-consequential DG tripped	Stable. No non-consequential source loss	0MW of Non-consequential DG tripped	Stable. No non-consequential source loss	Stable. No non-consequential source loss
	NC	345				0MW of Non-consequential DG tripped	Stable. No non-consequential source loss	0MW of Non-consequential DG tripped	Stable. No non-consequential source loss	Stable. No non-consequential source loss
S197-BS	NC	115	3-phase fault on S-197 at 20% from Bear Swamp to Deerfield 4	5 at Bear Swamp 30 at Deerfield Reclose after 5s	S-197 S1: Step Distance S2: Step Distance	2.7MW of Non-consequential DG tripped	Stable. No non-consequential source loss	2.7MW of Non-consequential DG tripped	Stable. No non-consequential source loss	Stable. No non-consequential source loss

Contingency Name	Type	kV	Location/ Description	Clearing times (cycles)	Protection Groups	Light Load Results				Peak Load
						EW		WE		EW
						Pre-SRD Change	Post-SRD Change	Pre-SRD Change	Post-SRD Change	Post-SRD Change
E131-BS	NC	115	3-phase fault on E-131 line at Bear Swamp	5 at Bear Swamp 5 at Adams 5 at Harriman	S-197 S1: POTT S2: Step Distance	-	Stable. No non-consequential source loss	-	Stable. No non-consequential source loss	Stable. No non-consequential source loss
[redacted]	NC	115	[redacted]	[redacted]	[redacted]	0MW of Non-consequential DG tripped	Stable. No non-consequential source loss	0MW of Non-consequential DG tripped	Stable. No non-consequential source loss	Stable. No non-consequential source loss
E5-WARE	NC	69	3-phase fault on E5 at 20% from Ware to Meadow St	5 at Ware 30 at Meadow St Reclose after 5s	E-5 S1: Step Distance S2: Step Distance	48MW of Non-consequential DG tripped	Stable. No non-consequential source loss	48MW of Non-consequential DG tripped	Stable. No non-consequential source loss	Stable. No non-consequential source loss
E5-F6E-DCT-Millbury	NC	69	Simultaneous 1ph fault on E5E/F6E lines at Millbury	5 at Millbury 30 at Meadow St	E-5E/F-6E S1: Step Distance S2: Step Distance	41MW of Non-consequential DG tripped	Stable. No non-consequential source loss	41MW of Non-consequential DG tripped	Stable. No non-consequential source loss	Stable. No non-consequential source loss
A1S-B2S-DCT-Gardner	NC	69	Simultaneous 1ph fault on A1/B2 lines at Gardner Switch Tower	6 at Otter River 6 at Pratts Jct 6 at Crystal Lake	A-1S/B2S S1: POTT S2: Step Distance	0MW of Non-consequential DG tripped	Stable. No non-consequential source loss	0MW of Non-consequential DG tripped	Stable. No non-consequential source loss	Stable. No non-consequential source loss
A1N-B2N-DCT-Royalston	NC	69	Simultaneous 1ph fault on A1/B2 lines at Royalston	6 at Vernon 6 at Crystal Lake 6 at Chestnut Hill	B-2N S1: POTT S2: Step Distance	0MW of Non-consequential DG tripped	Stable. No non-consequential source loss	0MW of Non-consequential DG tripped	Stable. No non-consequential source loss	Stable. No non-consequential source loss
D4-Solar	NC	69	3-phase fault on D4 at 20% from Vernon Solar to Vernon	5 at Vernon Solar 30 at Vernon	D-4 S1: Step Distance S2: Step Distance	9MW of Non-consequential DG tripped	Stable. No non-consequential source loss	9MW of Non-consequential DG tripped	Stable. No non-consequential source loss	Stable. No non-consequential source loss

Contingency Name	Type	kV	Location/ Description	Clearing times (cycles)	Protection Groups	Light Load Results				Peak Load
						EW		WE		EW
						Pre-SRD Change	Post-SRD Change	Pre-SRD Change	Post-SRD Change	Post-SRD Change
J136N-BELFS	NC	115	3-phase fault on J-136N line at 20% from Bellows Falls to Flagg Pond	6 at Bellows Falls 35 at Flagg Pond (assumption)	J-136N S1: Step Distance S2: Step Distance	-	Stable. No non-consequential source loss	-	Stable. No non-consequential source loss	Stable. No non-consequential source loss
O15N- PALM	NC	69	3-phase fault on O-15N at 20% from Palmer to Ware	5 at Palmer 30 at Ware	O-15N S1: Step Distance S2: Step Distance	71MW of Non-consequential DG tripped	Stable. No non-consequential source loss	71MW of Non-consequential DG tripped	Stable. No non-consequential source loss	Stable. No non-consequential source loss
[redacted]	NC	450	[redacted]	[redacted]	[redacted]	0MW of Non-consequential DG tripped	Stable. No non-consequential source loss	0MW of Non-consequential DG tripped	Stable. No non-consequential source loss	Stable. No non-consequential source loss
BS-1205E-BF-SLG	NC	230	1PH fault at Bear Swamp 230 kV #1 bus with failure of 1205E breaker at Bear Swamp Y 316 -2689 MVA	5 at BS G1 5 at BS T5 auto 15 at BS (BF) 17 at Pratts Junction 230 kV (DTT)	E-205E S1: Step Distance S2: Step Distance	-	Stable. Bear Swamp P1 tripped as part of fault clearing. No non-consequential source loss	-	Stable. Bear Swamp units are offline. No non-consequential source loss	Stable. Bear Swamp G1 tripped as part of fault clearing. No non-consequential source loss
BS-1205W-BF-SLG	EC	230	1PH fault at Bear Swamp on E-205W line with failure of 1205W breaker at Bear Swamp Y 316 -2689 MVA	5 at Eastover Rd 15 at BS T5 (BF) 15 at BS G2 (BF) 15 at C1 (BF)	E-205W S1: POTT S2: Step Distance	-	Stable. Bear Swamp P2 tripped as part of fault clearing. No non-consequential source loss	-	Stable. Bear Swamp units are offline. No non-consequential source loss	Stable. Bear Swamp G2 tripped as part of fault clearing. No non-consequential source loss
BS-T97-BF-SLG	NC	115	1PH fault at Bear Swamp 115 kV #1 bus with failure of T97 breaker at Bear Swamp Y 212 -1919 MVA	5 at BS G1 5 at BS #5 auto 5 cy at BS cap 19 at Bear Swamp (BF) 25 at Deerfield (Z2)	S-197 S1: Step Distance S2: Step Distance	-	Stable. Bear Swamp P1 tripped as part of fault clearing. No non-consequential source loss	-	Stable. Bear Swamp units are offline. No non-consequential source loss	Stable. Bear Swamp G1 tripped as part of fault clearing. No non-consequential source loss

Contingency Name	Type	kV	Location/ Description	Clearing times (cycles)	Protection Groups	Light Load Results				Peak Load
						EW		WE		EW
						Pre-SRD Change	Post-SRD Change	Pre-SRD Change	Post-SRD Change	Post-SRD Change
BS-T31-BF-SLG	NC	115	1PH fault at Bear Swamp 115 kV E-131 with failure of T31 breaker at Bear Swamp Y 212 -1919 MVA	5 at Harriman 5 at Adams 16 at BS C1 (BF) 16 at BS T5 (BF) 16 at BS G1	E-131 S1: POTT S2: Step Distance	-	Stable. Bear Swamp P1 tripped as part of fault clearing. No non-consequential source loss	-	Stable. Bear Swamp units are offline. No non-consequential source loss	Stable. Bear Swamp G1 tripped as part of fault clearing. No non-consequential source loss
AD-3T5T-BF-SLG	NC	115	3-phase fault on E-131 line at Adams. Failure of 3T5T breaker at Adams Y 212 -1919 MVA	6 cycles at Harriman, Bear Swamp (POTT) 14 cycles at Adams T3 Xfmr (BF)	E-131 S1: POTT S2: Step Distance	-	Stable. No non-consequential source loss	-	Stable. No non-consequential source loss	Stable. No non-consequential source loss

6.7 N-1-1 Stability Test Results

Table 18 N-1-1 Stability Design Contingency Results (tested on Design Contingency cases)

Initial N-1	Post N-1	N-1-1 Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)	Protection Groups	Light Load Results		Peak Load Results
Line Out	System Adjustments							EW	WE	EW
[redacted]	None	[redacted]	NC	230	[redacted]			Stable. No non-consequential source loss	Stable. No non-consequential source loss	Stable. No non-consequential source loss
			NC	115				Stable. No non-consequential source loss	Stable. No non-consequential source loss	Stable. No non-consequential source loss

Initial N-1	Post N-1	N-1-1 Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)	Protection Groups	Light Load Results		Peak Load Results
Line Out	System Adjustments							EW	WE	EW
		[redacted]	NC	115	[redacted]	[redacted]	[redacted]	Stable. No non-consequential source loss	Stable. No non-consequential source loss	Stable. No non-consequential source loss
		[redacted]	NC	115	[redacted]	[redacted]	[redacted]	Stable. Millennium C1,S1 tripped by overspeed relay The same result was observed under pre-project scenario	Stable. Millennium C1,S1 tripped by overspeed relay The same result was observed under pre-project scenario	Stable. Millennium C1,S1 tripped by overspeed relay The same result was observed under pre-project scenario
		[redacted]	NC	345	[redacted]	[redacted]	[redacted]	Stable. Northfield G1,G2 tripped as part of fault clearing	Stable. Northfield G1,G2 are offline	Stable. Northfield G1,G2 tripped as part of fault clearing
		[redacted]	NC	345	[redacted]	[redacted]	[redacted]	Stable. No non-consequential source loss	Stable. No non-consequential source loss	Stable. No non-consequential source loss
		[redacted]	NC	345	[redacted]	[redacted]	[redacted]	Stable. No non-consequential source loss	Stable. No non-consequential source loss	Stable. No non-consequential source loss
		[redacted]	NC	115	[redacted]	[redacted]	[redacted]	Stable. Millennium C1,S1 tripped by SPS action	Stable. Millennium C1,S1 tripped by SPS action	Stable. Millennium C1,S1 tripped by SPS action 7MW of Non-consequential DG tripped

Initial N-1	Post N-1	N-1-1 Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)	Protection Groups	Light Load Results		Peak Load Results
Line Out	System Adjustments							EW	WE	EW
					[redacted]					
		[redacted]	NC	345	[redacted]			Stable. No non-consequential source loss	Stable. No non-consequential source loss	Stable. No non-consequential source loss
		[redacted]	NC	345	[redacted]			Stable. No non-consequential source loss	Stable. No non-consequential source loss	Stable. No non-consequential source loss
		[redacted]	NC	450	[redacted]			Stable. No non-consequential source loss	Stable. No non-consequential source loss	Stable. No non-consequential source loss
		[redacted]	NC	115	[redacted]			Stable. Bearswamp P1 tripped as part of fault clearing No non-consequential source loss	Stable. Bearswamp P1, P2 are offline No non-consequential source loss	Stable. Bearswamp G1 tripped as part of fault clearing No non-consequential source loss

7 SHORT CIRCUIT ANALYSIS

7.1 Short Circuit Models

The short circuit study case was based on the ISO-NE's 2023 Master Short Circuit case which represents the transmission and generation system configuration that would be in place by 2023. Short circuit analysis will be conducted for the 320 MW Group 1 DER interconnection. All DER greater than 1 MW was modeled as a single equivalent generator, at the low side of each substation to which they will be connected. The MW size of the single equivalent generator, modeled at each specific substation, was equal the total amount of DER (greater than 1 MW) to be connected to that substation.

7.2 Methodology and Criteria

The modeling assumptions and short circuit performance criteria, including settings used in Aspen's breaker rating module, are per National Grid's TGP34 'Circuit Breaker Fault Current Assessment Guide' and its associated TGP34 Technical Guidelines.

Voltage Controlled Current Source (VCCS) model was used for all PV inverters in Group1. All DER was modeled as a voltage controlled current source, that will only deliver up to 1.2 p.u. of its nameplate current during fault conditions. The PF angle will be modelled as recommended for different voltage levels. The PF Angle (deg) was calculated based on the recommendation by ASPEN[1]. Figure 7-1 is an example of the ASPEN model that will be used for a 13.8 MW aggregate unit.

[1]. TECHNICAL BULLETIN ON MODELING TYPE-4 WIND PLANT AND SOLAR PLANTS

Prefault Voltage

Figure 7-1 shows the ASPEN setting that will be used to calculate pre-fault voltages.

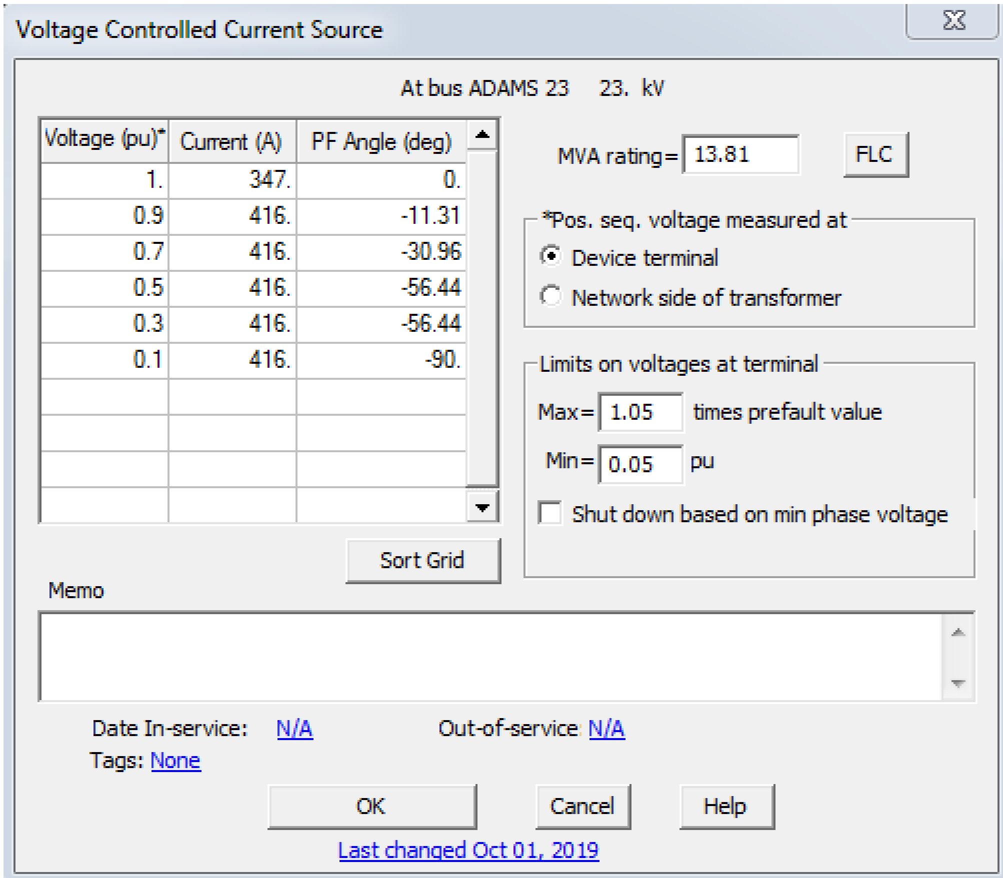


Figure 7-2 ASPEN setting to calculate pre-fault voltages.

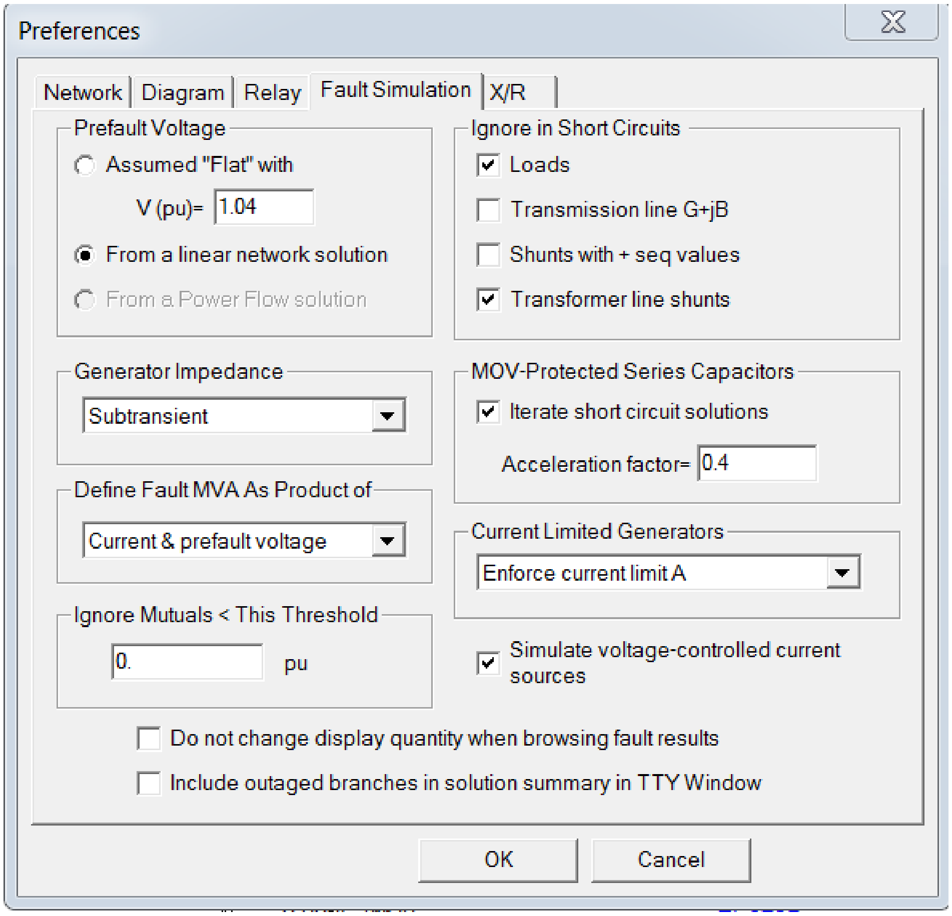
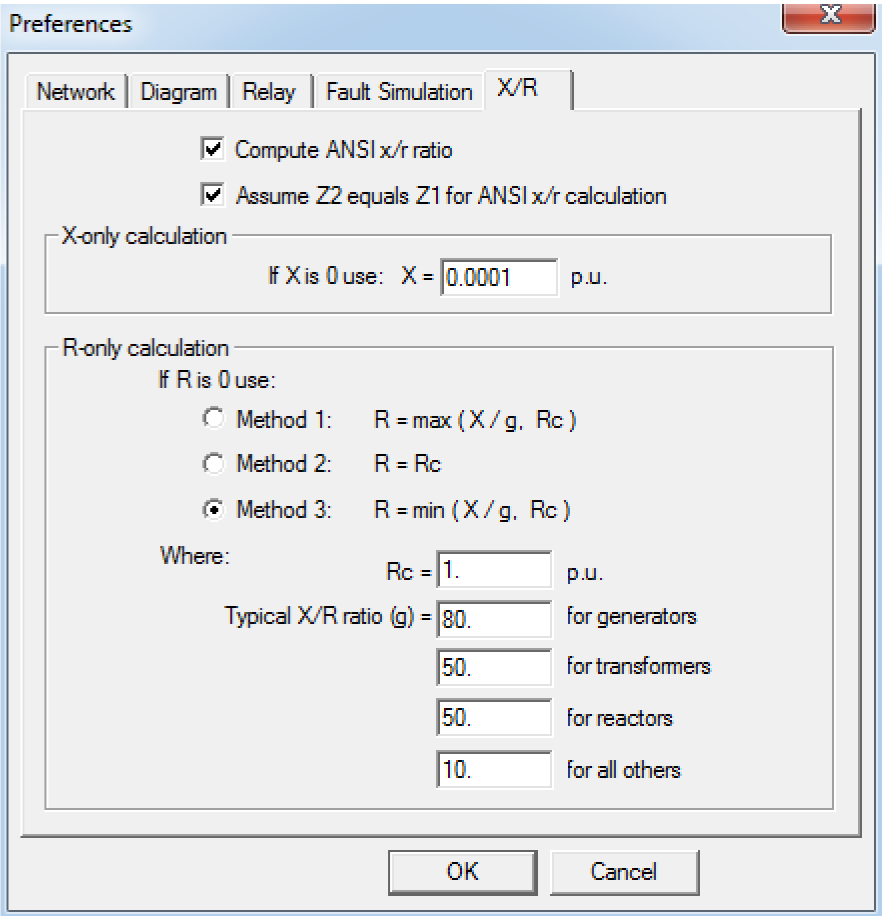


Figure 7-3 below shows the ASPEN options assumed for the short circuit analysis.

Figure 7-3 X/R options in short circuit analysis



7.3 Results

The table below shows the short circuit fault duty for three-phase to ground, line-line to ground, single-line to ground, and line-line faults on National Grid Western Central Massachusetts (WCMA) substation. Table includes the short circuit analysis results with and without the Project in service. For each breaker, the worst case short circuit fault duty is reported. All short circuit study results were adjusted to a 1.03 pu pre-fault voltage as per National Grid practices. The table documents the full listing of circuit breaker duties which include Breaker Duty in Percentage (Duty_P) and Momentary Breaker Duty in Percentage (M_Duty_P) generated by the ASPEN breaker module for all 69kV and above circuit breakers in WCMA.

The analysis results show that all the breaker duty are less than 90%, therefore the PV inverters in Group 1 does not cause any breaker in the system to become overdutied. The change of both Duty_P and M_Duty_P are neglible (<2%).

BUS	kV	Breaker Interrupting Capability (A)	Pre-Project Short Circuit Duty						Post-Project Short Circuit Duty							Duty_P Change (%)	M_Duty_P Change (%)
			3LG (A)	1LG (A)	2LG (A)	LL (A)	Duty_P (%)	M_Duty_P (%)	3LG (A)	1LG (A)	2LG (A)	LL (A)	Worst Case X/R	Duty_P (%)	M_Duty_P (%)		
ADAMS	69	40000	6928	4154	6182	5965	17.41	16.69	6941.5	4155.7	6190	5972	17	17.41	16.79	0	0.1
ADAMS	115	40000	14666	9906	13551	12482	36.71	33.4	14671	9930.7	13621	12542	10.8	36.71	33.4	0	0
AYER	115	40000	21118	15734	20057	18250	41.63	38.87	21137	15734	20064	18253	12.4	41.63	38.87	0	0
AYER	69	19000-40000	10402	9990	10343	9003	58.87	54.26	10403	9988.8	10343	9003	22.8	58.87	54.26	0	0
BEAR SWAMP	115	50000	22614	21714	22391	18647	47.64	45.27	22685	21745	22456	18688	25.7	47.74	45.38	0.1	0.1
BEAR SWAMP	230	50000	13636	13843	14089	10877	27.86	25.29	13674	13857	14118	10893	25.7	27.96	25.39	0.1	0.1
BELLOWS FALLS	69	40000	4291	4822	4680	3699	13	11.99	4284.6	4848.8	4726	3732	23.5	13.1	12.09	0.1	0.1
BELLOWS FALLS	115	40000	7989	7686	8072	6832	19.52	17.29	8021.7	7685.5	8097	6849	10.8	19.6	17.37	0.08	0.1
BLOOMINGDALE	115	63000	18242	12149	16654	15751	19.23	15.55	18327	12159	16698	15786	6.8	19.33	15.55	0.1	0
CARPENTER HILL	115	40000-63000	29133	25332	28790	25144	75.46	72.59	29434	25418	29028	25300	24.2	76.28	73.31	0.82	0.7
[redacted]																	
CHESTNUT HILL	69	22000	2579	1580	2359	2229	11.7	7.694	2580.1	1588.9	2388	2255	2.1	11.72	7.641	0.02	0
DEERFIELD 4	69	27000-31500	9971	9199	9851	8486	36.9	31.56	10049	9218.4	9899	8516	7.5	37.25	31.8	0.35	0.2
DEERFIELD 5	69	19000	7402	6562	7120	6354	38.95	34.13	7410.1	6563.8	7124	6357	8.5	39.05	34.13	0.1	0
EAST LONGMEADOW (N.O.)	69	40000	6787	5159	6237	5866	16.95	14.7	6758.4	5094	6218	5835	8.2	17.27	15.02	0.32	0.3
EAST MAIN ST	115	40000	15075	10413	13858	13052	23.83	20.15	15125	10425	13888	13077	6.3	23.86	20.17	0.02	0
FITCH RD	69	40000	6601	3677	5848	5682	16.55	14.49	6599.5	3675.3	5846	5680	8.6	16.55	14.49	0	0
GREENDALE	115	40000	19633	11610	18007	16970	39.54	33.79	19661	11609	18017	16976	7.4	39.64	33.79	0.1	0
HARRIMAN	69	40000	9233	8860	9108	7865	23.09	21.56	9241.7	8861.8	9113	7868	12.9	23.09	21.56	0	0

BUS	kV	Breaker Interrupting Capability (A)	Pre-Project Short Circuit Duty						Post-Project Short Circuit Duty							Duty_P Change (%)	M_Duty_P Change (%)
			3LG (A)	1LG (A)	2LG (A)	LL (A)	Duty_P (%)	M_Duty_P (%)	3LG (A)	1LG (A)	2LG (A)	LL (A)	Worst Case X/R	Duty_P (%)	M_Duty_P (%)		
HARRIMAN	115	40000	15036	11241	13965	12763	37.62	34.95	15079	11247	13988	12778	12.5	37.73	35.05	0.1	0.1
HARRINGTON ST (PV_E5)	69	40000	8322	5688	7647	7177	20.76	16.26	8758	5752.2	7889	7370	4.9	21.85	17.05	1.08	0.8
MEADOW ST	69	31500	9674	5878	8711	8336	30.69	24.04	10065	5946.1	9030	8600	5	31.92	24.99	1.23	0.9
[redacted]																	
[redacted]																	
MILLBURY5	69	31500	19395	19257	19348	16739	61.57	58.61	19811	19392	19633	16925	14.7	62.93	59.65	1.35	1
MILLBURY5	115	40000	34360	27633	32048	29636	85.92	76.1	34693	27714	32769	29795	9.2	86.74	76.82	0.82	0.7
MOUNT SUPPORT	115	40000	5666	4867	5377	4843	14.14	12.71	5666.6	4866.6	5377	4841	9.8	14.14	12.71	0	0
N OXFORD	115	40000	17242	10559	15900	14900	43.06	40.2	17336	10589	16005	14988	12.9	43.31	40.44	0.25	0.2
NASHUA ST	115	40000	15988	8494	14533	13823	28.65	23.82	16012	8493.6	14541	13830	6.6	28.65	23.82	0	0
NORTHBORO RD	115	40000-43000	16920	13246	15717	14665	42.35	35.8	16971	13260	15748	14689	7.2	42.39	35.94	0.04	0.1
NORTHBORO RD	69	19000-40000	15851	15513	15690	13724	83.46	75.89	15888	15522	15712	13738	9.9	83.65	76.07	0.19	0.2
OTTER RIVER	69	22000	2935	2000	2707	2538	13.34	8.72	2972.5	2008.4	2733	2560	2	13.46	8.77	0.12	0.1
PALMER	69	31500	14582	13126	13979	12573	46.29	44.35	14876	13227	14201	12738	16.1	47.26	45.31	0.97	1
PALMER	115	40000	15269	11403	14027	13164	38.22	35.36	15624	11465	14235	13323	12.2	39.03	36.17	0.82	0.8
CRYSTAL LAKE	69	31500	3677	2213	3290	3104	11.68	7.994	3727.5	2245.1	3397	3197	2.8	11.81	8.179	0.13	0.2
PRATTS JCT	69	40000	21044	20984	21322	18134	53.29	50.83	21253	21043	21480	18225	15.3	53.7	51.14	0.41	0.3
PRATTS JCT	115	40000	30444	24067	28597	26166	76.15	68.46	30650	24102	28673	26236	10	76.66	68.87	0.51	0.4
PRATTS JCT	230	50000	9079	8105	8795	7811	14.45	13.94	9114.6	8107.1	8815	7816	15	14.55	13.94	0.1	0
PROSPECT ST (N.O.)	69	19000	10715	6499	4680	9257	56.37	46.43	10777	6500.8	9498	9277	6.3	56.68	46.73	0.31	0.3
[redacted]																	

BUS	kV	Breaker Interrupting Capability (A)	Pre-Project Short Circuit Duty						Post-Project Short Circuit Duty							Duty_P Change (%)	M_Duty_P Change (%)
			3LG (A)	1LG (A)	2LG (A)	LL (A)	Duty_P (%)	M_Duty_P (%)	3LG (A)	1LG (A)	2LG (A)	LL (A)	Worst Case X/R	Duty_P (%)	M_Duty_P (%)		
SHUTESBURY	69	31500	3988	2304	3542	3432	12.71	9.531	4071.8	2312.8	3583	3467	4.3	12.9	9.727	0.19	0.2
SLAYTON HILL	115	40000	5745	4813	5414	4912	14.35	12.7	5744.7	4812.2	5413	4911	9.1	14.33	12.7	-0.01	0
VERNON HIL (VERN HLL)	115	50000	18378	12590	16775	15868	25.16	20.66	18469	12601	16822	15905	6.8	25.26	20.66	0.1	0
VERNON	69	22000-40000	4957	5378	5521	4262	25.06	20.85	5020.3	5404	5572	4291	6.6	25.31	21.11	0.26	0.3
[redacted]																	
WACHUSETT	69	40000	21000	22367	22085	18138	56.43	55	21007	22362	22087	18135	20.8	56.43	55	0	0
[redacted]																	
WARE	69	31500	9483	5098	8382	8173	30.07	24.14	9943.6	5149.9	8661	8413	5.6	31.54	25.32	1.47	1.2
WEBSTER ST	115	40000	14431	7647	13083	12463	24.86	21.99	14505	7653.5	13120	12495	9.2	24.86	21.99	0	0
WESTBOROUGH	69	22000	10993	7244	9986	9509	50.02	42.24	11041	7252.6	10013	9531	7.2	50.22	42.43	0.2	0.2
WEST HAMPDEN (W.HAMPDEN)	69	40000	5072	5334	5293	4380	13.37	12.96	5134.9	5363.1	5344	4416	16.9	13.39	13.08	0.01	0.1
WEST HAMPDEN	115	40000	14171	10711	13276	12250	35.42	32.36	14410	10765	13437	12372	11.1	36.07	32.9	0.65	0.5
WILDER	115	40000	5678	5496	5596	4853	13.02	11.68	5678	5493.7	5596	4852	10.3	13.02	11.68	0	0
WOODSIDE	69	40000	3847	1752	3356	3295	9.663	8.429	3845.7	1751.3	3354	3294	8.8	9.663	8.429	0	0

Appendix A

Base Case Summaries
For
Steady State Analysis

This Appendix has been redacted for Critical Energy/Electric Infrastructure Information (CEII).11/18/2019

Appendix B

Base Case Summaries
For
Stability Analysis

This Appendix has been redacted for Critical Energy/Electric Infrastructure Information (CEII). 11/18/2019

Appendix C

Stability Models for DER that is 5 MW or greater

Figure: REGC Block Diagram

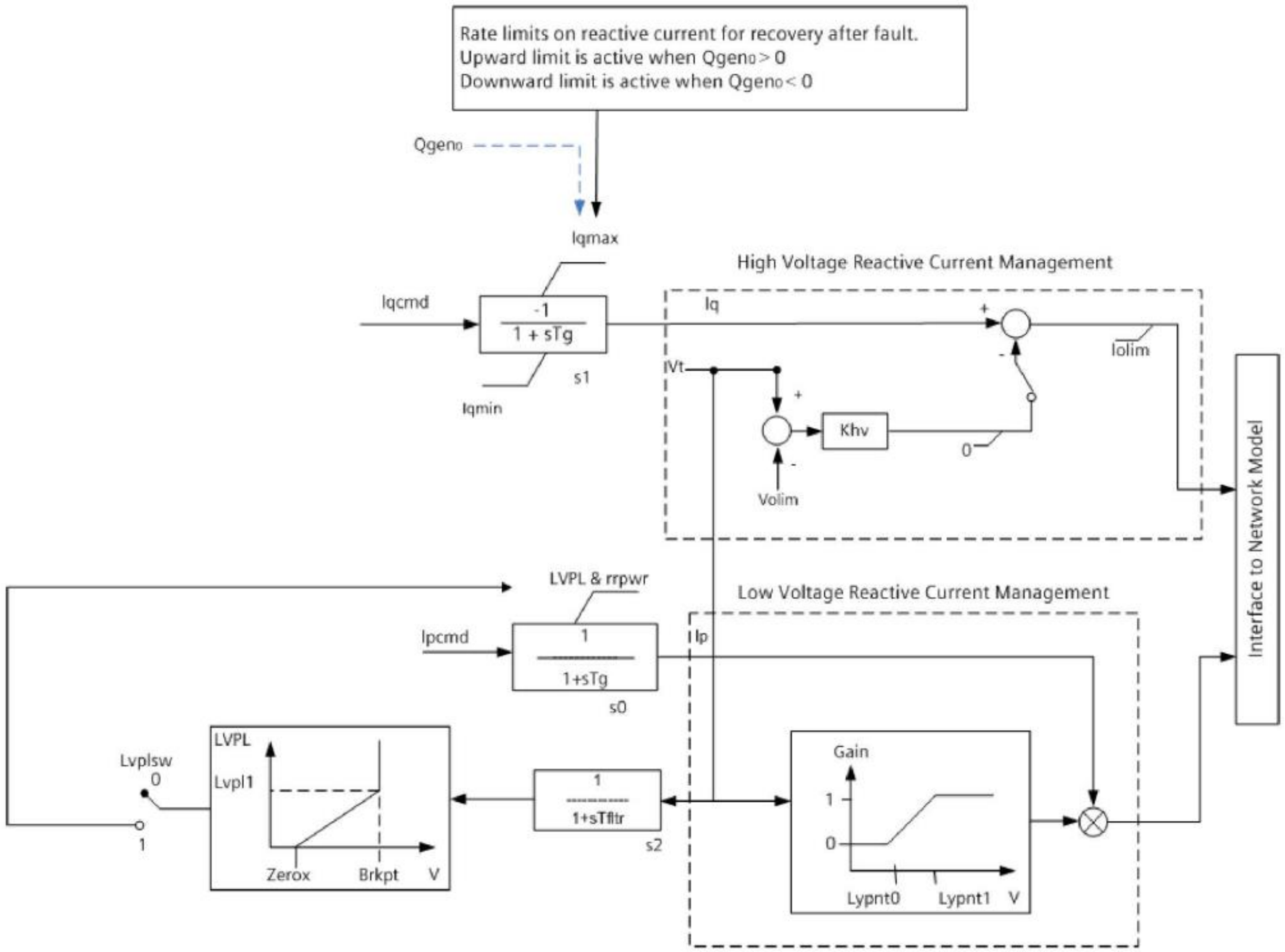


Figure: REECA Block Diagram

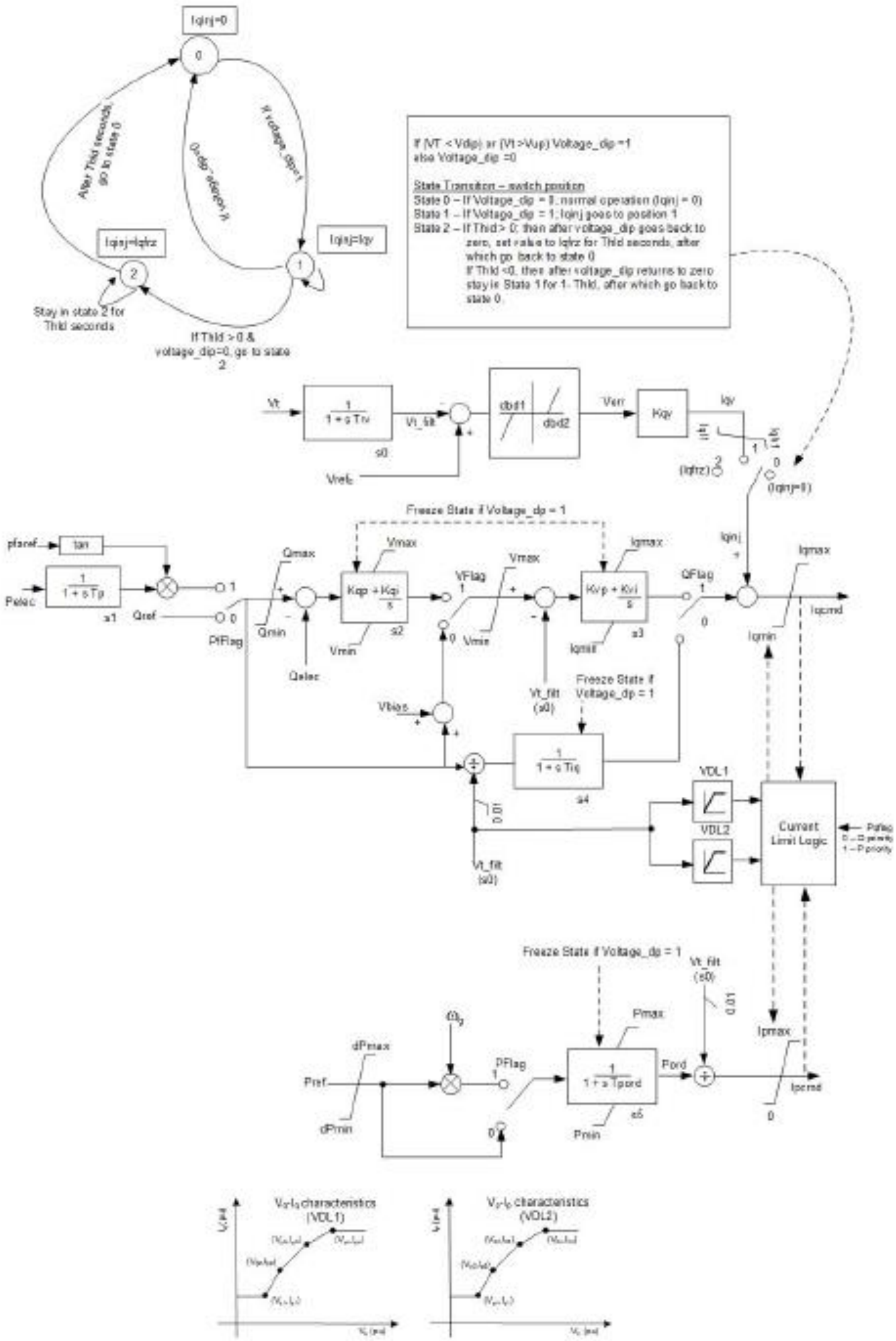
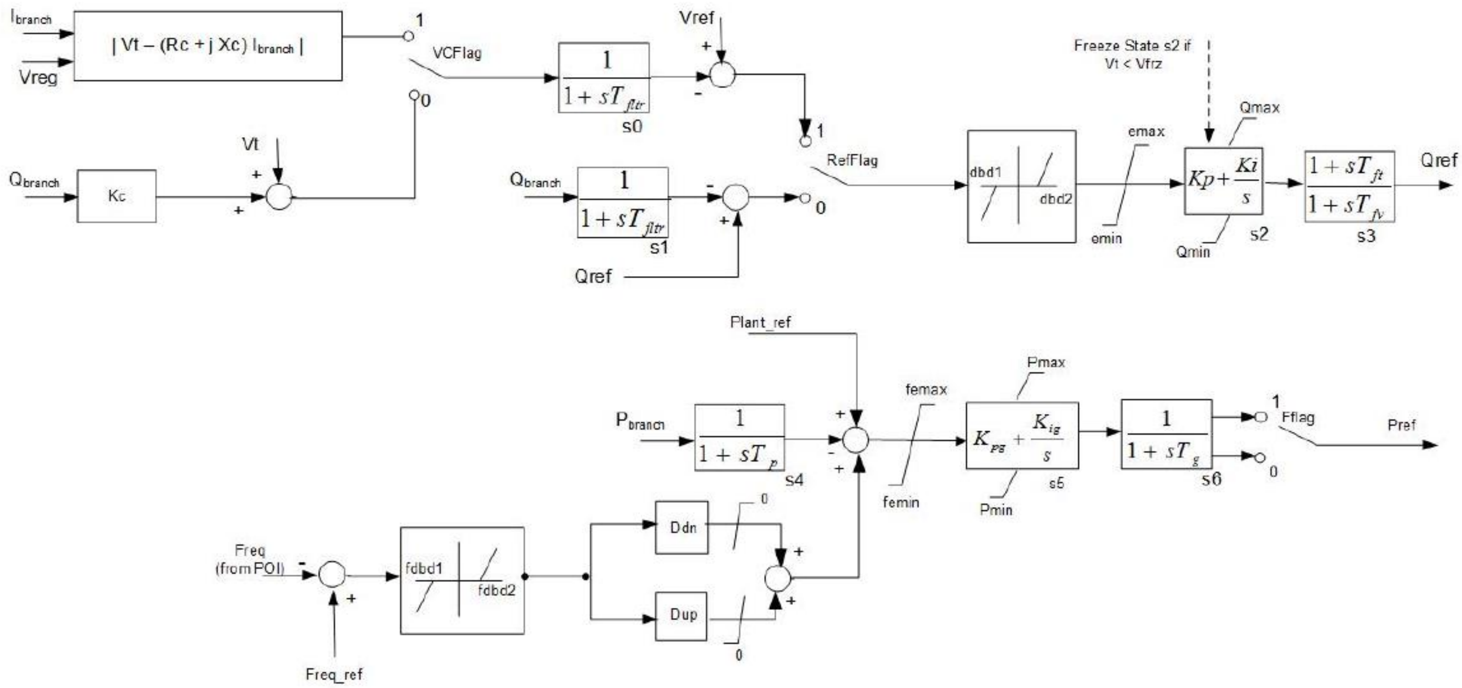


Figure: REPC Block Diagram



Snow Street DG Model Parameters

Model REGCAU1 Bus 113402 [SNOW STREET113.200] Machine "D2" :

I C O N	C O N S	S T A T E S	V A R S
70512	417868-417881	142456-142458	96308-96311

Tg	Rrpwr	Brkpt	Zerox	Lvpl1
0.0100	3.0000	0.5050	0.5000	1.0000

Volim	Lvpnt1	Lvpnt0	Iolim
1.2000	0.0100	0.0110	-1.0000

Tfltr	Khv	Iqrmax	Iqrmin	Accel
0.0100	1.0000	5.0000	-5.0000	1.0000

LVPL Switch flag: 0

Model REECAU1 Bus 113402 [SNOW STREET113.200] Machine "D2" :

I C O N S	C O N S	S T A T E S	V A R S
70513-70518	417882-417876	142459-142464	96312-96320

Vdip	Vup	Trv	dbd1	dbd2	Kqv	Iqhl
0.5000	1.2000	0.0100	0.0000	0.0000	0.0000	1.0000

Iqll	Vref0	Iqfrz	Thld	Thld2	Tp	QMAX
-1.0000	0.5000	0.0000	0.0000	0.0000	0.0100	0.8000

QMIN	VMAX	VMIN	Kqp	Kqi	Kvp	Kvi
-0.8000	1.1000	0.9000	0.0100	0.1000	1.0000	0.1000

Vbias	Tiq	dPMax	dPMin	Pmax	Pmin
0.0000	0.0100	1.0000	-1.0000	1.0000	0.0000

Imax	Tpord	VQ1	IQ1	VQ2	IQ2	VQ3
1.0000	0.0400	0.0010	0.0000	0.4990	0.0000	0.5000

IQ3	VQ4	IQ4	VP1	IP1	VP2	IP2
1.0000	1.2000	1.0000	0.0010	0.0000	0.4990	0.0000

VP3	IP3	VP4	IP4
0.5000	1.0000	1.2000	1.0000

PfFLAG: 0
VFLAG: 1
QFLAG: 0
PFLAG: 0
PQFLAG: 0

Model REPCAU1 Bus 113402 [SNOW STREET113.200] Machine "D2" :

I C O N S	C O N S	S T A T E S	V A R S
70519-70525	417877-417953	142465-142471	96321-96329

Tfltr	Kp	Ki	Tft	Tfv	Vfrz	Rc
0.0100	0.6000	3.0000	0.0000	0.0000	0.5000	0.0000

Xc	Kc	emax	emin	dbd1	dbd2	QMAX
0.0000	0.0000	1.0000	-1.0000	0.0000	0.0000	0.8000

QMIN	Kpg	Kig	tp	fdbd1	fdbd2	femax
-0.8000	2.0000	7.0000	0.0100	********	999.0000	999.0000

femin	Pmax	Pmin	Tg	Ddn	Dup
*********	1.0000	0.0000	0.0100	0.0000	0.0000

Bus Number for Voltage Control (if 0 local control): 0
Branch FROM bus number: 0
Branch TO bus number: 0
Branch circuit ID: 0
VCFlag: 0
RefFlag: 0
Fflag: 1

Belchertown DG Model Parameters

```
Model REGCAU1 Bus 930651 [BELCH-INV   0.6000] Machine "DG" :

    I C O N        C O N S       S T A T E S       V A R S
      70449       417750-417763   142440-142442    96277-96280


     Tg         Rrpwr      Brkpt       Zerox     Lvpl1
     0.0200    15.0000     0.8000      0.7900    1.0000

     Volim     Lvpnt1      Lvpnt0      Iolim
     2.0000     0.8000     0.0000     -2.0000

     Tfltr      Khv         Iqrmax       Iqrmin         Accel
     0.0200     0.0000       15.0000       -15.0000      1.0000


     LVPL Switch flag:   0


 Model REECAU1 Bus 930651 [BELCH-INV   0.6000] Machine "DG" :

   I C O N S        C O N S       S T A T E S       V A R S
   70450-70455    417764-417808   142443-142448    96281-96289

     Vdip      Vup       Trv       dbd1      dbd2      Kqv       Iqhl
     0.5000    1.1000    0.0200   -0.1000    0.1000    2.0000    1.0000

     Iqll      Vref0     Iqfrz     Thld      Thld2     Tp        QMAX
    -1.0000    0.0000    0.0000    0.0000    0.0000    0.0200    1.0000

     QMIN      VMAX      VMIN      Kqp       Kqi       Kvp       Kvi
    -1.0000    1.2000   -1.2000    1.0000    5.0000    1.0000    5.0000

     Vbias     Tiq       dPMax     dPMin     Pmax      Pmin
     0.0000    0.0200    1.0000   -1.0000    1.0000   -1.0000

     Imax      Tpord     VQ1       IQ1       VQ2       IQ2       VQ3
     1.0000    0.0250    0.1000    0.0000    0.4990    0.0000    0.5000

     IQ3       VQ4       IQ4       VP1       IP1       VP2       IP2
     1.0000    1.1000    1.0000    0.1000    0.0000    0.4990    0.0000

     VP3       IP3       VP4       IP4
     0.5000    1.0000    1.1000    1.0000


         PfFLAG: 0
          VFLAG: 0
          QFLAG: 0
          PFLAG: 0
         PQFLAG: 1


 Model REPCAU1 Bus 930651 [BELCH-INV   0.6000] Machine "DG" :

   I C O N S        C O N S       S T A T E S       V A R S
   70456-70462    417809-417835   142449-142455    96290-96298

     Tfltr     Kp        Ki        Tft       Tfv       Vfrz      Rc
     0.0200    1.0000    5.0000    0.0000    0.1000    0.8000    0.0000

     Xc        Kc        emax      emin       dbd1      dbd2      QMAX
     0.0000    0.0000    0.1000    -0.1000    0.0000    0.0000    1.0000

     QMIN      Kpg       Kig       tp        fdbd1     fdbd2     femax
    -1.0000    0.0100    2.5000    0.0200    0.0000    0.0000  ********

     femin     Pmax      Pmin        Tg        Ddn        Dup
   *********    1.0000    -1.0000    0.1000    20.0000    20.0000


   Bus Number for Voltage Control (if 0 local control):       0
    Branch FROM bus number:       0
      Branch TO bus number:       0
         Branch circuit ID:       1
                    VCFlag:       0
                   RefFlag:       0
                     Fflag:       0
```

Appendix D

N-1
Thermal and Voltage Results

N-1 Thermal Results

[redacted]

109528 VERNON VT 69.000 113055 N BLDWNVL_B269.000 1 ====================

Pre	Post	Rating	% Rating	ACCC Output File
38.0	48.9	53.0	90.1	23pk-we_x_x_x_x_x_x_x_x.out
38.0	49.5	53.0	91.3	23pk-we_x_x_x_x_x_x_x_x.out
36.7	47.8	53.0	90.1	22sh-we_x_x_x_x_x_x_x_x.out

113001 BEAR SWAMP 230.00 113266 PRATTS JCT 230.00 1 ====================

Pre	Post	Rating	% Rating	ACCC Output File
373.5	453.0	502.0	91.4	22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
373.5	452.7	502.0	91.3	22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
373.5	449.1	502.0	90.4	22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
373.5	452.8	502.0	91.3	22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
373.5	452.8	502.0	91.3	22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
373.5	450.9	502.0	90.8	22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
373.5	450.9	502.0	90.8	22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
373.5	449.0	502.0	90.4	22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
373.5	447.6	502.0	90.1	22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out

113008 BEAR SWAMP 115.00 113010 E131 TAP 115.00 1 ====================

Pre	Post	Rating	% Rating	ACCC Output File
235.0	411.1	440.0	93.7	22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
235.0	414.7	440.0	93.8	22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
229.1	400.0	440.0	90.1	22sh-ew-pump_x_x_x_x_x_x_x_x.out
235.0	415.7	440.0	94.1	22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
229.1	401.2	440.0	90.3	22sh-ew-pump_x_x_x_x_x_x_x_x.out
235.0	411.1	440.0	93.7	22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
235.0	411.1	440.0	93.7	22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out

113032 N BLDWNVL_A169.000 113038 ROYALSTON 69.000 1 ====================

Pre	Post	Rating	% Rating	ACCC Output File
30.0	38.2	43.0	91.0	23pk-we+group1_x_x_x_x_x_x_x_x.out
30.0	38.0	43.0	90.7	23pk-we+group1_x_x_x_x_x_x_x_x.out
30.0	38.2	43.0	91.0	23pk-we+group1_x_x_x_x_x_x_x_x.out
30.0	38.0	43.0	90.8	23pk-we+group1_x_x_x_x_x_x_x_x.out
30.0	40.2	43.0	96.6	23pk-we+group1_x_x_x_x_x_x_x_x.out
28.4	38.3	43.0	91.0	22sh-we+group1_x_x_x_x_x_x_x_x.out
30.0	37.9	43.0	91.2	23pk-we+group1_x_x_x_x_x_x_x_x.out
30.0	38.1	43.0	91.9	23pk-we+group1_x_x_x_x_x_x_x_x.out
30.0	38.6	43.0	92.3	23pk-we+group1_x_x_x_x_x_x_x_x.out
30.0	40.5	43.0	97.4	23pk-we+group1_x_x_x_x_x_x_x_x.out
28.4	38.6	43.0	91.7	22sh-we+group1_x_x_x_x_x_x_x_x.out
30.0	39.5	43.0	94.6	23pk-we+group1_x_x_x_x_x_x_x_x.out
30.0	39.9	43.0	95.8	23pk-we+group1_x_x_x_x_x_x_x_x.out
28.4	37.9	43.0	90.0	22sh-we+group1_x_x_x_x_x_x_x_x.out

[redacted]

```
      30.0    38.0    43.0     90.8    23pk-we+group1_x_x_x_x_x_x_x_x.out
      30.0    38.6    43.0     92.2    23pk-we+group1_x_x_x_x_x_x_x_x.out
      30.0    38.0    43.0     90.8    23pk-we+group1_x_x_x_x_x_x_x_x.out

113046 DEERFIELD 4 69.000 909528 VERNON SOLAR69.000 1     ====================

      Pre    Post   Rating  % Rating    ACCC Output File
     ------  ------  ------  ---------  -----------------
      53.9    71.3    82.0     91.2    2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
    54.0    71.6    82.0     90.8    2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
    52.0    70.8    82.0     90.4    22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
      53.9    70.9    82.0     90.1    2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
      53.9    71.3    82.0     91.2    2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
    54.0    71.6    82.0     90.8    2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
    52.0    70.8    82.0     90.4    22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
      53.9    71.3    82.0     91.2    2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
    54.0    71.6    82.0     90.8    2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
    52.0    70.8    82.0     90.4    22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out

113055 N BLDWNVL_B269.000 113342 CRYSTAL LAKE69.000 1     ====================

      Pre    Post   Rating  % Rating    ACCC Output File
     ------  ------  ------  ---------  -----------------
      36.5    47.2    53.0     90.8    23pk-we_x_x_x_x_x_x_x_x.out

113263 CARPENTER HL345.00 113264 MILLBURY    345.00 1     ====================

      Pre    Post   Rating  % Rating    ACCC Output File
     ------  ------  ------  ---------  -----------------
    1117.9  1392.3  1416.0     97.9    23pk-ew+group1_x_x_x_x_x_x_x_x.out
  1105.8  1387.8  1416.0     97.4    23pk-ew_x_x_x_x_x_x_x_x.out
    1117.9  1362.1  1416.0     95.6    23pk-ew+group1_x_x_x_x_x_x_x_x.out
  1105.8  1357.3  1416.0     95.1    23pk-ew_x_x_x_x_x_x_x_x.out
    1117.9  1332.1  1416.0     93.7    23pk-ew+group1_x_x_x_x_x_x_x_x.out
  1105.8  1312.2  1416.0     92.0    23pk-ew_x_x_x_x_x_x_x_x.out
    1117.9  1345.6  1416.0     94.3    23pk-ew+group1_x_x_x_x_x_x_x_x.out
  1105.8  1337.4  1416.0     93.6    23pk-ew_x_x_x_x_x_x_x_x.out
    1117.9  1298.4  1416.0     91.0    23pk-ew+group1_x_x_x_x_x_x_x_x.out
  1105.8  1291.0  1416.0     90.3    23pk-ew_x_x_x_x_x_x_x_x.out
    1117.9  1333.6  1416.0     93.7    23pk-ew+group1_x_x_x_x_x_x_x_x.out
  1105.8  1331.4  1416.0     93.3    23pk-ew_x_x_x_x_x_x_x_x.out
    1117.9  1392.1  1416.0     97.9    23pk-ew+group1_x_x_x_x_x_x_x_x.out
  1105.8  1387.6  1416.0     97.4    23pk-ew_x_x_x_x_x_x_x_x.out
    1117.9  1362.0  1416.0     95.6    23pk-ew+group1_x_x_x_x_x_x_x_x.out
  1105.8  1357.2  1416.0     95.1    23pk-ew_x_x_x_x_x_x_x_x.out
    1117.9  1362.0  1416.0     95.6    23pk-ew+group1_x_x_x_x_x_x_x_x.out
  1105.8  1357.2  1416.0     95.1    23pk-ew_x_x_x_x_x_x_x_x.out
    1117.9  1392.1  1416.0     97.9    23pk-ew+group1_x_x_x_x_x_x_x_x.out
  1105.8  1387.6  1416.0     97.4    23pk-ew_x_x_x_x_x_x_x_x.out
    1117.9  1393.2  1416.0     98.2    23pk-ew+group1_x_x_x_x_x_x_x_x.out
  1105.8  1369.1  1416.0     96.2    23pk-ew_x_x_x_x_x_x_x_x.out
    1117.9  1395.6  1416.0     98.2    23pk-ew+group1_x_x_x_x_x_x_x_x.out
  1105.8  1391.2  1416.0     97.6    23pk-ew_x_x_x_x_x_x_x_x.out
    1117.9  1386.2  1416.0     97.4    23pk-ew+group1_x_x_x_x_x_x_x_x.out
  1105.8  1380.4  1416.0     96.7    23pk-ew_x_x_x_x_x_x_x_x.out
    1117.9  1386.6  1416.0     97.4    23pk-ew+group1_x_x_x_x_x_x_x_x.out
```

[redacted]

Pre	Post	Rating	% Rating	ACCC Output File
1105.8	1380.9	1416.0	96.7	23pk-ew_x_x_x_x_x_x_x_x.out
1117.9	1293.4	1416.0	90.7	23pk-ew+group1_x_x_x_x_x_x_x_x.out
1117.9	1345.6	1416.0	94.3	23pk-ew+group1_x_x_x_x_x_x_x_x.out
1105.8	1337.4	1416.0	93.6	23pk-ew_x_x_x_x_x_x_x_x.out
1117.9	1333.6	1416.0	93.7	23pk-ew+group1_x_x_x_x_x_x_x_x.out
1105.8	1331.4	1416.0	93.3	23pk-ew_x_x_x_x_x_x_x_x.out
1117.9	1334.0	1416.0	93.7	23pk-ew+group1_x_x_x_x_x_x_x_x.out
1105.8	1331.8	1416.0	93.3	23pk-ew_x_x_x_x_x_x_x_x.out
1117.9	1334.0	1416.0	93.7	23pk-ew+group1_x_x_x_x_x_x_x_x.out
1105.8	1331.8	1416.0	93.3	23pk-ew_x_x_x_x_x_x_x_x.out

113263 CARPENTER HL345.00 116059 NU_301_NGR 345.00 1 ====================

Pre	Post	Rating	% Rating	ACCC Output File
1023.6	1292.3	1416.0	90.9	23pk-ew+group1_x_x_x_x_x_x_x_x.out
1023.6	1292.1	1416.0	90.9	23pk-ew+group1_x_x_x_x_x_x_x_x.out
1023.6	1292.1	1416.0	90.9	23pk-ew+group1_x_x_x_x_x_x_x_x.out
1023.6	1297.5	1416.0	91.5	23pk-ew+group1_x_x_x_x_x_x_x_x.out
1023.6	1295.4	1416.0	91.1	23pk-ew+group1_x_x_x_x_x_x_x_x.out
1023.6	1287.2	1416.0	90.4	23pk-ew+group1_x_x_x_x_x_x_x_x.out
1023.6	1287.5	1416.0	90.4	23pk-ew+group1_x_x_x_x_x_x_x_x.out

113265 WACHUSETT 345.00 113950 SANDY POND 345.00 1 ====================

Pre	Post	Rating	% Rating	ACCC Output File
888.0	1515.1	1611.0	91.8	23pk-ew+group1_x_x_x_x_x_x_x_x.out
882.6	1509.4	1611.0	91.0	22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out

113286 MILLBURY 115.00 113287 NORTH OXFORD115.00 1 ====================

Pre	Post	Rating	% Rating	ACCC Output File
184.3	361.8	389.0	92.2	22ll-we+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
184.3	361.8	389.0	92.1	22ll-we+group1_x_x_x_x_x_x_x_x.out
184.3	361.8	389.0	92.2	22ll-we+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
184.3	361.8	389.0	92.1	22ll-we+group1_x_x_x_x_x_x_x_x.out
184.3	361.8	389.0	92.2	22ll-we+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
184.3	361.8	389.0	92.1	22ll-we+group1_x_x_x_x_x_x_x_x.out
184.3	366.9	389.0	93.5	22ll-we+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
184.3	366.9	389.0	93.5	22ll-we+group1_x_x_x_x_x_x_x_x.out
184.3	373.1	389.0	95.2	22ll-we+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
184.3	373.1	389.0	95.1	22ll-we+group1_x_x_x_x_x_x_x_x.out
198.9	370.8	389.0	94.3	23pk-we+group1_x_x_x_x_x_x_x_x.out
184.3	361.1	389.0	92.0	22ll-we+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
184.3	361.2	389.0	92.0	22ll-we+group1_x_x_x_x_x_x_x_x.out
184.3	361.1	389.0	92.0	22ll-we+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
184.3	361.2	389.0	92.0	22ll-we+group1_x_x_x_x_x_x_x_x.out

113330 E.WESTMIN B269.000 113346 PRATTS JCT 69.000 1 ====================

Pre	Post	Rating	% Rating	ACCC Output File
39.7	48.2	53.0	91.8	23pk-we+group1_x_x_x_x_x_x_x_x.out
39.7	48.1	53.0	91.6	23pk-we+group1_x_x_x_x_x_x_x_x.out

[redacted]

39.7	39.7	43.0	92.9	23pk-we+group1_x_x_x_x_x_x_x_x.out
39.7	48.1	53.0	91.6	23pk-we+group1_x_x_x_x_x_x_x_x.out
39.7	48.1	53.0	91.6	23pk-we+group1_x_x_x_x_x_x_x_x.out
39.7	47.9	53.0	91.2	23pk-we+group1_x_x_x_x_x_x_x_x.out
39.7	48.1	53.0	91.5	23pk-we+group1_x_x_x_x_x_x_x_x.out
39.7	49.4	53.0	94.0	23pk-we+group1_x_x_x_x_x_x_x_x.out
39.7	49.3	53.0	94.6	23pk-we+group1_x_x_x_x_x_x_x_x.out
39.7	49.5	53.0	95.3	23pk-we+group1_x_x_x_x_x_x_x_x.out
39.7	48.2	53.0	91.8	23pk-we+group1_x_x_x_x_x_x_x_x.out
39.7	48.2	53.0	91.7	23pk-we+group1_x_x_x_x_x_x_x_x.out
39.7	49.4	53.0	94.0	23pk-we+group1_x_x_x_x_x_x_x_x.out
39.7	49.4	53.0	94.0	23pk-we+group1_x_x_x_x_x_x_x_x.out

113330 E.WESTMIN B269.000 113352 WESTMNSTR_B269.000 1 ====================

Pre	Post	Rating	% Rating	ACCC Output File
37.6	47.3	53.0	90.2	23pk-we+group1_x_x_x_x_x_x_x_x.out
37.6	47.2	53.0	90.7	23pk-we+group1_x_x_x_x_x_x_x_x.out
37.6	47.4	53.0	91.4	23pk-we+group1_x_x_x_x_x_x_x_x.out
37.6	47.3	53.0	90.2	23pk-we+group1_x_x_x_x_x_x_x_x.out
37.6	47.3	53.0	90.2	23pk-we+group1_x_x_x_x_x_x_x_x.out

N-1 Voltage Results

[redacted]

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 VERNON VT   69.000 ========================

 Pre     Post   % Chg    ACCC Output File
------  ------  ------  -----------------
0.9933  0.9399          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
.9948  0.9467          2211-ew-pump_x_x_x_x_x_x_x_x.out
0.9933  0.9400          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
.9948  0.9471          2211-ew-pump_x_x_x_x_x_x_x_x.out
0.9933  0.9428          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
.9948  0.9494          2211-ew-pump_x_x_x_x_x_x_x_x.out
0.9933  0.9402          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
.9948  0.9469          2211-ew-pump_x_x_x_x_x_x_x_x.out
0.9933  0.9402          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
.9948  0.9469          2211-ew-pump_x_x_x_x_x_x_x_x.out
0.9933  0.9418          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
.9948  0.9492          2211-ew-pump_x_x_x_x_x_x_x_x.out
0.9933  0.9416          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
.9948  0.9486          2211-ew-pump_x_x_x_x_x_x_x_x.out
0.9933  0.9497          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9933  0.9428          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
.9948  0.9495          2211-ew-pump_x_x_x_x_x_x_x_x.out
0.9933  0.9497          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9933  0.9435          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9933  0.9497          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out

 Pre     Post   % Chg    ACCC Output File
------  ------  ------  -----------------
1.0323  1.0503          22-min+group1_x_x_x_x_x_x_x_x.out

 BEAR SWAMP  230.00 ========================

 Pre     Post   % Chg    ACCC Output File
------  ------  ------  -----------------
1.0172  0.9678          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
.0180  0.9705          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
.0204  0.9759          2211-ew-pump_x_x_x_x_x_x_x_x.out
1.0172  0.9678          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
.0180  0.9705          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
.0204  0.9762          2211-ew-pump_x_x_x_x_x_x_x_x.out
1.0172  0.9706          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
.0180  0.9733          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
.0204  0.9787          2211-ew-pump_x_x_x_x_x_x_x_x.out
1.0172  0.9680          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
.0180  0.9707          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
.0204  0.9761          2211-ew-pump_x_x_x_x_x_x_x_x.out
1.0172  0.9680          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
.0180  0.9707          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
.0204  0.9761          2211-ew-pump_x_x_x_x_x_x_x_x.out
1.0172  0.9699          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
```

[redacted]

```
1.0180  0.9726          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
1.0204  0.9791          2211-ew-pump_x_x_x_x_x_x_x_x.out
  1.0172  0.9696          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
1.0180  0.9722          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
1.0204  0.9781          2211-ew-pump_x_x_x_x_x_x_x_x.out
  1.0172  0.9706          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
1.0180  0.9733          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
1.0204  0.9787          2211-ew-pump_x_x_x_x_x_x_x_x.out
  1.0172  0.9711          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
1.0180  0.9738          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
1.0204  0.9792          2211-ew-pump_x_x_x_x_x_x_x_x.out

09 DEERFIELD 4 115.00 ========================

PU
    Pre     Post   % Chg    ACCC Output File
  ------  ------  ------   -----------------
  0.9972  0.9416          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9992  0.9463          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9972  0.9417          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9992  0.9464          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9972  0.9449          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9992  0.9495          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9972  0.9419          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9992  0.9465          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9972  0.9419          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9992  0.9465          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9972  0.9439          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9992  0.9485          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9972  0.9436          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9992  0.9482          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9972  0.9449          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9992  0.9495          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9972  0.9456          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out

19 OTTER RIVER 69.000 ========================

PU
    Pre     Post   % Chg    ACCC Output File
  ------  ------  ------   -----------------
  0.9738  0.9487          22sh-we_x_x_x_x_x_x_x_x.out
  0.9709  0.9471          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9709  0.9465          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9709  0.9468          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9709  0.9486          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9709  0.9466          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9709  0.9466          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9709  0.9477          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9709  0.9476          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9709  0.9197          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9738  0.9415          22sh-we_x_x_x_x_x_x_x_x.out
  0.9709  0.9472          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9709  0.9244          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9738  0.9270          22sh-we_x_x_x_x_x_x_x_x.out
  0.9709  0.9196          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9738  0.9406          22sh-we_x_x_x_x_x_x_x_x.out
```

[redacted]

```
 0.9709  0.9191          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9738  0.9430          22sh-we_x_x_x_x_x_x_x_x.out
 0.9738  0.9485          22sh-we_x_x_x_x_x_x_x_x.out
 0.9709  0.9192          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9738  0.9418          22sh-we_x_x_x_x_x_x_x_x.out
 0.9709  0.9487          22sh-ew-pump_x_x_x_x_x_x_x_x.out
 0.9709  0.9488          22sh-ew-pump_x_x_x_x_x_x_x_x.out

PU
  Pre     Post   % Chg    ACCC Output File
 ------  ------  ------   -----------------
 1.0247  1.0576          22-min+group1_x_x_x_x_x_x_x_x.out
 1.0247  1.0697          22-min+group1_x_x_x_x_x_x_x_x.out
 1.0247  1.0574          22-min+group1_x_x_x_x_x_x_x_x.out
 1.0247  1.0588          22-min+group1_x_x_x_x_x_x_x_x.out
 1.0247  1.0573          22-min+group1_x_x_x_x_x_x_x_x.out
 1.0247  1.0529          22-min+group1_x_x_x_x_x_x_x_x.out

27 DEERFLD 2_E569.000 ========================

PU
  Pre     Post   % Chg    ACCC Output File
 ------  ------  ------   -----------------
 0.9880  0.9318          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9905  0.9371          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9928  0.9459          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9955  0.9459          22ll-ew-pump_x_x_x_x_x_x_x_x.out
 0.9880  0.9319          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9905  0.9372          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9928  0.9463          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9955  0.9464          22ll-ew-pump_x_x_x_x_x_x_x_x.out
 0.9880  0.9350          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9905  0.9403          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9955  0.9489          22ll-ew-pump_x_x_x_x_x_x_x_x.out
 0.9880  0.9321          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9905  0.9374          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9955  0.9462          22ll-ew-pump_x_x_x_x_x_x_x_x.out
0.9928  0.9462          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9880  0.9321          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9905  0.9374          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9955  0.9462          22ll-ew-pump_x_x_x_x_x_x_x_x.out
0.9928  0.9462          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9880  0.9339          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9905  0.9393          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9928  0.9488          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9955  0.9489          22ll-ew-pump_x_x_x_x_x_x_x_x.out
 0.9880  0.9337          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9905  0.9390          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9955  0.9481          22ll-ew-pump_x_x_x_x_x_x_x_x.out
0.9928  0.9486          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9880  0.9475          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9928  0.9499          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9880  0.9350          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9905  0.9403          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9955  0.9490          22ll-ew-pump_x_x_x_x_x_x_x_x.out
 0.9880  0.9475          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
```

[redacted]

```
 0.9928  0.9499          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9880  0.9357          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9905  0.9410          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9955  0.9496          2211-ew-pump_x_x_x_x_x_x_x_x.out
   0.9880  0.9475          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9928  0.9499          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out

028 DEERFLD 3_F669.000 ========================

 PU
     Pre     Post   % Chg    ACCC Output File
   ------  ------  ------  ----------------
   0.9878  0.9302          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9904  0.9356          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9956  0.9448          2211-ew-pump_x_x_x_x_x_x_x_x.out
 0.9930  0.9453          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9878  0.9303          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9904  0.9357          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9956  0.9452          2211-ew-pump_x_x_x_x_x_x_x_x.out
 0.9930  0.9456          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9878  0.9334          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9904  0.9388          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9956  0.9478          2211-ew-pump_x_x_x_x_x_x_x_x.out
 0.9930  0.9497          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9878  0.9304          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9904  0.9359          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9956  0.9450          2211-ew-pump_x_x_x_x_x_x_x_x.out
 0.9930  0.9455          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9878  0.9304          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9904  0.9359          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9956  0.9450          2211-ew-pump_x_x_x_x_x_x_x_x.out
 0.9930  0.9455          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9878  0.9324          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9904  0.9378          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9956  0.9478          2211-ew-pump_x_x_x_x_x_x_x_x.out
 0.9930  0.9483          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9878  0.9321          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9904  0.9375          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9956  0.9470          2211-ew-pump_x_x_x_x_x_x_x_x.out
 0.9930  0.9480          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9878  0.9465          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9930  0.9493          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9878  0.9335          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9904  0.9389          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9956  0.9479          2211-ew-pump_x_x_x_x_x_x_x_x.out
 0.9930  0.9498          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9878  0.9465          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9930  0.9493          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9878  0.9342          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9904  0.9396          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9956  0.9486          2211-ew-pump_x_x_x_x_x_x_x_x.out
   0.9878  0.9465          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9930  0.9493          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out

032 N BLDWNVL_A169.000 ========================
```

[redacted]

```
 Pre     Post   % Chg    ACCC Output File
------  ------  ------  -----------------
.9738  0.9487          22sh-we_x_x_x_x_x_x_x_x.out
.9709  0.9471          22sh-ew-pump_x_x_x_x_x_x_x_x.out
.9709  0.9465          22sh-ew-pump_x_x_x_x_x_x_x_x.out
.9709  0.9468          22sh-ew-pump_x_x_x_x_x_x_x_x.out
.9709  0.9486          22sh-ew-pump_x_x_x_x_x_x_x_x.out
.9709  0.9466          22sh-ew-pump_x_x_x_x_x_x_x_x.out
.9709  0.9466          22sh-ew-pump_x_x_x_x_x_x_x_x.out
.9709  0.9477          22sh-ew-pump_x_x_x_x_x_x_x_x.out
.9709  0.9476          22sh-ew-pump_x_x_x_x_x_x_x_x.out
.9709  0.9197          22sh-ew-pump_x_x_x_x_x_x_x_x.out
9738  0.9415          22sh-we_x_x_x_x_x_x_x_x.out
.9709  0.9472          22sh-ew-pump_x_x_x_x_x_x_x_x.out
.9709  0.9244          22sh-ew-pump_x_x_x_x_x_x_x_x.out
9738  0.9270          22sh-we_x_x_x_x_x_x_x_x.out
.9709  0.9196          22sh-ew-pump_x_x_x_x_x_x_x_x.out
9738  0.9406          22sh-we_x_x_x_x_x_x_x_x.out
.9709  0.9191          22sh-ew-pump_x_x_x_x_x_x_x_x.out
9738  0.9430          22sh-we_x_x_x_x_x_x_x_x.out
.9738  0.9485          22sh-we_x_x_x_x_x_x_x_x.out
.9709  0.9192          22sh-ew-pump_x_x_x_x_x_x_x_x.out
9738  0.9418          22sh-we_x_x_x_x_x_x_x_x.out
.9709  0.9487          22sh-ew-pump_x_x_x_x_x_x_x_x.out
.9709  0.9488          22sh-ew-pump_x_x_x_x_x_x_x_x.out


Pre     Post   % Chg    ACCC Output File
------  ------  ------  -----------------
.0247  1.0576          22-min+group1_x_x_x_x_x_x_x_x.out
.0247  1.0697          22-min+group1_x_x_x_x_x_x_x_x.out
.0247  1.0574          22-min+group1_x_x_x_x_x_x_x_x.out
.0247  1.0588          22-min+group1_x_x_x_x_x_x_x_x.out
.0247  1.0573          22-min+group1_x_x_x_x_x_x_x_x.out
.0247  1.0529          22-min+group1_x_x_x_x_x_x_x_x.out

BELCHRTWN_F669.000 ========================


 Pre     Post   % Chg    ACCC Output File
------  ------  ------  -----------------
.0324  1.0509          22-min+group1_x_x_x_x_x_x_x_x.out

BELCHERTOWN 69.000 ========================


 Pre     Post   % Chg    ACCC Output File
------  ------  ------  -----------------
.0328  1.0513          22-min+group1_x_x_x_x_x_x_x_x.out

ROYALSTON   69.000 ========================


Pre     Post   % Chg    ACCC Output File
------  ------  ------  -----------------
```

[redacted]

```
  0.9748  0.9435          22sh-we_x_x_x_x_x_x_x_x.out
  0.9694  0.9494          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9694  0.9424          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9694  0.9428          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9694  0.9448          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9694  0.9425          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9694  0.9425          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9694  0.9437          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9694  0.9436          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9694  0.9245          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9748  0.9468          22sh-we_x_x_x_x_x_x_x_x.out
  0.9694  0.9499          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9694  0.9495          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9694  0.9294          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9748  0.9325          22sh-we_x_x_x_x_x_x_x_x.out
  0.9694  0.9244          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9748  0.9459          22sh-we_x_x_x_x_x_x_x_x.out
   0.9694  0.9462          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9748  0.9487          22sh-we_x_x_x_x_x_x_x_x.out
  0.9694  0.9239          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9748  0.9483          22sh-we_x_x_x_x_x_x_x_x.out
  0.9748  0.9433          22sh-we_x_x_x_x_x_x_x_x.out
  0.9694  0.9240          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9748  0.9471          22sh-we_x_x_x_x_x_x_x_x.out
  0.9694  0.9473          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9748  0.9480          22sh-we_x_x_x_x_x_x_x_x.out
  0.9694  0.9449          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9694  0.9450          22sh-ew-pump_x_x_x_x_x_x_x_x.out

PU
   Pre     Post   % Chg    ACCC Output File
  ------  ------  ------  -----------------
  1.0278  1.0534          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0278  1.0569          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0278  1.0690          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0278  1.0568          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0278  1.0581          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0278  1.0566          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0278  1.0537          22-min+group1_x_x_x_x_x_x_x_x.out

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PU
   Pre     Post   % Chg    ACCC Output File
  ------  ------  ------  -----------------
  0.9686  0.9489          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9761  0.9376          22sh-we_x_x_x_x_x_x_x_x.out
0.9686  0.9443          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9686  0.9390          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9824  0.9472          22ll-ew-pump_x_x_x_x_x_x_x_x.out
  0.9686  0.9394          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9824  0.9474          22ll-ew-pump_x_x_x_x_x_x_x_x.out
  0.9686  0.9417          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9824  0.9491          22ll-ew-pump_x_x_x_x_x_x_x_x.out
  0.9686  0.9392          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9824  0.9473          22ll-ew-pump_x_x_x_x_x_x_x_x.out
```

[redacted]

```
  0.9686  0.9489          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9686  0.9490          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9686  0.9392          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9824  0.9473          22ll-ew-pump_x_x_x_x_x_x_x_x.out
  0.9686  0.9405          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9824  0.9489          22ll-ew-pump_x_x_x_x_x_x_x_x.out
  0.9686  0.9404          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9824  0.9485          22ll-ew-pump_x_x_x_x_x_x_x_x.out
  0.9686  0.9303          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9686  0.9453          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9686  0.9481          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9686  0.9458          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9686  0.9354          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9761  0.9390          22sh-we_x_x_x_x_x_x_x_x.out
  0.9686  0.9301          22sh-ew-pump_x_x_x_x_x_x_x_x.out
   0.9686  0.9398          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9761  0.9429          22sh-we_x_x_x_x_x_x_x_x.out
  0.9686  0.9296          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9761  0.9374          22sh-we_x_x_x_x_x_x_x_x.out
0.9686  0.9443          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9686  0.9297          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9686  0.9412          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9761  0.9422          22sh-we_x_x_x_x_x_x_x_x.out
  0.9686  0.9418          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9824  0.9491          22ll-ew-pump_x_x_x_x_x_x_x_x.out
  0.9686  0.9453          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9686  0.9419          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9824  0.9496          22ll-ew-pump_x_x_x_x_x_x_x_x.out
  0.9686  0.9453          22sh-ew-pump_x_x_x_x_x_x_x_x.out

PU
   Pre     Post   % Chg    ACCC Output File
  ------  ------  ------  -----------------
  1.0313  1.0509          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0313  1.0532          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0313  1.0508          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0313  1.0561          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0313  1.0681          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0313  1.0559          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0313  1.0510          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0313  1.0573          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0313  1.0558          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0313  1.0547          22-min+group1_x_x_x_x_x_x_x_x.out

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PU
   Pre     Post   % Chg    ACCC Output File
  ------  ------  ------  -----------------
  0.9890  0.9328          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9915  0.9381          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9962  0.9467          22ll-ew-pump_x_x_x_x_x_x_x_x.out
0.9938  0.9469          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9890  0.9329          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9915  0.9382          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9962  0.9471          22ll-ew-pump_x_x_x_x_x_x_x_x.out
```

[redacted]

```
 0.9938  0.9472         22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9890  0.9360         2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9915  0.9413         2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9962  0.9497         2211-ew-pump_x_x_x_x_x_x_x_x.out
   0.9890  0.9330         2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9915  0.9384         2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9962  0.9469         2211-ew-pump_x_x_x_x_x_x_x_x.out
 0.9938  0.9471         22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9890  0.9330         2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9915  0.9384         2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9962  0.9469         2211-ew-pump_x_x_x_x_x_x_x_x.out
 0.9938  0.9471         22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9890  0.9349         2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9915  0.9402         2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9962  0.9497         2211-ew-pump_x_x_x_x_x_x_x_x.out
 0.9938  0.9498         22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9890  0.9347         2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9915  0.9400         2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9962  0.9489         2211-ew-pump_x_x_x_x_x_x_x_x.out
 0.9938  0.9496         22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9890  0.9485         2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
   0.9890  0.9360         2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9915  0.9413         2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9962  0.9497         2211-ew-pump_x_x_x_x_x_x_x_x.out
   0.9890  0.9485         2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
   0.9890  0.9367         2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9915  0.9420         2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9890  0.9485         2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out

3043 DEERFLD 3_E569.000 ========================

5 PU
      Pre     Post   % Chg    ACCC Output File
    ------  ------  ------  -----------------
   0.9874  0.9298         2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9900  0.9352         2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9953  0.9445         2211-ew-pump_x_x_x_x_x_x_x_x.out
 0.9926  0.9449         22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9874  0.9299         2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9900  0.9353         2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9953  0.9449         2211-ew-pump_x_x_x_x_x_x_x_x.out
 0.9926  0.9452         22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9874  0.9330         2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9900  0.9384         2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9953  0.9475         2211-ew-pump_x_x_x_x_x_x_x_x.out
 0.9926  0.9493         22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9874  0.9300         2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9900  0.9355         2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9953  0.9447         2211-ew-pump_x_x_x_x_x_x_x_x.out
 0.9926  0.9451         22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9874  0.9300         2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9900  0.9355         2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9953  0.9447         2211-ew-pump_x_x_x_x_x_x_x_x.out
 0.9926  0.9451         22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9874  0.9320         2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9900  0.9374         2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
```

[redacted]

```
 0.9953  0.9475          22ll-ew-pump_x_x_x_x_x_x_x_x.out
 0.9926  0.9478          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9874  0.9317          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9900  0.9371          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9953  0.9467          22ll-ew-pump_x_x_x_x_x_x_x_x.out
 0.9926  0.9476          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9874  0.9497          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
   0.9874  0.9461          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9926  0.9489          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9874  0.9331          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9900  0.9385          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9953  0.9476          22ll-ew-pump_x_x_x_x_x_x_x_x.out
 0.9926  0.9494          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9874  0.9461          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9926  0.9489          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9874  0.9338          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9900  0.9392          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9953  0.9482          22ll-ew-pump_x_x_x_x_x_x_x_x.out
   0.9874  0.9461          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9926  0.9489          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out

3044 DEERFIELD 2 69.000 ========================

5 PU
     Pre     Post   % Chg    ACCC Output File
   ------  ------  ------  -----------------
   0.9890  0.9328          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9915  0.9381          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9962  0.9467          22ll-ew-pump_x_x_x_x_x_x_x_x.out
 0.9938  0.9469          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9890  0.9329          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9915  0.9382          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9962  0.9471          22ll-ew-pump_x_x_x_x_x_x_x_x.out
 0.9938  0.9472          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9890  0.9360          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9915  0.9413          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9962  0.9497          22ll-ew-pump_x_x_x_x_x_x_x_x.out
   0.9890  0.9331          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9915  0.9384          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9962  0.9469          22ll-ew-pump_x_x_x_x_x_x_x_x.out
 0.9938  0.9472          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9890  0.9331          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9915  0.9384          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9962  0.9469          22ll-ew-pump_x_x_x_x_x_x_x_x.out
 0.9938  0.9472          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9890  0.9349          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9915  0.9402          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9962  0.9497          22ll-ew-pump_x_x_x_x_x_x_x_x.out
 0.9938  0.9498          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9890  0.9347          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9915  0.9400          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
 0.9962  0.9489          22ll-ew-pump_x_x_x_x_x_x_x_x.out
 0.9938  0.9496          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
   0.9890  0.9485          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
   0.9890  0.9360          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
 0.9915  0.9413          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
```

[redacted]

```
0.9962  0.9497          2211-ew-pump_x_x_x_x_x_x_x_x.out
  0.9890  0.9485          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
  0.9890  0.9367          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9915  0.9420          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9890  0.9485          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out

045 DEERFIELD 3 69.000 ========================

PU
    Pre     Post   % Chg    ACCC Output File
  ------  ------  ------  -----------------
  0.9874  0.9298          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9900  0.9352          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9953  0.9445          2211-ew-pump_x_x_x_x_x_x_x_x.out
0.9926  0.9449          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9874  0.9299          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9900  0.9353          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9953  0.9449          2211-ew-pump_x_x_x_x_x_x_x_x.out
0.9926  0.9452          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9874  0.9330          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9900  0.9384          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9953  0.9475          2211-ew-pump_x_x_x_x_x_x_x_x.out
0.9926  0.9493          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9874  0.9300          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9900  0.9355          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9953  0.9447          2211-ew-pump_x_x_x_x_x_x_x_x.out
0.9926  0.9451          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9874  0.9300          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9900  0.9355          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9953  0.9447          2211-ew-pump_x_x_x_x_x_x_x_x.out
0.9926  0.9451          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9874  0.9320          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9900  0.9374          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9953  0.9475          2211-ew-pump_x_x_x_x_x_x_x_x.out
0.9926  0.9478          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9874  0.9317          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9900  0.9371          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9953  0.9467          2211-ew-pump_x_x_x_x_x_x_x_x.out
0.9926  0.9476          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9874  0.9497          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
  0.9874  0.9461          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9926  0.9489          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9874  0.9331          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9900  0.9385          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9953  0.9476          2211-ew-pump_x_x_x_x_x_x_x_x.out
0.9926  0.9494          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9874  0.9461          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9926  0.9489          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9874  0.9338          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9900  0.9392          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9953  0.9482          2211-ew-pump_x_x_x_x_x_x_x_x.out
  0.9874  0.9461          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9926  0.9489          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out

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```

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```
PU
    Pre     Post   % Chg    ACCC Output File
  ------  ------  ------  -----------------
  0.9870  0.9283          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9896  0.9338          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9951  0.9434          22ll-ew-pump_x_x_x_x_x_x_x_x.out
0.9925  0.9442          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9870  0.9284          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9896  0.9339          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9951  0.9438          22ll-ew-pump_x_x_x_x_x_x_x_x.out
0.9925  0.9446          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9870  0.9316          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9896  0.9371          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9951  0.9465          22ll-ew-pump_x_x_x_x_x_x_x_x.out
0.9925  0.9487          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9870  0.9286          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9896  0.9341          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9951  0.9436          22ll-ew-pump_x_x_x_x_x_x_x_x.out
0.9925  0.9445          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9870  0.9286          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9896  0.9341          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9951  0.9436          22ll-ew-pump_x_x_x_x_x_x_x_x.out
0.9925  0.9445          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9870  0.9305          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9896  0.9361          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9951  0.9465          22ll-ew-pump_x_x_x_x_x_x_x_x.out
0.9925  0.9473          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9870  0.9303          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9896  0.9358          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9951  0.9456          22ll-ew-pump_x_x_x_x_x_x_x_x.out
0.9925  0.9470          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9870  0.9485          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
  0.9870  0.9452          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9925  0.9483          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9896  0.9496          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9870  0.9316          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9896  0.9371          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9951  0.9465          22ll-ew-pump_x_x_x_x_x_x_x_x.out
0.9925  0.9488          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9870  0.9452          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9925  0.9483          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9896  0.9496          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
  0.9870  0.9324          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9896  0.9379          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9951  0.9472          22ll-ew-pump_x_x_x_x_x_x_x_x.out
  0.9870  0.9452          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
0.9925  0.9483          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9896  0.9496          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out

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PU
    Pre     Post   % Chg    ACCC Output File
  ------  ------  ------  -----------------
  0.9744  0.9471          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9744  0.9474          22sh-ew-pump_x_x_x_x_x_x_x_x.out
```

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0.9744	0.9495		22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9744	0.9472		22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9744	0.9472		22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9744	0.9485		22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9744	0.9483		22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9744	0.9262		22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9776	0.9450		22sh-we_x_x_x_x_x_x_x_x.out
0.9744	0.9311		22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9776	0.9337		22sh-we_x_x_x_x_x_x_x_x.out
0.9744	0.9264		22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9776	0.9449		22sh-we_x_x_x_x_x_x_x_x.out
0.9744	0.9250		22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9776	0.9464		22sh-we_x_x_x_x_x_x_x_x.out
0.9744	0.9258		22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9776	0.9457		22sh-we_x_x_x_x_x_x_x_x.out
0.9744	0.9496		22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9744	0.9497		22sh-ew-pump_x_x_x_x_x_x_x_x.out

PU

Pre	Post	% Chg	ACCC Output File
1.0205	1.0527		22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0357	1.0669		22-min+group1_x_x_x_x_x_x_x_x.out
1.0357	1.0513		22-min+group1_x_x_x_x_x_x_x_x.out
1.0205	1.0527		22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0357	1.0669		22-min+group1_x_x_x_x_x_x_x_x.out
1.0205	1.0607		22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0357	1.0815		22-min+group1_x_x_x_x_x_x_x_x.out
1.0205	1.0526		22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0357	1.0672		22-min+group1_x_x_x_x_x_x_x_x.out
1.0205	1.0603		22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0084	1.0611		22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
1.0357	1.0886		22-min+group1_x_x_x_x_x_x_x_x.out
1.0205	1.0607		22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0357	1.0815		22-min+group1_x_x_x_x_x_x_x_x.out
1.0205	1.0609		22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0357	1.0810		22-min+group1_x_x_x_x_x_x_x_x.out
1.0205	1.0607		22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0357	1.0813		22-min+group1_x_x_x_x_x_x_x_x.out
1.0205	1.0518		22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0084	1.0527		22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
1.0357	1.0712		22-min+group1_x_x_x_x_x_x_x_x.out
1.0205	1.0526		22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0357	1.0661		22-min+group1_x_x_x_x_x_x_x_x.out

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PU

Pre	Post	% Chg	ACCC Output File
1.0324	1.0509		22-min+group1_x_x_x_x_x_x_x_x.out

094 BEARSWAMP 1X230.00 ========================

PU

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Contingency                                    Pre     Post   % Chg    ACCC Output File
[redacted]
                                              ------  ------  ------  -----------------
                                              1.0172  0.9678          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
                                            1.0181  0.9705          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
                                            1.0205  0.9760          2211-ew-pump_x_x_x_x_x_x_x_x.out
                                              1.0172  0.9679          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
                                            1.0181  0.9706          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
                                            1.0205  0.9763          2211-ew-pump_x_x_x_x_x_x_x_x.out
                                              1.0172  0.9707          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
                                            1.0181  0.9733          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
                                            1.0205  0.9788          2211-ew-pump_x_x_x_x_x_x_x_x.out
                                              1.0172  0.9680          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
                                            1.0181  0.9707          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
                                            1.0205  0.9761          2211-ew-pump_x_x_x_x_x_x_x_x.out
                                              1.0172  0.9680          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
                                            1.0181  0.9707          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
                                            1.0205  0.9761          2211-ew-pump_x_x_x_x_x_x_x_x.out
                                              1.0172  0.9699          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
                                            1.0181  0.9726          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
                                            1.0205  0.9792          2211-ew-pump_x_x_x_x_x_x_x_x.out
                                              1.0172  0.9696          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
                                            1.0181  0.9723          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
                                            1.0205  0.9782          2211-ew-pump_x_x_x_x_x_x_x_x.out
                                              1.0172  0.9707          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
                                            1.0181  0.9733          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
                                            1.0205  0.9788          2211-ew-pump_x_x_x_x_x_x_x_x.out
                                              1.0172  0.9712          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
                                            1.0181  0.9738          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
                                            1.0205  0.9793          2211-ew-pump_x_x_x_x_x_x_x_x.out

                                           95 BEARSWAMP 2X230.00 ========================

                                            PU
                                                Pre     Post   % Chg    ACCC Output File
                                              ------  ------  ------  -----------------
                                              1.0172  0.9678          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
                                            1.0181  0.9705          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
                                            1.0205  0.9760          2211-ew-pump_x_x_x_x_x_x_x_x.out
                                              1.0172  0.9679          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
                                            1.0181  0.9706          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
                                            1.0205  0.9763          2211-ew-pump_x_x_x_x_x_x_x_x.out
                                              1.0172  0.9707          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
                                            1.0181  0.9733          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
                                            1.0205  0.9788          2211-ew-pump_x_x_x_x_x_x_x_x.out
                                              1.0172  0.9680          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
                                            1.0181  0.9707          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
                                            1.0205  0.9761          2211-ew-pump_x_x_x_x_x_x_x_x.out
                                              1.0172  0.9680          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
                                            1.0181  0.9707          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
                                            1.0205  0.9761          2211-ew-pump_x_x_x_x_x_x_x_x.out
                                              1.0172  0.9700          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
                                            1.0181  0.9726          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
                                            1.0205  0.9792          2211-ew-pump_x_x_x_x_x_x_x_x.out
                                              1.0172  0.9696          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
                                            1.0181  0.9723          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
                                            1.0205  0.9782          2211-ew-pump_x_x_x_x_x_x_x_x.out
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0172 0.9707 2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
81 0.9733 2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
05 0.9788 2211-ew-pump_x_x_x_x_x_x_x_x.out
0172 0.9712 2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
81 0.9739 2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
05 0.9793 2211-ew-pump_x_x_x_x_x_x_x_x.out

RATTS JCT 230.00 ========================

Pre	Post	% Chg	ACCC Output File
9931	0.9774		22sh-we_x_x_x_x_x_x_x_x.out

STMNSTR MA 69.000 ========================

Pre	Post	% Chg	ACCC Output File
9745	0.9072		22sh-ew-pump_x_x_x_x_x_x_x_x.out
20	0.9249		22sh-we_x_x_x_x_x_x_x_x.out
9745	0.9114		22sh-ew-pump_x_x_x_x_x_x_x_x.out
20	0.9123		22sh-we_x_x_x_x_x_x_x_x.out
9745	0.9074		22sh-ew-pump_x_x_x_x_x_x_x_x.out
20	0.9248		22sh-we_x_x_x_x_x_x_x_x.out
9745	0.9060		22sh-ew-pump_x_x_x_x_x_x_x_x.out
20	0.9263		22sh-we_x_x_x_x_x_x_x_x.out
9745	0.9069		22sh-ew-pump_x_x_x_x_x_x_x_x.out
20	0.9256		22sh-we_x_x_x_x_x_x_x_x.out

re	Post	% Chg	ACCC Output File
9940	1.0500		22sh-we+group1_x_x_x_x_x_x_x_x.out
88	1.0529		2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
36	1.0698		2211-we+group1_x_x_x_x_x_x_x_x.out
00	1.0938		22-min+group1_x_x_x_x_x_x_x_x.out
0007	1.0504		22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
36	1.0689		2211-we+group1_x_x_x_x_x_x_x_x.out
88	1.0697		2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
00	1.1008		22-min+group1_x_x_x_x_x_x_x_x.out
0088	1.0531		2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
36	1.0698		2211-we+group1_x_x_x_x_x_x_x_x.out
00	1.0937		22-min+group1_x_x_x_x_x_x_x_x.out
0088	1.0524		2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
36	1.0700		2211-we+group1_x_x_x_x_x_x_x_x.out
00	1.0933		22-min+group1_x_x_x_x_x_x_x_x.out
9940	1.0501		22sh-we+group1_x_x_x_x_x_x_x_x.out
88	1.0525		2211-ew-pump+group1_x_x_x_x_x_x_x_x.out
36	1.0698		2211-we+group1_x_x_x_x_x_x_x_x.out
00	1.0936		22-min+group1_x_x_x_x_x_x_x_x.out

AST WEBSTER69.000 ========================

[redacted]

```
    Pre     Post   % Chg    ACCC Output File
  ------  ------  ------  -----------------
  0.9876  0.9457          22sh-we_x_x_x_x_x_x_x_x.out
  0.9876  0.9480          22sh-we_x_x_x_x_x_x_x_x.out

329 E WSTNSTR_A169.000 ========================

 PU
    Pre     Post   % Chg    ACCC Output File
  ------  ------  ------  -----------------
  0.9818  0.9138          22sh-ew-pump_x_x_x_x_x_x_x_x.out
 0.9782  0.9345          22sh-we_x_x_x_x_x_x_x_x.out
  0.9818  0.9181          22sh-ew-pump_x_x_x_x_x_x_x_x.out
 0.9782  0.9197          22sh-we_x_x_x_x_x_x_x_x.out
  0.9818  0.9137          22sh-ew-pump_x_x_x_x_x_x_x_x.out
 0.9782  0.9336          22sh-we_x_x_x_x_x_x_x_x.out
  0.9818  0.9132          22sh-ew-pump_x_x_x_x_x_x_x_x.out
 0.9782  0.9361          22sh-we_x_x_x_x_x_x_x_x.out
  0.9818  0.9133          22sh-ew-pump_x_x_x_x_x_x_x_x.out
 0.9782  0.9349          22sh-we_x_x_x_x_x_x_x_x.out

 PU
   Pre     Post   % Chg    ACCC Output File
  ------  ------  ------  -----------------
  1.0192  1.0609          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0192  1.0730          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0192  1.0607          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0192  1.0621          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0192  1.0606          22-min+group1_x_x_x_x_x_x_x_x.out

330 E WSTNSTR_B269.000 ========================

 PU
   Pre     Post   % Chg    ACCC Output File
  ------  ------  ------  -----------------
  0.9788  0.9069          22sh-ew-pump_x_x_x_x_x_x_x_x.out
 0.9750  0.9245          22sh-we_x_x_x_x_x_x_x_x.out
  0.9788  0.9110          22sh-ew-pump_x_x_x_x_x_x_x_x.out
 0.9750  0.9117          22sh-we_x_x_x_x_x_x_x_x.out
  0.9788  0.9071          22sh-ew-pump_x_x_x_x_x_x_x_x.out
 0.9750  0.9244          22sh-we_x_x_x_x_x_x_x_x.out
  0.9788  0.9057          22sh-ew-pump_x_x_x_x_x_x_x_x.out
 0.9750  0.9259          22sh-we_x_x_x_x_x_x_x_x.out
  0.9788  0.9066          22sh-ew-pump_x_x_x_x_x_x_x_x.out
 0.9750  0.9252          22sh-we_x_x_x_x_x_x_x_x.out

 PU
   Pre     Post   % Chg    ACCC Output File
  ------  ------  ------  -----------------
  0.9925  1.0506          22sh-we+group1_x_x_x_x_x_x_x_x.out
 1.0075  1.0535          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
 1.0112  1.0704          22ll-we+group1_x_x_x_x_x_x_x_x.out
 1.0265  1.0944          22-min+group1_x_x_x_x_x_x_x_x.out
  0.9925  1.0503          22sh-we+group1_x_x_x_x_x_x_x_x.out
 1.0004  1.0510          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
 1.0112  1.0695          22ll-we+group1_x_x_x_x_x_x_x_x.out
```

[redacted]

```
1.0075  1.0703          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
1.0265  1.1015          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0075  1.0537          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
1.0112  1.0704          22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0265  1.0944          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0075  1.0530          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
1.0112  1.0707          22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0265  1.0939          22-min+group1_x_x_x_x_x_x_x_x.out
  0.9925  1.0507          22sh-we+group1_x_x_x_x_x_x_x_x.out
1.0075  1.0532          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
1.0112  1.0705          22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0265  1.0942          22-min+group1_x_x_x_x_x_x_x_x.out


42 CRYSTAL LAKE69.000 ========================

PU
    Pre     Post   % Chg    ACCC Output File
  ------  ------  ------  -----------------
  0.9709  0.9468          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9709  0.9471          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9709  0.9490          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9709  0.9469          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9709  0.9469          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9709  0.9480          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9709  0.9479          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9709  0.9137          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9712  0.9318          22sh-we_x_x_x_x_x_x_x_x.out
  0.9712  0.9498          22sh-we_x_x_x_x_x_x_x_x.out
  0.9709  0.9182          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9712  0.9198          22sh-we_x_x_x_x_x_x_x_x.out
  0.9709  0.9139          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9712  0.9317          22sh-we_x_x_x_x_x_x_x_x.out
  0.9709  0.9124          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9712  0.9332          22sh-we_x_x_x_x_x_x_x_x.out
  0.9709  0.9133          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9712  0.9325          22sh-we_x_x_x_x_x_x_x_x.out
  0.9709  0.9490          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9709  0.9491          22sh-ew-pump_x_x_x_x_x_x_x_x.out

PU
   Pre     Post   % Chg    ACCC Output File
  ------  ------  ------  -----------------
  1.0192  1.0575          22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0361  1.0728          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0361  1.0542          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0192  1.0575          22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0361  1.0728          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0109  1.0507          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
1.0192  1.0674          22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0361  1.0903          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0192  1.0573          22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0361  1.0731          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0023  1.0500          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
1.0192  1.0668          22ll-we+group1_x_x_x_x_x_x_x_x.out
```

[redacted]

```
  1.0109  1.0676         221l-ew-pump+group1_x_x_x_x_x_x_x_x.out
  1.0361  1.0974         22-min+group1_x_x_x_x_x_x_x_x.out
    1.0109  1.0510         221l-ew-pump+group1_x_x_x_x_x_x_x_x.out
  1.0192  1.0674         221l-we+group1_x_x_x_x_x_x_x_x.out
  1.0361  1.0903         22-min+group1_x_x_x_x_x_x_x_x.out
    1.0109  1.0502         221l-ew-pump+group1_x_x_x_x_x_x_x_x.out
  1.0192  1.0676         221l-we+group1_x_x_x_x_x_x_x_x.out
  1.0361  1.0899         22-min+group1_x_x_x_x_x_x_x_x.out
    1.0109  1.0504         221l-ew-pump+group1_x_x_x_x_x_x_x_x.out
  1.0192  1.0675         221l-we+group1_x_x_x_x_x_x_x_x.out
  1.0361  1.0902         22-min+group1_x_x_x_x_x_x_x_x.out
    1.0192  1.0564         221l-we+group1_x_x_x_x_x_x_x_x.out
  1.0109  1.0573         221l-ew-pump+group1_x_x_x_x_x_x_x_x.out
  1.0361  1.0770         22-min+group1_x_x_x_x_x_x_x_x.out
    1.0192  1.0574         221l-we+group1_x_x_x_x_x_x_x_x.out
  1.0361  1.0720         22-min+group1_x_x_x_x_x_x_x_x.out

351 WESTMNSTR_A169.000 ========================

5 PU
      Pre     Post   % Chg    ACCC Output File
    ------  ------  ------  -----------------
    0.9792  0.9152          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9771  0.9361         22sh-we_x_x_x_x_x_x_x_x.out
    0.9792  0.9195          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9771  0.9214         22sh-we_x_x_x_x_x_x_x_x.out
    0.9792  0.9150          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9771  0.9352         22sh-we_x_x_x_x_x_x_x_x.out
    0.9792  0.9145          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9771  0.9377         22sh-we_x_x_x_x_x_x_x_x.out
    0.9792  0.9146          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9771  0.9364         22sh-we_x_x_x_x_x_x_x_x.out

5 PU
     Pre     Post   % Chg    ACCC Output File
    ------  ------  ------  -----------------
    1.0204  1.0602          22-min+group1_x_x_x_x_x_x_x_x.out
    1.0204  1.0723          22-min+group1_x_x_x_x_x_x_x_x.out
    1.0204  1.0601          22-min+group1_x_x_x_x_x_x_x_x.out
    1.0204  1.0614          22-min+group1_x_x_x_x_x_x_x_x.out
    1.0204  1.0599          22-min+group1_x_x_x_x_x_x_x_x.out

3352 WESTMNSTR_B269.000 ========================

5 PU
     Pre     Post   % Chg    ACCC Output File
    ------  ------  ------  -----------------
    0.9750  0.9077          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9726  0.9254         22sh-we_x_x_x_x_x_x_x_x.out
    0.9750  0.9119          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9726  0.9129         22sh-we_x_x_x_x_x_x_x_x.out
    0.9750  0.9080          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9726  0.9253         22sh-we_x_x_x_x_x_x_x_x.out
    0.9750  0.9065          22sh-ew-pump_x_x_x_x_x_x_x_x.out
  0.9726  0.9268         22sh-we_x_x_x_x_x_x_x_x.out
    0.9750  0.9074          22sh-ew-pump_x_x_x_x_x_x_x_x.out
```

[redacted]

```
0.9726  0.9261          22sh-we_x_x_x_x_x_x_x_x.out

PU
   Pre     Post   % Chg    ACCC Output File
  ------  ------  ------  -----------------
  0.9941  1.0501          22sh-we+group1_x_x_x_x_x_x_x_x.out
1.0087  1.0528          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
1.0135  1.0697          22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0298  1.0936          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0007  1.0505          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
1.0135  1.0688          22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0087  1.0696          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
1.0298  1.1007          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0087  1.0531          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
1.0135  1.0697          22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0298  1.0936          22-min+group1_x_x_x_x_x_x_x_x.out
  1.0087  1.0523          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
1.0135  1.0699          22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0298  1.0931          22-min+group1_x_x_x_x_x_x_x_x.out
  0.9941  1.0502          22sh-we+group1_x_x_x_x_x_x_x_x.out
1.0087  1.0525          22ll-ew-pump+group1_x_x_x_x_x_x_x_x.out
1.0135  1.0698          22ll-we+group1_x_x_x_x_x_x_x_x.out
1.0298  1.0934          22-min+group1_x_x_x_x_x_x_x_x.out


[redacted]41 PROSPCT_V22E69.000 ========================

PU
    Pre     Post   % Chg    ACCC Output File
  ------  ------  ------  -----------------
  0.9703  0.9301          22sh-we_x_x_x_x_x_x_x_x.out
0.9686  0.9304          23pk-ew+group1_x_x_x_x_x_x_x_x.out
0.9713  0.9315          22sh-we+group1_x_x_x_x_x_x_x_x.out
0.9706  0.9346          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9710  0.9346          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9725  0.9359          23pk-ew_x_x_x_x_x_x_x_x.out
0.9728  0.9401          23pk-we+group1_x_x_x_x_x_x_x_x.out
0.9781  0.9447          23pk-we_x_x_x_x_x_x_x_x.out
  0.9703  0.9296          22sh-we_x_x_x_x_x_x_x_x.out
0.9686  0.9304          23pk-ew+group1_x_x_x_x_x_x_x_x.out
0.9713  0.9310          22sh-we+group1_x_x_x_x_x_x_x_x.out
0.9706  0.9348          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9710  0.9348          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9725  0.9360          23pk-ew_x_x_x_x_x_x_x_x.out
0.9728  0.9384          23pk-we+group1_x_x_x_x_x_x_x_x.out
0.9781  0.9432          23pk-we_x_x_x_x_x_x_x_x.out
  0.9703  0.9246          22sh-we_x_x_x_x_x_x_x_x.out
0.9713  0.9266          22sh-we+group1_x_x_x_x_x_x_x_x.out
0.9686  0.9281          23pk-ew+group1_x_x_x_x_x_x_x_x.out
0.9706  0.9285          22sh-ew-pump_x_x_x_x_x_x_x_x.out
0.9710  0.9293          22sh-ew-pump+group1_x_x_x_x_x_x_x_x.out
0.9725  0.9350          23pk-ew_x_x_x_x_x_x_x_x.out
0.9728  0.9388          23pk-we+group1_x_x_x_x_x_x_x_x.out
0.9781  0.9442          23pk-we_x_x_x_x_x_x_x_x.out
0.9764  0.9472          22ll-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x_x.out
0.9765  0.9480          22ll-ew-pump_x_x_x_x_x_x_x_x.out
```

```
[redacted]0.9768  0.9488          2211-ew-pump+group1_x_x_x_x_x_x_x_x.out

[redacted]28 VERNON SOLAR69.000 ========================

[redacted]PU
    Pre     Post   % Chg    ACCC Output File
  ------  ------  ------  -----------------
[redacted]  0.9966  0.9417          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
[redacted]0.9987  0.9495          2211-ew-pump_x_x_x_x_x_x_x_x.out
[redacted]  0.9966  0.9418          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
[redacted]0.9987  0.9499          2211-ew-pump_x_x_x_x_x_x_x_x.out
[redacted]  0.9966  0.9447          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
[redacted]  0.9966  0.9419          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
[redacted]0.9987  0.9497          2211-ew-pump_x_x_x_x_x_x_x_x.out
[redacted]  0.9966  0.9419          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
[redacted]0.9987  0.9497          2211-ew-pump_x_x_x_x_x_x_x_x.out
[redacted]  0.9966  0.9437          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
[redacted]  0.9966  0.9435          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
[redacted]  0.9966  0.9447          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
[redacted]  0.9966  0.9454          2211-ew-pump+group1_smart-cap-21mvar_x_x_x_x_x_x_x.out
```

Appendix E

N-1-1 Voltage Results

Table E1:

N-1-1 Voltage Results for first contingencies only involving 69 kV facilities

Bus Name	Bus #	Base kV	First Level Scenario	Cont Name	22ll-ew-pump1 Base V	22ll-ew-pump1 Cont V	22-min+grp1- Base V	22-min+grp1- Cont V	22sh-ew-pump Base V	22sh-ew-pump Cont V	22sh-we+grp1 Base V	22sh-we+grp1 Cont V	23pk-ew+grp1 Base V	23pk-ew+grp1 Cont V	23pk-we+grp1 Base V	23pk-we+grp1 Cont V
BEAR SWAMP					1.022	0.980										
CHESNUT HILL					0.992	0.946			0.988	0.950						
CRYSTAL LAKE	**113342**	69	**B-2S**	E131	0.993	0.946										
			D-4E	B-2S									1.013	1.051		
				BO_B2s pratts					1.003	1.051			1.013	1.079		
DEERFIELD 2	**113044**	69	**E-5D**	E131	0.992	0.943			0.996	0.947						
			E-5W	E131	0.993	0.944										
			HARR_GSU2	E205E					0.993	0.948						
			HARRMN_G2	E205E					0.993	0.948						
			HARRMN_G3	E205E					0.993	0.948						
			O-15N	BO_F6W deerfld 4			1.033	1.057								
			O15N+trip Deerfld G2+3	E131	0.991	0.944										
			Y-25S sears-dfld 5	E131					0.994	0.948						
DEERFIELD 3					0.992	0.942			0.994	0.946						
DEERFIELD 4					0.992	0.941			0.995	0.945						
DEERFIELD 5	**113021**	69	**HARRMN_G3**	BENN_T3	1.033	1.055			1.033	1.051			1.031	1.050		
				BO_Y25N Bennington	1.033	1.054			1.033	1.050						
				BS_BENINGTON	1.033	1.055			1.033	1.051			1.031	1.050		
				Y-25N Bennington-putnam	1.033	1.054			1.033	1.050						
				Y25N Bennington-Putnam rd	1.033	1.054			1.033	1.050						
			Y25N Bennington-Putnam rd	BO_HARriman T3 69kV	1.040	1.053			1.035	1.050						

Bus Name	Bus #	Base kV	First Level Scenario	Cont Name	22ll-ew-pump1 Base V	Cont V	22-min+grp1- Base V	Cont V	22sh-ew-pump Base V	Cont V	22sh-we+grp1 Base V	Cont V	23pk-ew+grp1 Base V	Cont V	23pk-we+grp1 Base V	Cont V
				HARRiMaN_T3 + G3	1.040	1.052										
DEERFLD 2_E5					0.993	0.944			0.994	0.947						
DEERFLD 2_F6					0.993	0.944	1.033	1.057	0.996	0.948						
DEERFLD 3_E5					0.992	0.942			0.994	0.946						
DEERFLD 3_F6					0.992	0.943	1.032	1.057	0.993	0.946						
E WSTNSTR_B2									1.004	1.052						
E.WESTMIN B2	**113330**	69	**D-4E**	BO_B2s pratts									1.009	1.083		
HARRIMAN	**109501**	69	**HARRMN_G3**	BENN_T3	1.030	1.058			1.031	1.054			1.031	1.055		
				BO_Y25N Bennington	1.030	1.057			1.031	1.053			1.031	1.054		
				BS_BENINGTON	1.030	1.058			1.031	1.054			1.031	1.055		
				Y-25N Bennington-putnam	1.030	1.057			1.031	1.053			1.031	1.054		
				Y25N Bennington-Putnam rd	1.030	1.057			1.031	1.053			1.031	1.054		
			Y25N Bennington-Putnam rd	BO_HARriman T3 69kV	1.040	1.056			1.035	1.053			1.030	1.053		
				HARRiMaN_T3 + G3	1.040	1.056			1.035	1.052			1.030	1.053		
HOOSAC WIND	**113058**	69	**HARRMN_G3**	BENN_T3	1.032	1.056			1.032	1.053			1.031	1.053		
				BO_Y25N Bennington	1.032	1.055			1.032	1.051			1.031	1.051		
				BS_BENINGTON	1.032	1.056			1.032	1.053			1.031	1.053		
				Y-25N Bennington-putnam	1.032	1.055			1.032	1.051			1.031	1.051		
				Y25N Bennington-Putnam rd	1.032	1.055			1.032	1.051			1.031	1.051		
			Y25N Bennington-Putnam rd	BO_HARriman T3 69kV	1.040	1.054			1.035	1.051			1.030	1.050		
				HARRiMaN_T3 + G3	1.040	1.054			1.035	1.050			1.030	1.050		

Bus Name	Bus #	Base kV	First Level Scenario	Cont Name	22ll-ew-pump1 Base V	Cont V	22-min+grp1- Base V	Cont V	22sh-ew-pump Base V	Cont V	22sh-we+grp1 Base V	Cont V	23pk-ew+grp1 Base V	Cont V	23pk-we+grp1 Base V	Cont V
N BLDWNVL_A1					0.989	0.947			0.980	0.945						
N BLDWNVL_B2	**113055**	69	**B-2S**	E131	0.994	0.947										
			D-4E	BO_B2s pratts									1.013	1.074		
OTTER RIVER					0.989	0.947			0.980	0.945						
PRATTS JCT											0.993	0.979				
PROSPECT T1															0.984	0.948
ROYALSTON					0.990	0.949			0.983	0.948						
SEARS HYD_TP	**109515**	69	**HARRMN_G3**	BENN_T3	1.026	1.064			1.027	1.059			1.030	1.063		
				BO_Y25N Bennington	1.026	1.062			1.027	1.057			1.030	1.061		
				BS_BENINGTON	1.026	1.064			1.027	1.059			1.030	1.063		
				Y-25N Bennington-putnam	1.026	1.062			1.027	1.057			1.030	1.061		
				Y25N Bennington-Putnam rd	1.026	1.062			1.027	1.057			1.030	1.061		
			Y25N Bennington-Putnam rd	BO_HARriman T3 69kV	1.045	1.061			1.039	1.056			1.036	1.059		
				HARRiMaN_T3 + G3	1.045	1.060			1.039	1.056			1.036	1.059		
			Y-25S sears-dfld 5	K6											1.034	1.050
SEARS WND_TP	**109518**	69	**HARRMN_G3**	BENN_T3	1.025	1.065			1.026	1.060			1.029	1.064		
				BO_Y25N Bennington	1.025	1.063			1.026	1.058			1.029	1.062		
				BS_BENINGTON	1.025	1.065			1.026	1.060			1.029	1.064		
				Y-25N Bennington-putnam	1.025	1.063			1.026	1.058			1.029	1.062		
				Y25N Bennington-Putnam rd	1.025	1.063			1.026	1.058			1.029	1.062		
			Y25N Bennington-Putnam rd	BO_HARriman T3 69kV	1.045	1.061			1.039	1.056			1.037	1.059		
				HARRiMaN_T3 + G3	1.045	1.060			1.039	1.056			1.037	1.059		
SEARSBURG_N	**109574**	69	**HARRMN_G3**	BENN_T3	1.027	1.064			1.027	1.059			1.030	1.063		

Bus Name	Bus #	Base kV	First Level Scenario	Cont Name	22ll-ew-pump1 Base V	Cont V	22-min+grp1- Base V	Cont V	22sh-ew-pump Base V	Cont V	22sh-we+grp1 Base V	Cont V	23pk-ew+grp1 Base V	Cont V	23pk-we+grp1 Base V	Cont V
				BO_Y25N Bennington	1.027	1.062			1.027	1.057			1.030	1.061		
				BS_BENINGTON	1.027	1.064			1.027	1.059			1.030	1.063		
				Y-25N Bennington-putnam	1.027	1.062			1.027	1.057			1.030	1.061		
				Y25N Bennington-Putnam rd	1.027	1.062			1.027	1.057			1.030	1.061		
			Y25N Bennington-Putnam rd	BO_HARriman T3 69kV	1.045	1.061			1.039	1.056			1.036	1.059		
				HARRiMaN_T3 + G3	1.045	1.060			1.039	1.056			1.036	1.059		
			Y-25S sears-dfld 5	K6											1.034	1.051
SEARSBURG_S	**109516**	69	**HARRMN_G3**	BENN_T3	1.027	1.064			1.027	1.059			1.030	1.063		
				BO_Y25N Bennington	1.027	1.062			1.027	1.057			1.030	1.061		
				BS_BENINGTON	1.027	1.064			1.027	1.059			1.030	1.063		
				Y-25N Bennington-putnam	1.027	1.062			1.027	1.057			1.030	1.061		
				Y25N Bennington-Putnam rd	1.027	1.062			1.027	1.057			1.030	1.061		
			Y25N Bennington-Putnam rd	BO_HARriman T3 69kV	1.045	1.061			1.039	1.056			1.036	1.059		
				HARRiMaN_T3 + G3	1.045	1.060			1.039	1.056			1.036	1.059		
			Y-25S sears-dfld 5	K6											1.034	1.051
SHUTESBURY					0.993	0.943			0.997	0.948						
VERNON SOLAR					0.998	0.948			1.001	0.949						
VERNON VT					0.995	0.950			0.998	0.950			1.012	1.051		
WESTMNSTR_B2	**113352**	69	**A-1**	BO_B2s pratts					1.000	1.050						
			D-4E	BO_B2s pratts					1.000	1.051			1.010	1.082		
			D-4W	BO_B2s pratts					1.007	1.050						
WSTMNSTR MA	**113316**	69	**D-4E**	BO_B2s pratts					1.000	1.051			1.010	1.082		
			D-4W	BO_B2s pratts					1.007	1.050						

Table E2:

N-1-1 Voltage Results for first contingencies 345, 230 and 115 kV facilities

Bus Name	22ll-ew-pump+grp1p		22ll-we+grp1		22sh-ew-pump+grp1		22sh-we+grp1		23pk-ew+grp1		23pk-we+grp1	
	Base V	Cont V	Base V	Cont V	Base V	Cont V	Base V	Cont V	Base V	Cont V	Base V	Cont V
ADAMS	1.030	0.949			1.032	0.938						
BARRE A127	1.014	0.948					0.999	0.950				
BEAR SWAMP	1.022	0.980			1.024	0.979			0.999	0.980		
BEARSWAMP_C1	1.018	0.942			1.024	0.949						
BEARSWAMP_C2	1.017	0.941			1.024	0.948						
CABOT B128_T	1.006	0.948			1.007	0.948						
CARPENTER HL							0.995	0.979				
CHESNUT HILL	0.991	0.949			0.989	0.949						
CRYSTAL LAKE	0.991	0.947			0.999	0.948						
DEERFIELD 2	1.000	0.950			0.995	0.949						
DEERFIELD 3	0.998	0.950			0.994	0.950						
DEERFIELD 4	1.006	0.950			1.002	0.950						
DEERFIELD 5	1.029	0.946			1.032	0.939						
DEERFLD 2_E5	0.999	0.950			0.994	0.950						
DEERFLD 2_F6	1.000	0.950			0.995	0.950						
DEERFLD 3_E5	0.998	0.950			0.994	0.950						
DEERFLD 3_F6	0.999	0.950			0.994	0.950						
E WINCHENDON	1.030	1.053			1.030	1.052						
FRENCH KG 28	1.005	0.947			1.006	0.948						
HARRIMAN	1.029	0.946			1.031	0.940						
HARRIMAN 1	1.013	0.946			1.016	0.948						
HARRIMAN 2	1.013	0.946			1.016	0.948						

Bus Name	22ll-ew-pump+grp1p Base V	Cont V	22ll-we+grp1 Base V	Cont V	22sh-ew-pump+grp1 Base V	Cont V	22sh-we+grp1 Base V	Cont V	23pk-ew+grp1 Base V	Cont V	23pk-we+grp1 Base V	Cont V
HOOSAC WIND	1.029	0.946			1.032	0.940						
N BLDWNVL_A1	0.987	0.947			0.988	0.949						
N BLDWNVL_B2	0.993	0.950			1.000	0.949						
OTTER RIVER	0.987	0.947			0.988	0.949						
PRATTS JCT	1.012	0.980			1.009	0.979	0.999	0.980			1.002	0.980
ROYALSTON	0.990	0.950			0.988	0.947						
SEARS HYD_TP	1.025	0.942			1.029	0.947					1.022	1.051
SEARS WND_TP	1.024	0.941			1.027	0.946						
SEARSBURG_N	1.025	0.942			1.029	0.947					1.022	1.051
SEARSBURG_S	1.025	0.942			1.029	0.947					1.022	1.050
SHERMAN	1.014	0.949			1.016	0.936						
SHERMAN TAP	1.014	0.949			1.016	0.936						
SHUTESBURY	0.995	0.949			0.997	0.950						
VERNON SOLAR	1.006	0.950			1.001	0.950						
VERNON VT	1.002	0.950			1.001	0.950						
WEBSTER ST	1.011	0.846	1.013	0.854	1.008	0.735	1.001	0.713	1.017	0.725	1.027	0.805
WESTMNSTR_A1					0.990	0.949						

Appendix F

PSCAD Results

Distributed Energy Resource PSCAD Interconnection Evaluation (Group 1) – Final Report

November 8, 2019

Report Submitted to:
National Grid

Prepared by:
Lukas Unruh
Reviewed by:
Andrew Isaacs

Electranix Corporation

Contents

1 Executive Summary

1.1 Background

National Grid plans to interconnect approximately 330 MW of distributed energy resources (DER) into the ISONE system, with individual plants sizes greater than 1 MW (see Figure 1.1 below for proposed DER locations).

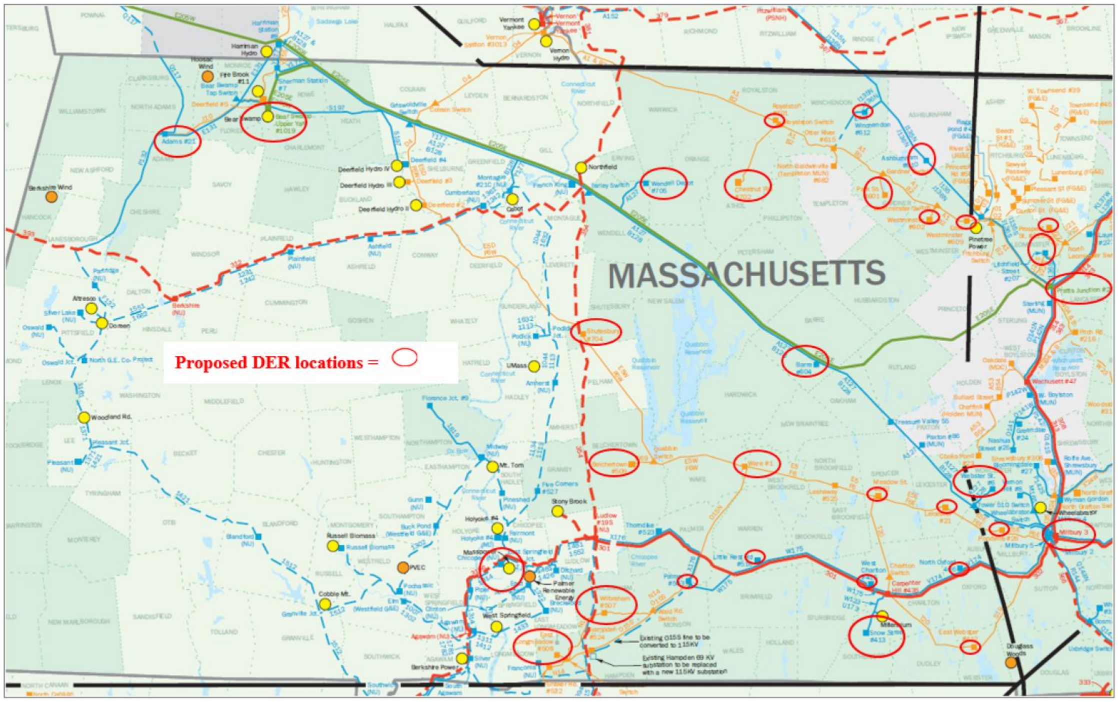

Figure 1.1: *Region which will include approximately 330 MW of DER resources*

Special considerations needed with this type of interconnection plan include:

1. *Weak grid control instability*. Particularly at the end of long radial circuits, where available short circuit capacity may be relatively low, inverter-based generator controls are vulnerable to small signal instabilities and control issues.
2. *Ride through capability*. Following faults on the large lines in the connection area, the generators in the region are expected to recover full power. Inverter Based Resources (IBR) such as the DER being planned may trip for many reasons which may not be accurately represented in conventional transient stability tools.
3. *Voltage control coordination*. It is likely that the plants will have sufficient impedance between them to avoid voltage controller interactions, particularly since the majority of these DER plants are planned to be operated in constant power factor mode. However,

if voltages throughout the distribution system vary significantly under various operating conditions, the individual plants may struggle to maintain their terminal voltages within acceptable ranges.

4. *Adequacy of PSS/E models.* It is possible that the PSS/E models used to represent the DER are not sufficiently accurate or detailed to identify the above concerns.

In order to evaluate the first two of these concerns, the PSCAD simulation tool is required, as conventional transient stability tools are not usually capable of correctly predicting inverter behaviors of these types. The third concern is out of scope for this effort. To confirm adequacy of the PSS/E models (or understand the impact of any shortcomings), PSCAD RMS simulation traces of voltage and power will be compared to the corresponding PSS/E simulation traces for select DER plants, transmission lines, and conventional generators (separate effort by National Grid).

This is a unique study, as the PSCAD tool has not typically been used for wide-area DER system impact analysis in the past, especially using highly detailed inverter specific models. Based on the modelling state of the art, and unknowns in several key technical areas, substantial assumptions were required in order to complete the study. It is anticipated that lessons learned here as well as in other related efforts will continue to improve this type of study into the future.

1.2 Key Findings and Recommendations

The following are summaries of the key findings and recommendations in the report. Further details may be found in the results sections of the respective chapters.

1. *DER Performance*[1]*.* The DER did not trip, enter into momentary cessation, or introduce instabilities for any studied contingencies. Some investigations into fault behaviour were made and these are noted in the DER Performance results section of this report, including minor recommendations.

2. *Representative Modelling Approach.* The current modelling state of the art does not allow explicit modelling of each individual inverter, and (for group studies of this size) requires aggregation of the plants themselves to some extent. The individual inverter

[1] Momentary cessation is required by National Grid for terminal voltages below 0.5 p.u.

models supplied were numerous, and varied in quality, requiring a modeling approach which assumed a representative distribution of the most common types of inverters. A statistical approach was also used to model the lengths and impedances of the collector and distribution feeder circuits. These approaches are suitable to evaluate overall system stability, however may misrepresent individual plant performance.

The method of deriving the equivalent feeder model used in this study may be reviewed and verified against an explicitly modelled feeder, and as experience is gained in actual system performance this should be fed back into the models to determine where improvements are required in aggregation assumptions. If possible, high resolution event recording capability should be integrated into the region to assist with analysis and model validation.

3. *DER Model Accuracy.* Although significant effort was made to obtain high quality DER models for the most common inverter types being connected into the region, the inverters ultimately modelled may not match the actual equipment purchased and installed. From a brief investigation into DER inverter fault ride through behaviour, it was observed that the DER PSCAD models do not meet National Grid's ESB 756 ride through criteria as modelled in this study. Due to schedule restrictions, it was not possible for DER inverter manufacturers / project developers to update the DER PSCAD models with the protection / momentary cessation settings required to meet the criteria. The DER protection, control, and momentary cessation settings in all installed equipment will be verified by National Grid for adherence to National Grid's ride-through criteria before connecting to the grid.

4. *Harmonics and Oscillations.* The issues noted below are related to incorrect modelling of nearby conventional synchronous generators. The extend to which these generators contributed to the observed issues will be further investigated.
    a. *Harmonic Distortions.* The SG60 inverter (60 kW, Sungrow) used at several DER stations and the Q660 BPS-connected plant (20 MW near Deerfield, SMA inverters) are sources of harmonic distortions which propagate into the wider system. The light load case showed higher levels of distortion than the peak load case. The harmonic performance of these devices should be investigated further and mitigated as necessary.
    b. *System Oscillations.* 0.8 Hz (peak load and light load case) and 2.5 Hz (light load case only) system oscillations were observed on several transmission line flows

with a highest magnitude of 2 MW. These oscillations were nearly eliminated when the dynamics of the synchronous machines at Harriman were not released, indicating that these machines are significant contributors to the oscillatory mode.

2 Methodology and Assumptions

2.1 PSCAD and E-Tran Software

Inverter-based resource control interactions and instabilities are often not detectable using positive sequence simulation tools such as PSSE software since these models usually do not represent the fast-inner controllers that are responsible for the unstable modes, or protection circuits which can cause ride-through failure. More complex studies using Electromagnetic transient (EMT) tools such as PSCAD software are required to identify control interactions or control instability for power electronic resources (such as DERs) connected to weak grids.
The studies in this report were completed using the PSCAD/EMTDC program (V4.6.3). The E-Tran program (5.1.0.1) was used to translate PSS/E .raw loadflow cases into PSCAD models. Detailed models such as fault logic, DER plants, and BPS connected wind/solar plants are maintained in PSCAD "substitution libraries" and are automatically imported into the PSCAD case (and initialized) by E-Tran.

2.2 PSCAD Parallel System Model

2.2.1 PSCAD Parallel Processing Capabilities

The use of multiple PSCAD detailed power electronic-based simulation models (such as DER plants) introduces numerous possible problems:

- *Slow simulations*: Power electronic models are inherently slow due to switching of IGBT/diode models. Voltage Source-based or "interface based" models can be used (which avoid the switching) however are less accurate and can be numerically unstable (particularly in weak systems). The simulation time step requirements of some models can also be very small which requires the entire simulation to be performed with the minimum required step size.
- *Compiling/linking issues*: Binary .obj/.lib code from many suppliers needs to be linked into one executable .exe – each vendor supplies models compiled with various Fortran or C compilers, and compatibility problems can occur.

To resolve these issues, the modeling approach used in these studies uses parallel processing using a commercially available PSCAD add-on program called "E-Tran Plus for PSCAD" as shown in Figure 2.1 (see reference paper entitled "Parallel Processing and Hybrid Simulation for HVDC/VSC PSCAD Studies", ACDC conference 2012).

The simulation speed issues are solved by placing each wind farm onto its own CPU/CORE (either on one computer or on other computers connected to the LAN). Each DER and BPS connected plant is modeled on its own CPU/processor (through a Bergeron line model or scaling transformer model) – this allows each DER / BPS connected PSCAD model to:

- use a different time step (so the entire simulation is not slowed down if one model needs a smaller time step)
- to be compiled with different Fortran/C compilers (solving compiling/linking/compatibility issues)
- to be generated with different versions of PSCAD (i.e. older PSCAD V4.2.1 models can be run with PSCAD V4.6.3/newer versions)
- The modeling approach used in these studies is based on a database approach – i.e. each detailed model is maintained in a PSCAD/E-Tran database, which allows a PSCAD case to be quickly generated for any existing or future loadflow conditions. The simulations are also more accurate, because the complete system and wind farm models are fully initialized by the standard PSS/E loadflow setup.

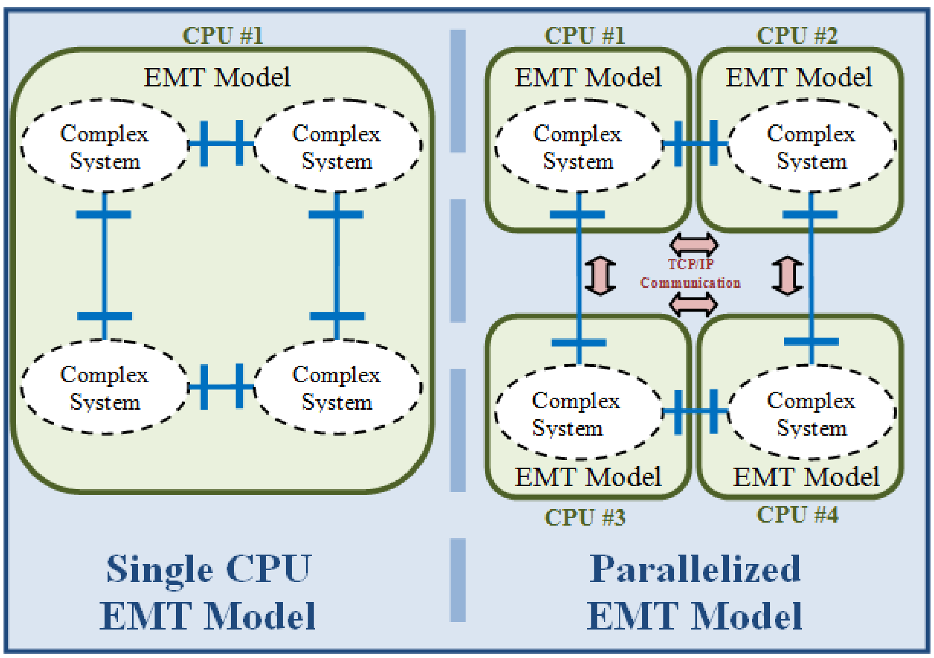

Figure 2.1: PSCAD single processing Vs. E-Tran Plus Parallel Processing in PSCAD

2.2.2 Application of PSCAD Parallel Processing

Each of the new DER substations are modelled in an individual parallel PSCAD case, with one or two different PSCAD solar models included in each case. Several DER substations require two parallel PSCAD cases due to incompatibilities between the two PSCAD models which are used to model the plant. Additionally, five Bulk Power System (BPS) connected wind / solar plants and the Sandy Pond LCC HVDC link were modelled in parallel PSCAD cases. This results in a total of 47 individual parallel PSCAD cases.

2.3 DER Modelling

The following assumptions were used in developing representative PSCAD models of DER plants. Note that some approximations were made to facilitate the computational limits of the hardware used to perform the simulations and to limit the required PSCAD modelling effort:

- Substations at which the total DER was less than 2 MWs were neglected.
- A maximum of two PSCAD inverter models were used to represent any DER substation.
- PSCAD inverter models for specific DER substations were selected based the following process:
    1. National Grid provided a list of how many of each type of inverter planned to interconnect at each substation (based on the generation applications received at that time), from which Electranix identified the 9 most common inverter models.
    2. Electranix rejected 4 of these 9 models based on a model quality check performed on each of the 9 models to determine their usability for the PSCAD. The model deficiencies of the rejected models were conveyed to manufacturers, and models of sufficient quality may have been received between the time of testing and the writing of this report.
    3. Electranix selected up to two inverter models (out of 5 acceptable models) for each substation. The model selection and the division of generated power attributed to each model was done on a case-by-case basis, with the following general criteria:
        - If the inverters which make up a large percentage of generated power at a substation did not have acceptable PSCAD models, the generated power was split evenly between the two most common acceptable inverter models.
        - In the case of one acceptable inverter model representing a large percentage of the power generated at the substation, that inverter was selected to represent the entire substation (some exceptions made for substations with relatively high amount of total generated power).
        - In cases where two acceptable inverter models each make up a significant percentage of power generated at the substation, both of the

models were used to represent the substation. The remaining percentage of power was split evenly between the two selected acceptable inverter models.

4. If possible, both of the selected acceptable inverter models were modelled in one parallel PSCAD case. When this was not possible due to conflicts between models (different timesteps required, duplicate definition/variable names), each model was modelled in an individual parallel PSCAD case.

Table 2.1 below provides the list of 9 most common PSCAD models, as well as which models were rejected and the reason for rejection. In cases where multiple models are listed in the same field for one manufacturer, the model name in bold was tested and used to represent all inverters produced by that manufacturer (if model was acceptable).

Table 2.2 provides the relevant details of each of the inverter models used to represent each DER substation.

Table 2.1: Selected and Rejected PSCAD model list (model in bold was tested and used as a representative model)

Manufacturer	Model	Total KW (at time of evaluation)	Status
SUNGROW	SG125HV	42147	Selected
SUNGROW	SG2500U	57317	Selected
SUNGROW	SG60KU	61392	Selected
POWER ELECTRONICS	**HEC V1500 v1001** & HEMK v1004	147746	Selected
SMA	**SC2500** & SC 2000	51984	Selected
GP TECH	**MP2800WD3-HV690/DC1200** & MP1400WD3-HV690/DC1200	66400	Rejected. Model tripped inappropriately and showed oscillations even in a relatively strong system.
HUAWEI	**SUN2000_45KTL_US_HV_D0** & SUN2000_100KTL_US_HV_D0	66789	Rejected. Model required a very small timestep and only compiled with the GF421 compiler.
CHINT	**SCA 50/60KTL** & SCA 100/125KTL	45094	Rejected. Initialization time was longer than 15 seconds and tripped inappropriately.
SOLECTRIA	**PVI50_60TL** & SGI 500XTM	15100	Rejected. Model tripped inappropriately.

Table 2.2: DER modelling details

Substation Name	Abbreviation	PSS/E Bus	Substation total MW	Inverter #1 Model Name	Inverter #1 Fraction	Inverter #2 Model Name	Inverter #2 Fraction	Inverter models compatible?
Belchertown	BT	113065	13	SG60KUM	1.00	N/A		

Substation Name	Abbreviation	PSS/E Bus	Substation total MW	Inverter #1 Model Name	Inverter #1 Fraction	Inverter #2 Model Name	Inverter #2 Fraction	Inverter models compatible?
E. Longmeadow 1	ELM1	113066	4.5	PE HEC V1500 v1001	1.00	N/A		
E. Longmeadow 2	ELM2	113067	4.5	PE HEC V1500 v1001	1.00	N/A		
Hampden	HD	113069	15.8	PE HEC V1500 v1001	0.61	SC2500	0.39	Yes
Lashaway 1	LSH1	113070	10	SG125HV	1.00	N/A		
Meadow St	MS	113071	24.5	SC2500	0.34	PE HEC V1500 v1001	0.66	Yes
Palmer 1	P1	113072	10	SC2500	0.43	PE HEC V1500 v1001	0.57	Yes
Palmer 2	P2	113073	7	SC2500	0.43	PE HEC V1500 v1001	0.57	Yes
Thorndike	TD	113075	12.5	PE HEC V1500 v1001	0.49	SG125HV	0.51	Yes
Little Rest Road	LR	113076	15.4	SCS2500	0.22	PE HEC V1500 v1001	0.78	Yes
Ware	WR	113077	13.2	SC2500-EV	0.28	PE HEC V1500 v1001	0.72	Yes
Wilbraham	WB	113078	6.4	SG2500U	0.58	PE HEC V1500 v1001	0.42	Yes
Lashaway 2	LSH2	113079	7	SG125HV	1.00	N/A		
Chestnut Hill S	CHLS	113080	4.5	SG60KUM	1.00	N/A		
Chestnut Hill N	CHLN	113081	4.5	SG60KUM	1.00	N/A		
Barre 1	BR1	113082	8.25	SG2500U	0.61	HEC V1500 v1001	0.39	Yes
Barre 2	BR2	113083	6.85	SG2500U	0.61	HEC V1500 v1001	0.39	Yes
Wendel Depot	WD_1,WD_2	113085	15	SG125HV	0.25	SG2500U	0.75	No
Adams	AD_1,AD_2	113086	20.8	SG60KU	0.53	SG2500U	0.47	No
Bear Swamp	BS	113087	2.7	SG125HV	1.00	N/A		
Pondville 1	PNDV1	113364	2.5	SG2500U	1.00	N/A		
Pondville 2	PNDV2	113365	2.5	SG2500U	1.00	N/A		
Treasure Valley	TV	113368	4.2	SG2500U	1.00	N/A		
Litchfield St	LFS	113381	5	PE HEC V1500 v1001	0.5	SG2500U	0.5	Yes
E. Webster St 1	EWS1	113386	2.5	PE HEC V1500 v1001	1.00	N/A		
North Oxford 2	NO2	113388	4	PE HEC V1500 v1001	0.72	SC2500	0.28	Yes
Snow St	SS2	113389	7	PE HEC V1500 v1001	1.00	N/A		
Charlton	CT	113390	22.5	SG125HV	1.00	N/A		
E. Webster St 2	EWS2	113391	2.5	PE HEC V1500 v1001	1.00	N/A		
E. Westminster 1	EWM1	113394	5	SG60KU	1.00	N/A		
E. Winchendon	EWD	113395	20	PE HEC V1500 v1001	0.75	SC2500	0.25	Yes
Crystal Lake 1	CL1	113396	8.5	SG60KU	1.00	N/A		
Crystal Lake 2	CL2	113397	8.5	SG60KU	1.00	N/A		
E. Westminster 2	EWM2	113399	5	SG60KU	1.00	N/A		
Snow St	SS1	113402	8	PE HEC V1500 v1001	1.00	N/A		
North Oxford 1	NO1	113425	2.5	PE HEC V1500 v1001	1.00	N/A		
Ashburnham	ABH	113862	9.5	SG125HV	1.00	N/A		
Westminster	WM	113398	4.4.99	PE HEC V1500 v1001	0.29	SC2500	0.71	Yes

2.4 BPS Connected Wind/Solar Plant Modelling

Electranix used PSCAD plant models developed for previous study efforts to represent in detail the BPS connected plants in the study area. Figure 2.2 below provides relevant details for each of the 5 plants.

Table 2.3: BPS Connected Plant Details

Line	POI Description	MW	Type	Manufacturer
Q679	Peterborough 69 kV, near Monadnock	20	Solar	SMA

Q660	Deerfield - Chestnut Hill 69 kV	20	Solar	SMA
Q686	Adams - Partridge 115 kV	20	Solar	SMA
Q727	Vernon Road 115 kV	50	Solar	TMEIC
Q543	Tuttle Hill 115 kV	28	Wind	Siemens

2.5 Sandy Pond HVDC Modelling

A generic LCC HVDC PSCAD model was used to represent the HVDC link connecting at Sandy Pond because no manufacturer specific PSCAD model was available. Figure 2.2 below depicts the PSCAD model topology of the Sandy Pond inverter station. The following modelling assumptions are a combination of information in the loadflow and typical engineering values:

- Two 12-pulse converter poles in a bipole configuration, rated at +/- 250 kV each.
- A Y-Y and a Y-D transformer feed each of the four 12-pulse converters. On rectifier side, each transformer is rated at 315/212.5 kV, 7.3% impedance on 650 MVA base. On rectifier side, each transformer is rated at 315/172.5 kV, 7.9% impedance on 650 MVA base.
- Two DC conductors, with DC resistance of 15.4 ohms each. One return conductor with DC resistance of 59 ohms.
- In steady state, rectifier is in current control mode, while inverter is in gamma control mode.

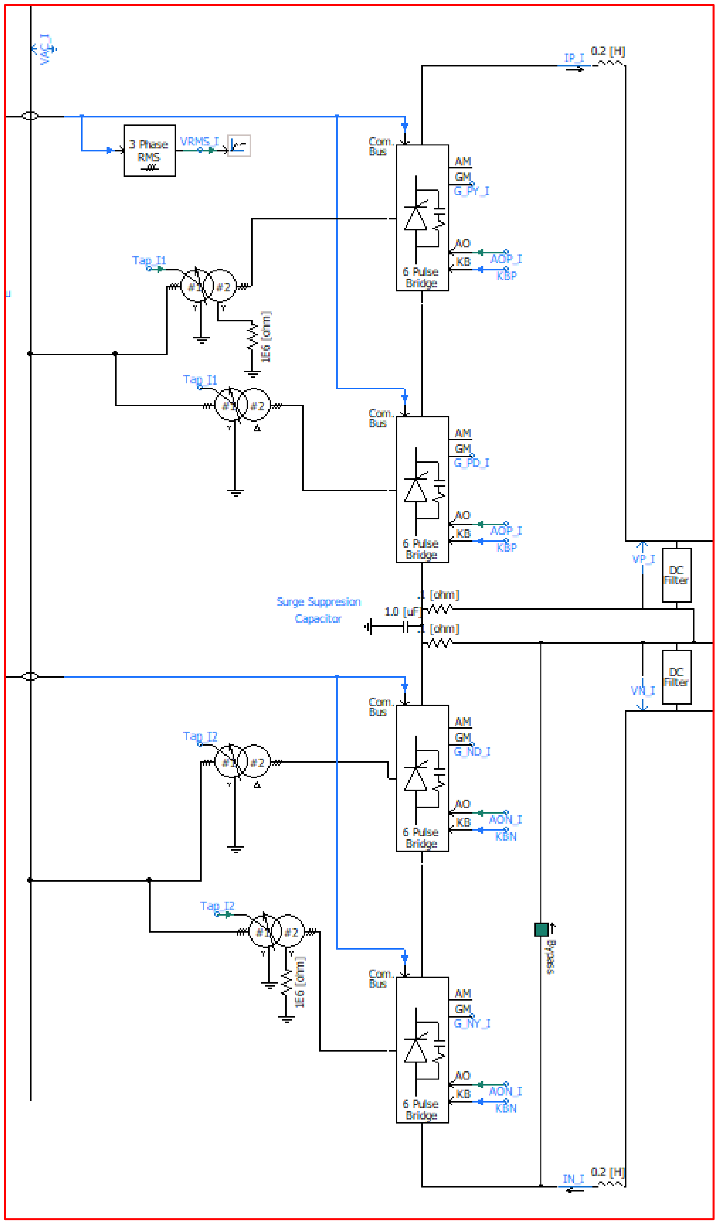

Figure 2.2: *Sandy Pond HVDC PSCAD model topology (inverter station is shown)*

2.6 Distribution Feeder Modelling

An equivalent distribution feeder impedance was calculated for each DER substation based on a combination of assumptions and statistical data. It should be noted that the method of deriving accurate feeder impedances for aggregate DER models is an ongoing industry research topic. The method described below may be improved upon in future studies, and should be validated against explicitly modelled feeders.

The methodology used is as follows:

1. Determine the 'base power' of the feeder by taking the maximum of DER output and peak load at each substation.
2. Approximate how many load / generation connection sites are present the distribution feeder. This was done by dividing the 'base power' by 3.5 MW (using 3.5 MW as a typical connection site feed in / out power amount).
3. Statistical data (normal distribution) on the lengths of distribution network between DER connection locations and the distribution substation transformers was provided by National Grid. A length was selected for each load / generation connection sites based on the data.
4. Assuming that two distribution feeder circuits were present at each substation, the impedance between load/generation connection sites was calculated based on typical impedance per mile of distribution circuit provided by National Grid.
5. The resulting network of impedances was reduced down to a single R, X, B branch using the method described in "WECC Wind Power Plant Power Flow Modeling Guide, May 2008, WECC Wind Generator Modeling Group".

2.7 PSCAD System Modelling

The following two base case data files were provided by National Grid for use in this PSCAD analysis:

- Light Load Power Flow Model: 2023_SLL_EW+DER-group1-new.raw
- Peak Load Power Flow Model: 2023_SUMPK_EW_DG-10.8.raw
- Light Load Dynamics Data: 2023_SUM_PPA.dyr
- Peak Load Dynamics Data: 2023_SUMPK_DG-10.8.dyr

A number of changes were made to the base cases such as re-allocation of DER and re-dispatching various generators. [redacted]

The AC network included in the PSCAD model (i.e. the study area) contains 459 buses, roughly bounded by the following transmission level buses: Vermont Yankee 345 kV, Bellows Falls 115 kV, Greggs 115 kV, Scobie Pond 345 kV, Tewksbury 345 kV, West Medway 345 kV, Agawam 345 kV, Berkshire 345 kV, Bennington 115 kV. Only buses which were deemed pertinent to the accuracy of the PSCAD study were kept in this footprint, as simulation size limitations make it difficult to add significantly more buses.

Transmission lines were represented as Bergeron line models when the travel time across the line is greater than one simulation timestep (automated by E-Tran). Short line sections were represented with PI section line models

2.8 Contingency Modelling

A list of 12 contingencies to apply in the PSCAD analysis was provided by National Grid. The contingencies were all N-1-1 contingencies, [redacted]. Contingencies were modelled using the fault automation (see Figure 2.3) feature of E-Tran. Logic to automate each contingency was included and stored in a database for ease of analysis. Contingency details are provided in Table 2.4 below. Note that three phase and single phase reclosing logic was not modelled for these contingencies.

Table 2.4: PSCAD Contingency List

Initial N-1	Number	N-1-1 Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)
[redacted]	1	[redacted]	NC	230	[redacted]	[redacted]
	2		NC	115		
	3		NC	115		
	4		NC	115		
	5		NC	345		

Initial N-1	Number	N-1-1 Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)
	6	[redacted]	NC	345	[redacted]	[redacted]
	7	[redacted]	NC	345	[redacted]	[redacted]
	8	[redacted]	NC	115	[redacted]	[redacted]
	9	[redacted]	NC	345	[redacted]	[redacted]
	10	[redacted]	NC	345	[redacted]	[redacted]
	11	[redacted]	NC	450	[redacted]	[redacted]
	12	[redacted]	NC	115	[redacted]	[redacted]

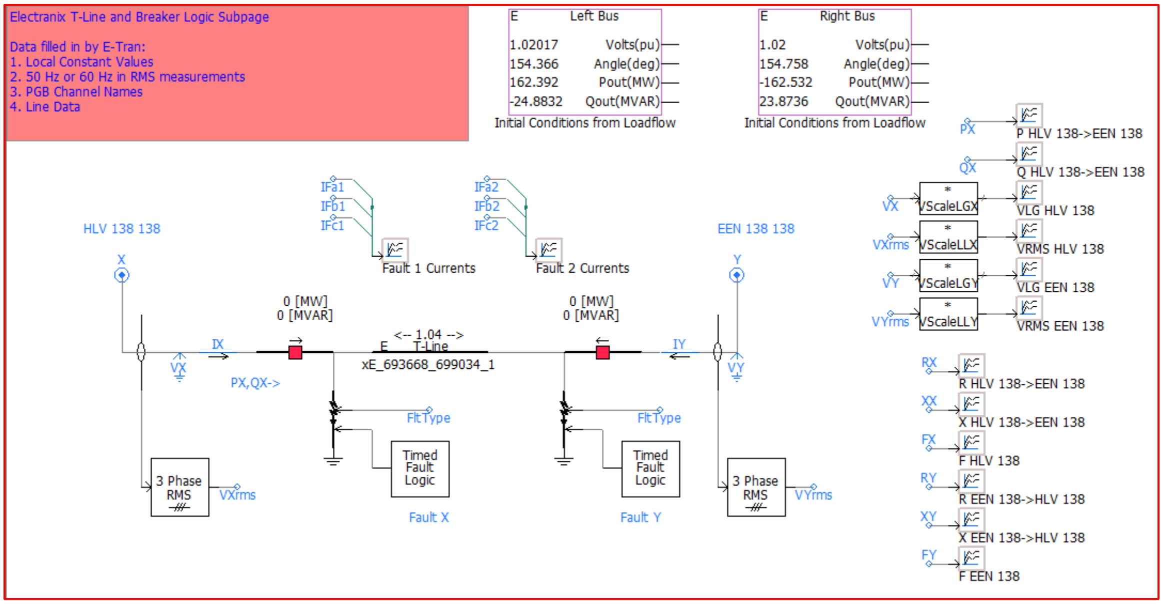

Figure 2.3: 138 kV Transmission Line Model with Faults and Monitoring

2.9 Additional Assumptions

The following additional assumptions were made:

1. Surge Arresters or Metal Oxide Varisters (MOVs) were not modeled in any of the simulations (including line-end, station, and across series capacitors)
2. All the PSCAD simulations were run with a simulation time step of 20 µs in the AC system case. Each individual project parallel case ran with the time step required by the PSCAD model in that case. The PSCAD snapshot feature was not used in the simulations as some models do not support this feature.
3. *Transformer Saturation.* Saturation was modelled on the DER and BPS-connected inverter step-up transformers with typical characteristics. Saturation was not modelled on transmission level transformers.
4. *Conventional Machine Representation.* Conventional machines were represented with the standard library dynamic models (generator, exciter, governor, and stabilizer models) and parameters listed in the PSS/E transient stability data provided by National Grid. E-Tran automatically populates the PSCAD case with these models and parameters when translating from PSS/E. Note that generators using the GENTPJ machine model were represented with the GENSAL model (with matching machine parameters).
5. *Network Equivalent Representation.* A passive network equivalent was used to represent the network not captured in the kept PSCAD case. The network equivalent is auto-generated by E-Tran, and is a multi-port system which is valid for steady state,

fault and open circuit conditions. E-Tran uses the following methodology to create the network equivalent:

a. Read in the complete PSS/E loadflow case (.raw)
b. Form Yfull (admittance matrix) of the entire system.
c. Verify Yfull by computing PQ mismatch (V*conj(V*Yfull)-generator PQ) and checking it is within the PSS/E loadflow convergence limit
d. Calculate Yreduced by performing LDU matrix reduction to reduce the Yfull matrix to the size of the kept system
e. Calculate Ykept which is the admittance matrix of all system elements which are kept and represented in detail in the PSCAD model
f. Calculate Yeq = Yfull-Yreduced (the difference of the entire system and what is modeled in detail is what must go into the system equivalent)
g. Compute the PQ mismatch at all boundary busses of the system equivalent and use this to compute the PQ into the system equivalent (representing remote generation).

6. *Load Modelling.* The real load component was represented as constant current and the imaginary load component as constant admittance. No induction motor load content or other detailed load was modelled.
7. *Device and System Protection.* DER and BPS-connected device protection was included in the manufacturer provided PSCAD models. No protection settings were modelled for conventional machines. System protection relays were not modelled, but fault protection schemes were operated with the breaker clearing times provided by National Grid.

3 Results and Discussion

3.1 Study Results Summary

Table 3.1 provides a summary of contingency-specific study results for the light load case and peak load case. Subsequent sections discuss general observations relating to all contingencies. Table 3.2 contains the comments referred to in Table 3.1.

Table 3.1: Table of Study Results

Case #	Fault Description	Light Load Case	Peak Load Case
		Comment #	Comment #
1	3-phase fault at Pratts Junction - Bear Swamp 230 kV	1, 2, 3, 9	1, 4

Case #	Fault Description	Light Load Case Comment #	Peak Load Case Comment #
[redacted]		1	1
3	3-phase fault at Bear Swamp - Deerfield 115 kV	1	1
4	3-phase fault at N Oxford - Deerfield 115 kV	1, 5, 6	1, 6
[redacted]		1	1
		1	1
[redacted]		1	1, 7
8	1-phase fault at Carpenter Hill 115 kV (BF)	1	1, 8
[redacted]		1	1
[redacted]		1, 9	1
[redacted]		1	1
12	1-phase fault at Bear Swamp 115 kV (BF)	1	1

Table 3.2: Comments referred to in Table of Study Results

Comment Number	Comment
1	DER: No Tripping, Momentary Cessation, or Instabilities Observed.
2	Voltage at Bear Swamp DER dips below 0.85 p.u. for 0.75 seconds during fault and fault recovery.
3	Bear Swamp synch. gens. undergo a 75-degree machine angle swing.
4	Bear Swamp synch. gens. undergo a 35-degree machine angle swing
5	Voltage at North Oxford 1 & 2 DER dropped below 0.2 p.u. during fault.
6	Millennium synch. gens. undergo a 95-degree machine angle swing
7	Post-fault Voltage is sustained below 0.95 p.u. at E. Longmeadow, Wilbraham DERs
8	Post-fault Voltage is sustained below 0.95 p.u. at Snow Street DERs
9	Q660 real power drops as reactive power increases near end of simulation, possibly due to P/Q priority logic.

3.2 Study Results Discussion

3.2.1 DER Performance

Ride-through Performance

No DER tripped, entered momentary cessation, or introduced instabilities during the studied contingencies. DER did prioritize reactive current over real current during some faults, and returned to full real power when the fault cleared. This can be seen in Figure 3.1 below for the DER at Snow Street in response to contingency 4. Note that National Grid's SRD criteria requires DERs to enter into momentary cessation mode when inverter terminal voltage drops below 0.5 pu. This was not observed in the results of this analysis.

A brief investigation into the trip times and current priority of the selected DER inverters was performed, results of which are shown in Table 3.3. The following are highlights from this investigation:

- The protections settings of the SG2500 inverter specifically should be reviewed as they are abnormally permissive.
- The PV V1500 inverter trips at fault clearing when a low voltage (less than 0.15 p.u.) is applied at the inverter terminals. The cause of the tripping is likely not an undervoltage protection setting as the inverter does not trip until fault clearing.
- Two out of the five inverters prioritised reactive current during some over voltage/undervoltage scenarios.
- Some of the trip times below do not adhere to the trip /no trip requirements provided in National Grid's SRD criteria.

Table 3.3: Results of DER inverter trip times and current priority investigation

Inverter	Item	Terminal Voltage (p.u.)			
		0.15	0.5	1.2	1.4
SG2500	Trip Time (s)	2.0	2.0	1.0	1.0
	P injection	0	0	0	0
	Q injection	0	0	0	0
SG125	Trip Time (s)	0.6	3.0	0.25	0.016
	P injection	0	0	0	0
	Q injection	0	0	0	0
SG60	Trip Time (s)	0.63	0.63	0.17	0.02
	P injection	0	0	83%	0
	Q injection	11%	53%	-33%	0
PE V1500	Trip Time (s)	0.016	1.45	1.0	0.07
	P injection	0	33%	100%	130%
	Q injection	0	42%	0%	0%

Inverter	Item	Terminal Voltage (p.u.)			
		0.15	0.5	1.2	1.4
SMCA SC2500	Trip Time (s)	1.1	1.14	0.18	0.17
	P injection	9%	48%	116%	116%
	Q injection	10%	0%	0%	7.60%

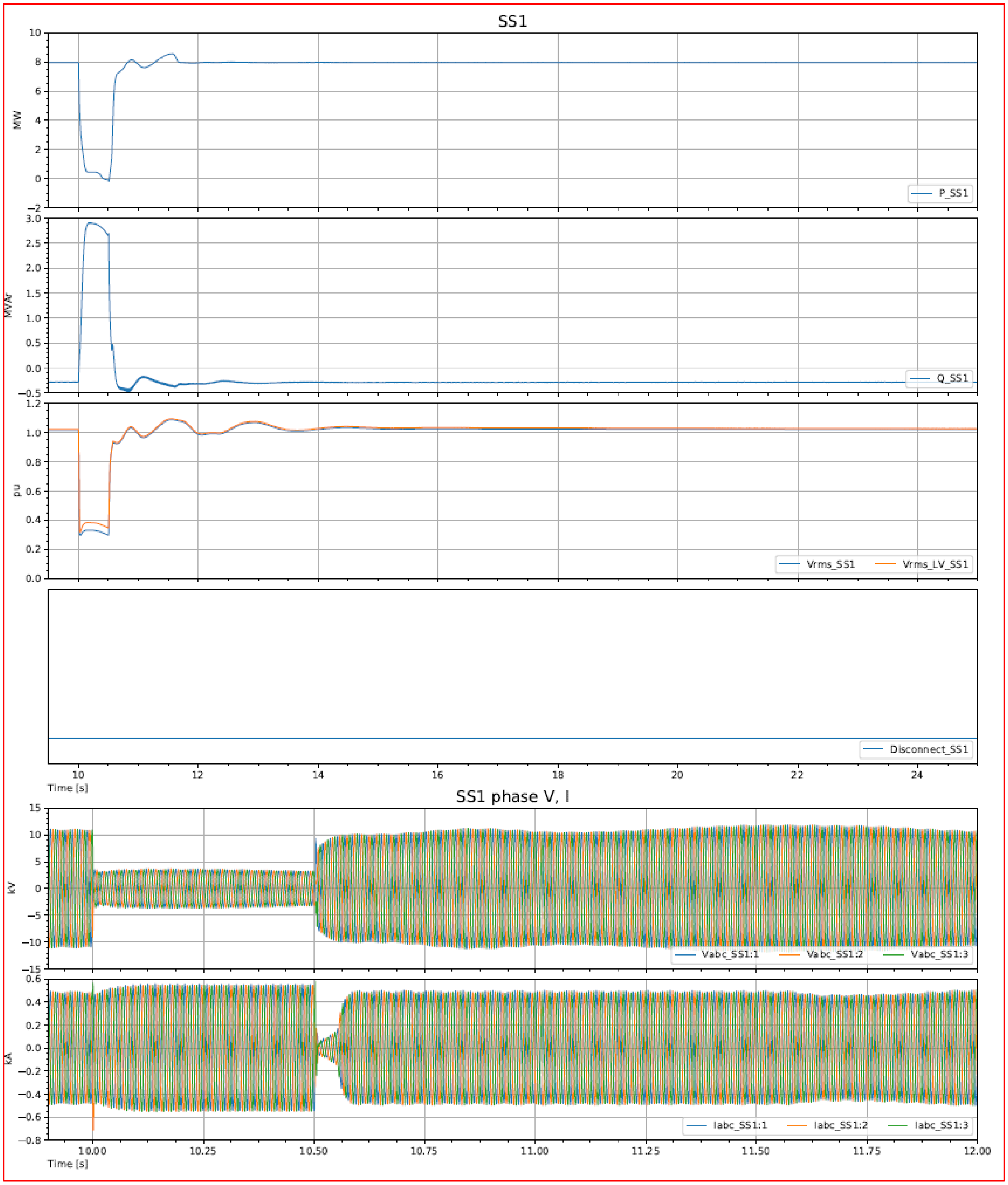

Figure 3.1: Snow Street DER responding to contingency 4 in the light load case. Note the reactive current priority during the fault.

DER voltage distortion

DER stations which use the SG60 inverter (60 kW Sungrow) showed more distortion in phase voltage and current than those using other inverters. The THD levels at these plants was between 5% and 10% at the distribution level in the post-fault state for the light load case. Distortion levels were lower in the peak load case. Note that the distortion noted above may be influenced by incorrect modelling of nearby conventional synchronous generators at Harriman and Vernon.

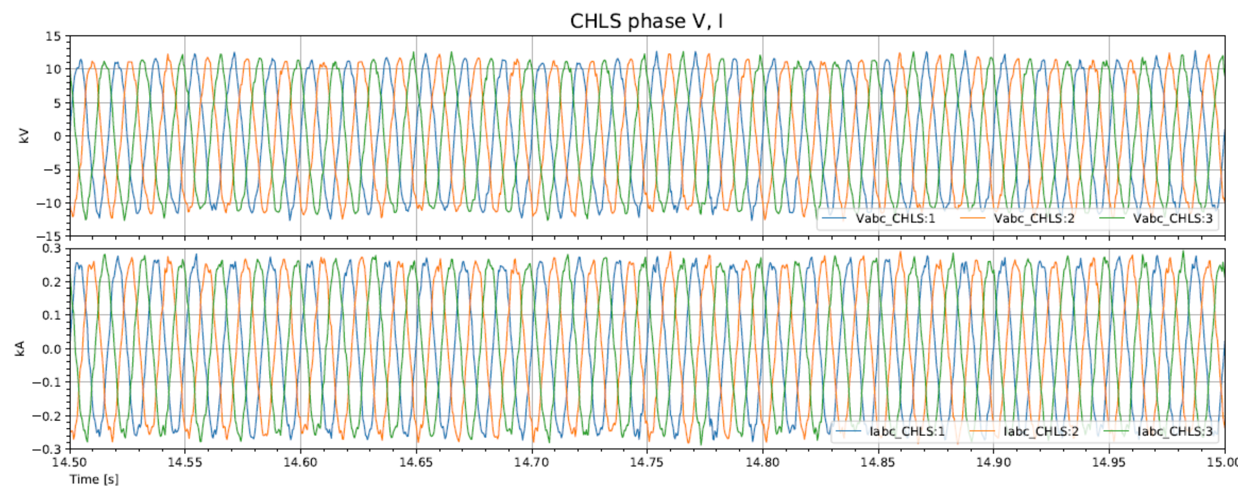

Figure 3.2: Phase voltages and currents at the Chestnut Hill South 13.8 kV bus. Note heavily distorted waveforms.

3.2.2 BPS Connected Plants Performance

None of the BPS connected plants tripped or entered momentary cessation during the studied contingencies. Minor movement in post-fault P and Q can be observed following some contingencies due to slow plant controllers and mode changes.

Q660 voltage distortion

The Q660 plant (20 MW plant connected near Deerfield, made up of SMA inverters) produces a distorted voltage waveform which propagates into the 115 kV system, resulting in THD levels of greater than 3% at Deerfield 115 kV in the light load case. Distortion levels were lower in the peak load case. Figure 3.3 shows a plot of the pre-fault phase voltages at the Q660 69 kV bus. Note that the distortion noted above may be influenced by incorrect modelling of nearby conventional synchronous generators at Harriman and Vernon.

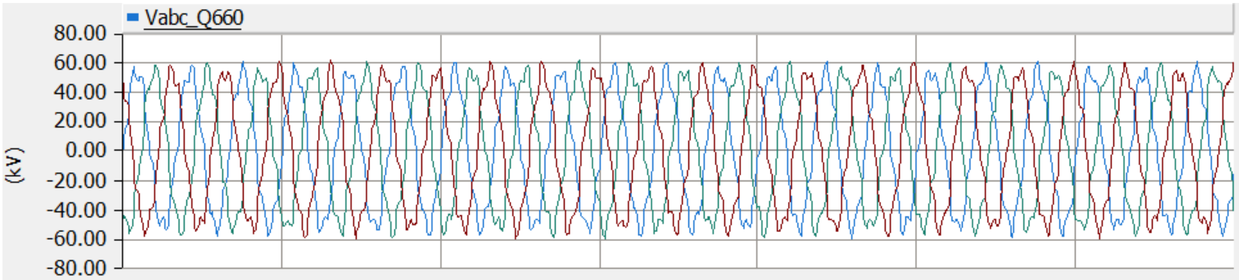

Figure 3.3: Phase voltages at the Q660 69 kV bus in the light load case. Note heavily distorted waveform.

3.2.3 System Oscillations

A 0.8 Hz oscillations was observed on system transmission line real power flows in the pre-fault and post-fault condition, for light load and peak load case. The magnitude of the oscillation was most prominent on the line from Adams to the Bear Swamp tap, where it was 2.1 MW.

To test whether the DER was contributing to this oscillation, a new power flow case was prepared in which all of the DER was disabled. The same 0.8 Hz oscillation was observed without the DER present, with similar oscillation magnitudes. Figure 3.4 shows a comparison of the flow on this line between the two cases.

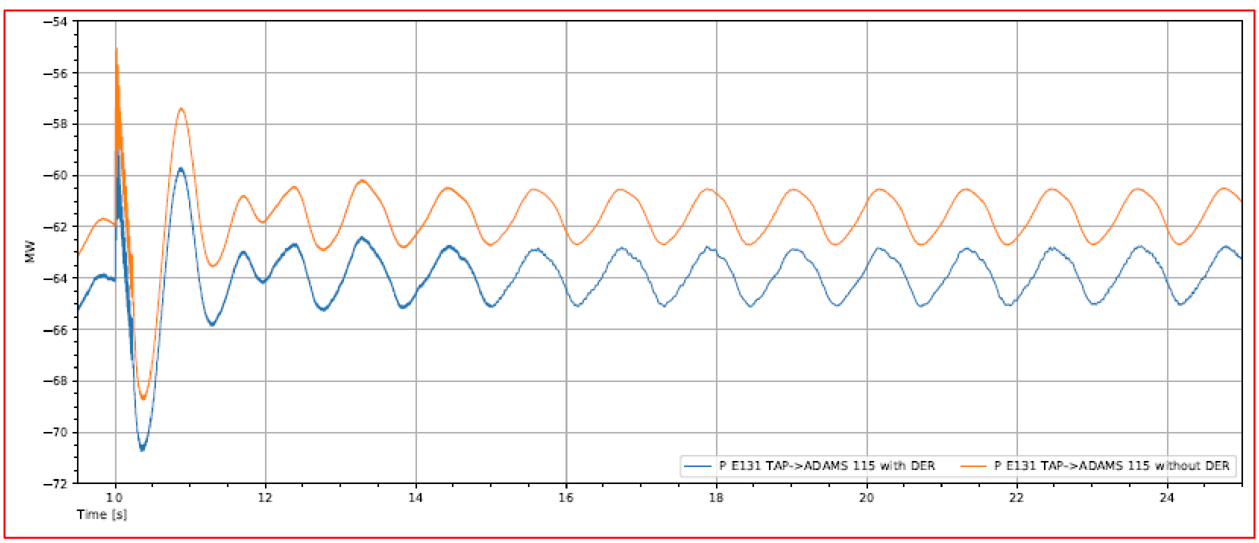

Figure 3.4: Comparison of MW flow on Adams to Bear Swamp 115 kV line with and without DER (light load case)

A 2.5 Hz oscillation was also observed on system transmission line flows in the post-fault state, for the light load case only. This oscillation was most prominent on the line from Deerfield to

Bear Swamp, where it was close to 2 MW in some cases. Figure 3.5 shows this oscillation on the Deerfield – Bear Swamp line for Contingency 11. This 2.5 Hz oscillation was not observed in the DER out-of-service case.

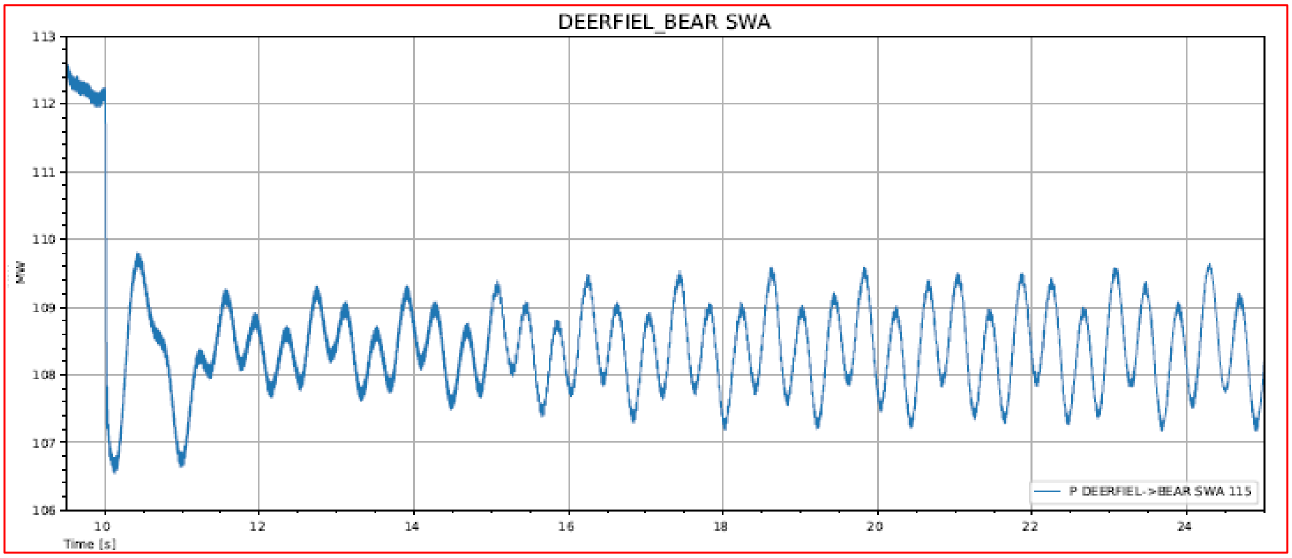

Figure 3.5: MW flow on Deerfield to Bear Swamp 115 kV line (light load case, contingency 11)

Both of the oscillations noted above are influenced by incorrect modelling of nearby conventional synchronous generators at Harriman and Vernon. Correcting the modelling of these generators may eliminate presence of these oscillations for all cases, however this was not thoroughly tested due to schedule restraints.

Both the 0.8 Hz and 2.5 Hz oscillations were nearly eliminated when the dynamics of the synchronous generators at Harriman (13 MW at bus 109504 and 109505) were not released (i.e. machine was represented as source behind impedance), indicating that these machines are significant contributors to the oscillatory mode.

Both the 2.5 Hz and 0.8 Hz have a relatively small impact, but further investigation could be done to isolate the source of the oscillations, and determine which equipment is participating in the various modes.

Available Appendices (Not Attached)
Appendix A – PSCAD Results Traces

This Appendix has been redacted for Critical Energy/Electric Infrastructure Information (CEII).
11/19/2019

This document has been redacted for Confidential Information and Critical Energy/Electric Infrastructure Information.

Transmission System Impact Study Report for Group 2 of Distributed Energy Resource (DER) Additions in Western Massachusetts

May 2020

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1 EXECUTIVE SUMMARY

This document provides the transmission system impact study report for Group 2 of National Grid's Western MA DER interconnection cluster study. Group 2 consists of the second stage of proposed Distributed Energy Resources (DER) additions applying for interconnection into the National Grid distribution system in Western MA. Group 1 of the cluster was approved in November 2019 and consisted of 312 MW of DER in Western Massachusetts. Group 2 consists of an additional 391 MW of DER in Western Massachusetts. This transmission impact study for Group 2 was conducted for the incremental 391 MW of DER. In addition to the 391 MW of Group 2 DER, 27 MW of existing DER will be moved to other substations.

To accommodate the integration of the Group 2 DER, the following new substations are proposed to be built.

- Powder Mill substation – Will be connected to A-127 115 kV transmission Line in Barre MA.
- Lost Town substation – Will be connected to A-127 115 kV transmission Line in Wendell MA
- Whitmanville Substation – Will be connected to I-135 115 kV transmission line in Westminster MA.

An additional new substation will also be built near Stafford St. in Leicester, MA to meet the NPCC dual pilot scheme requirement which will also enable the interconnection of DER in this area.

Study Results:

- All sections of the A-1/B-2 69 kV circuits were found to overload under a variety of different load conditions. These overloads will be resolved with the reconductoring of these circuits.
- Terminal equipment at Deerfield 4, Vernon and Chestnut Hill 69 kV substations demonstrated overloaded buswork and switches. All will be resolved with upgrades of the affected assets.
- Sections of the E-5/F-6 69 kV circuits were found to overload which can be resolved with the addition of a third 69 kV bay at Ware substation.
- There were high voltages observed on the A-1/B-2 69 kV lines at all load levels, resolved by two 16 MVAr DVArs at Otter River 69 kV switching station.
- Additional high voltages were observed on the A-127 115 kV line at Wendell Depot which can be resolved with the addition of a 13 kV reactor a Wendell Depot.

2 INTRODUCTION

This document provides the system impact study for the interconnection of 391 MW of Distributed Energy Resources (DER), greater than 1 MW, into the Western Massachusetts distribution system, owned by National Grid, over the years 2020 to 2023. The 391 MW represents "Group 2" of the Western Massachusetts DER Cluster study, and is incremental to "Group 1" (312 MW), already approved by the NEPOOL Reliability Committee in November 2019, resulting in a total of 703 MW DER proposed for the National Grid distribution system in Western MA. An additional 27 MW of DER, which will be moved to other stations once new stations are built to accommodate the Group 2 DER, was also modeled at 100 % output at all load levels. This brought the total DER to 730 MW for this study.

None of the additional DER will be directly connected to the transmission system. All the DER will be mixed with distribution load. None of the additional DER will control voltage. All DER was set to a power factor of unity in the study.

2.1 Study Objective

The objective of this study was to identify the transmission upgrades, if any, required to integrate the proposed DER without resulting in any significant adverse impact on the reliability, stability, and operating characteristic of the New England bulk power transmission system and National Grid transmission system.

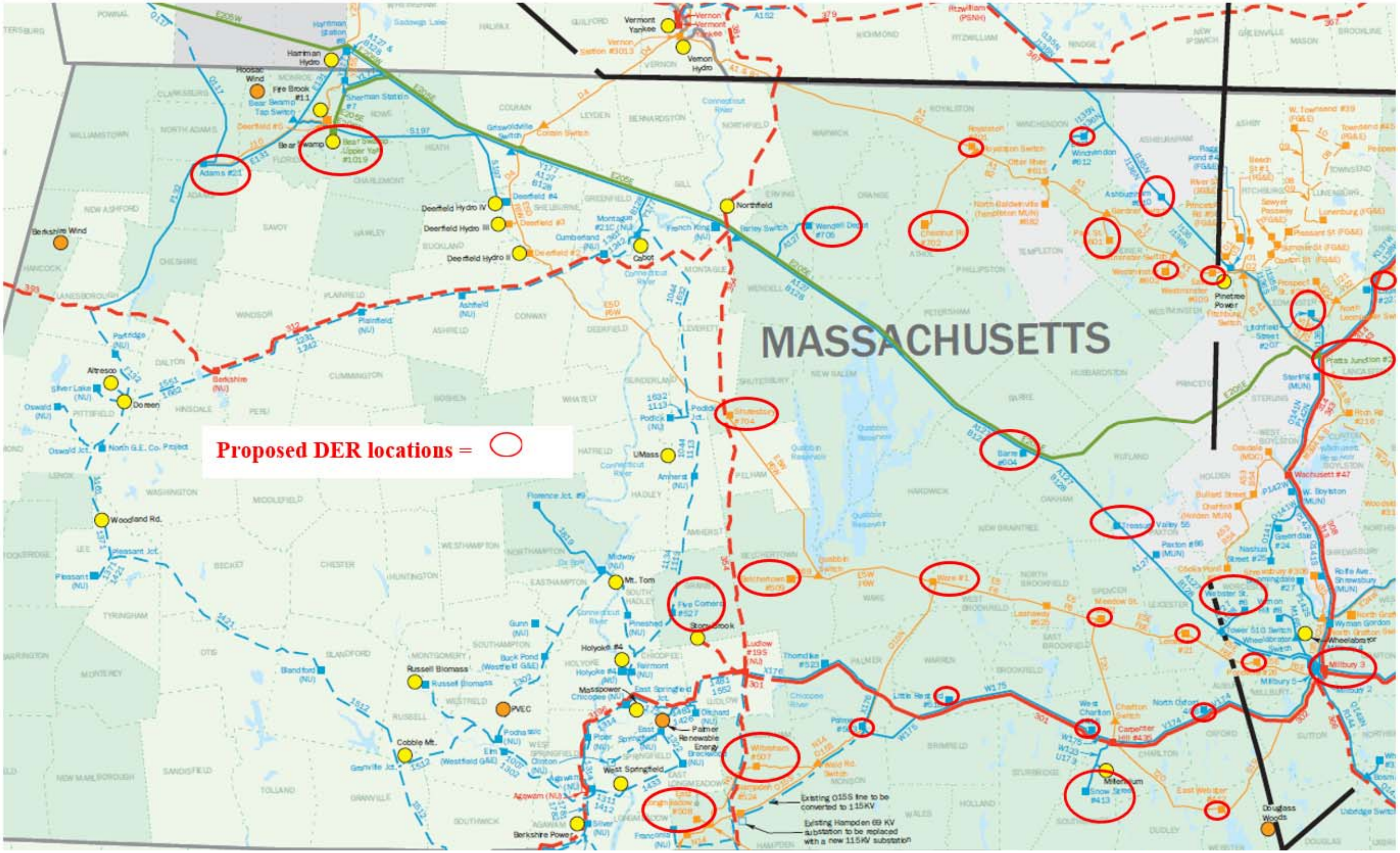
2.2 Project Description

391 MW of DER (>1 MW) have applied to interconnect to the National Grid distribution system in Western MA by 2023.

2.3 Study Area

The transmission system geographic map and one-line diagram of the study area are shown in the following figures, with the DER project locations identified.

Figure 1 - Proposed DER Locations - Geographic Map



[redacted]

3 STUDY APPROACH

DER additions 1 MW and below, did not need to be added to the base cases for this study. The base cases utilized for this study already modeled DER 1 MW and below, via negative loads (with "PD" identifiers) that model the forecasted PV, 1 MW and below, out to year 2022/23. This DER, 1 MW and below, is distributed proportionally across the load busses in Western Massachusetts. Therefore, only DER additions that exceed 1 MW, were added to the cases utilized for this study. All 391 MW associated with Group 2 is greater than 1 MW.

3.1 Group 2 Totals by Substation

The Group 2 total amounts to 391 MW and constitutes the second increment of DER to be studied in Western MA. The DER totals for Group 2 are shown in the following table for each substation.

Table 1 - Group 2 Total DER by Substation

Substation for Group 2	Total KW
Adams Substation	13,273
Bear Swamp Upper Yard Substation	14,958
Belchertown Substation	4,950
Chestnut Hill 702 Substation	1,350
Crystal Lake Substation	30,570
E. Webster Substation	5,370
E. Westminster Substation	10,251
E. Winchendon Substation	25,373
Five Corners Substation	5,650
Lashaway Substation	6,799
Litchfield St Substation	4,999
Little Rest Rd Substation	35,195
Meadow Street 552 Substation	9,399
Millbury Substation	7,702
N. Oxford Substation	8,750
Lost Town Substation-New	14,996
Palmer 503 Substation	3,875
Powder Mill Substation-New	68,664
Royalston Substation	4,990
Shutesbury Substation	19,992
Snow St. Substation	11,373
Stafford St Substation-New	28,873
Thorndike Substation	8,450
Treasure Valley Substation	4,300

Substation for Group 2	Total KW
W. Charlton Substation	1,980
Ware Substation	11,548
Wendell Depot Substation	15,589
Whitmanville Substation-New	8,779
Wilbraham Substation	3,110
Total	**391,108**

Table 2 - Relocation of Existing DER

From Substation	To Substation	KW
Westminster – To Be Retired	Crystal Lake	4720
Chestnut Hill	Lost Town -New	3000
Leicester – To Be Retired	Stafford St -New	10769
N. Oxford	Stafford St -New	5000
Ashburnham	Whitmanville -New	1499
E. Westminster	Whitmanville -New	1497
	Total	**26,485**

The total DER studied for the Western MA Cluster study amounts to 730 MW. This includes Groups 1 and 2 of the Western Massachusetts Cluster, as well as the 27 MW of existing DER being moved (as shown in Table 2). The totals for each substation are shown in the following table.

Table 3 - Total DER by Substation

Substation for Groups 1 + 2	**Total KW**
Adams Substation	34,083
Barre Substation	12,099
Bear Swamp Upper Yard Substation	17,708
Belchertown Substation	17,930
Chestnut Hill 702 Substation	1,350
Crystal Lake Substation	56,762
E. Webster Substation	10,350
E. Westminster Substation	15,231
E. Winchendon Substation	29,273
East Longmeadow Substation	8,990
Five Corners Substation	8,650
Lashaway Substation	30,444
Litchfield St Substation	9,949
Little Rest Rd Substation	47,127
Meadow Street 552 Substation	13,599
Millbury Substation	21,062
N. Oxford Substation	16,458
Lost Town Substation-New	21,272
Palmer 503 Substation	21,205
Powder Mill Substation-New	70,664
Royalston Substation	7,490
Shutesbury Substation	19,992
Snow St. Substation	24,717
Stafford St Substation-New	52,197
Thorndike Substation	20,898
Treasure Valley Substation	8,530
W. Charlton Substation	24,499
Ware Substation	24,820
Wendell Depot Substation	30,559
West Hampden 139 Substation	15,673
Whitmanville Substation-New	26,612
Wilbraham Substation	9,510
Total	**729,703**

3.2 New Distribution Substations

Several new distribution substations will be built to accommodate the interconnection of the Group 2 DER into the Western MA Distribution system:

Powder Mill Substation - A new 115/34.5 kV substation, named "Powder Mill", will be built in Barre MA to accommodate the interconnection of DER in the Barre Area. This substation will be directly connected to the A-127 115 kV line, with no in-line 115 kV breaker.

Lost Town Substation - A new 115/13.8 kV substation, named "Lost Town", will be built in Wendell MA to accommodate the interconnection of DER in the Wendell Area. This substation will be connected to the A-127 115 kV line, with an in-line 115 kV breaker.

[redacted]

No breaker failure transfer trip protection schemes will be installed at the station.

Stafford St Substation – A new 115/13.8 kV substation, named "Stafford St", will be built along the A-127/B-128/Z-126 corridor in Leicester MA, a few spans away from the existing Tower 510 switching structure. [redacted] The 115 kV switches at Tower 510 will be removed once the Stafford St substation is built. The existing Leicester 69/13kV substation will also be removed once the Stafford St substation is built, and all load at the existing Leicester substation will be supplied from the Stafford St substation.

[redacted]

[redacted]

No breaker failure transfer trip protection schemes will be installed at the station.

Note that a substantial amount of DER will be connected to Stafford St substation at the 13.8 kV level.

These three new substations are shown in following one-line diagram.

[redacted]

Whitmanville Substation – A new 115/34.5/13.8 kV substation, along the I-135/J-136 115 kV corridor, near Flagg Pond substation will be built in Westminster MA to accommodate the interconnection of DER in the Westminster MA Area. This substation will be connected to the I-135 115 kV line, with an in-line 115 kV breaker.

Dual step distance protection schemes will be installed between Whitmanville and Flagg Pond substations, and between Whitmanville and Chinook substations. No breaker failure transfer trip protection schemes will be installed at the station.

The existing Westminster substation will be removed upon completion of the new Whitmanville substation.

Figure 4 - New Whitmanville Substation and Removal of Westminster Substation

[redacted]

The impedance and ratings information associated with the four new substations are shown in the table below.

Table 4 - Impedance and Ratings Data for New Substations

Substation	Line	From	To	Length* (miles)	Impedance Date (%) (100 MVA Base)			Ratings (MVA) Summer
					R	X	B	NORM/LTE/STE
Powder Mill	A-127	Powder Mill	Barre	1.1	[redacted]			
	A-127	Powder Mill	Paxton	9.6				
Lost Town	A-127	Lost Town	Barre	16.6				
	A-127	Lost Town	Wendell Depot Tap	3.3				
Whitmanville	I-135	Whitmanville	Flagg Pd	2.6	0.20	1.46	0.20	262/262/262
	I-135	Whitmanville	Ashburnham	3.8	0.27	2.12	0.29	235/290/315
Stafford St	A-127E	Stafford St	Millbury	6.9	[redacted]			
	B-128E	Stafford St	Millbury	6.9				
	A-127W	Stafford St	Paxton	6.6				
	A-127	Stafford St	Treasure Valley	9.4				
	Z-126W	Stafford St	Webster St	2.2				

*All new substations are adjacent to existing Right-Of-Ways, so there is no overall increase in line impedances introduced by these new substations.

The loads that are being moved from existing substations to new substations are shown in the table below.

Table 5 - Load Shifts to New Substations

Substation*	Transformer	*Pre* Peak MW	*Post* Peak MW	Difference	Comments
Ashburnham	TR1	4.984	0.487	-4.497	shift to Whitmanville
Crystal Lake	TR1	13.271	6.880	-6.391	shift from Westminster
	TR2	10.592	22.856	12.264	shift from Westminster
E. Westminster	TR1	6.237	3.580	-2.657	shift to Whitmanville
	TR2	9.292	9.236	-0.056	none
Westminster (to be removed)	TR1	12.770	0.000	-12.770	shift to Whitmanville and Crystal lake
Whitmanville (New)	TR1	0.000	11.206	11.206	shift from Westminster/E Westmistinster/Ashburnham
	TR2	0.000	3.261	3.261	
Leicester (to be removed)	TR1	6.317	0.000	-6.317	shift to Stafford St
	TR2	5.810	0.000	-5.810	shift to Stafford St
Webster St	TR101, TR102, TR103, TR104	80.179	74.871	-5.308	shift to Stafford St
	TR6W1	4.997	0.000	-4.997	Shift to Stafford St
	TR6W2	7.028	0.000	-7.028	shift to Stafford St
Stafford St- (New)	TR1	0.000	24.682	24.682	shifted from Leicester and Webster st
	TR2	0.000	8.741	8.741	shifted from Leicester and Webster st
Chestnut Hill	TR1	12.250	10.040	-2.210	shift load to Lost Town
	TR2	6.660	6.660	0.000	None
Lost Town- (New)	TR1	0.000	2.614	2.614	load shifted from Chestnut hill

*Note that the new “Powder Mill” substation is not included in this table because this substation will not supply distribution load initially when it goes into service. However, there is future load planned to be served from the new Powder Mill substation

3.3 115 kV Breaker and Transformer Additions

North Oxford Substation – A 2nd 115/13.8kV transformer will be installed at the existing North Oxford substation to accommodate the interconnection of the Group 2 DER in the North Oxford Area. A new 115 kV breaker will also be installed, in-line with the V-174 line.

[redacted] One pilot and one step distance protection scheme will be installed between North Oxford and Carpenter Hill substations.

No breaker failure transfer trip protection schemes will be installed at the station.

[redacted]

Little Rest Rd Substation – A 115/34.5 kV transformer, and a 2nd 115/13.2 kV transformer will be installed at the existing Little Rest Road substation to accommodate the interconnection of Group 2 DER in the area. A new 115 kV breaker will also be installed, in-line with the W-175 line.

Dual step distance protection schemes will be installed between Little Rest Rd and Palmer substations, and between Little Rest Rd and Carpenter Hill substations.

No breaker failure transfer trip protection schemes will be installed at the station.

[redacted]

Thorndike Substation – A 2nd 115/13.2 kV transformer will be installed at the existing Thorndike substation to accommodate the interconnection of Group 2 DER in the area. A new 115 kV breaker will also be installed, in-line with the X-176 line.

[redacted] Dual pilot scheme protection scheme will be installed between Thorndike and Palmer substations.

No breaker failure transfer trip protection schemes will be installed at the station.

[redacted]

3.4 Study Assumptions

- DER was dispatched as follows in both the steady state base cases, as well as the stability base cases:
  - o All the new DER in this study, greater than 1 MW, were added to the cases, and dispatched at 100% nameplate, at all load levels. This DER was modeled with negative load[1] at each distribution bus for the substations listed in Table 3. No distribution feeder impedance was assumed.
  - o For the purposes of describing the treatment of existing and forecasted PV in the study, PV was placed into three categories:
    - ▪ All existing Category 1 PV (existing or PPA approved PV facilities greater than or equal to 5 MW) in the 2022/23 base case representation provided by ISO-NE, was dispatched at 100 % output for all load levels.
    - ▪ All existing Category 2 PV (existing PV facilities greater than 1 MW and less than 5 MW) provided by ISO-NE with the 2022/23 base cases, was dispatched at 100 % output at the peak load level only. No Category 2 PV was modeled in the light load and intermediate load cases.
    - ▪ All existing Category 3 PV (Existing facilities less than or equal to 1 MW and all future forecasted solar PV for which locational information is not available) provided by ISO-NE with the 2022/23 base cases, was dispatched at 100 % output at the peak load level only. Note that the "future" solar PV greater than 1 MW and less than 5 MW was carved out of the Category 3 PV to avoid double counting of the new DER for which this study is being conducted. No Category 3 PV was modeled in the light load and intermediate load cases.

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- None of the DER additions were modeled in voltage control mode, since all of the new DER will be mixed with distribution load (i.e. no DER will be installed on dedicated feeders)
- None of the additional DER will be operated in frequency response mode, and therefore the DER additions were modeled accordingly in the stability study.
- No transmission ring busses are required for any DER additions that are mixed with distribution load, or will be mixed with distribution load in the future.
- Starting from the original base cases developed for this study, and prior to testing any contingencies, the new DER was dispatched (at 100% output) against existing (and PPA approved) non-DER generation in Connecticut. This maintained the same transfer levels (pre vs post DER additions) of interfaces relevant to this study (i.e. E-W and NY-NE).
- Treatment of transmission overloads above 100 kV in study:

[1] DER was modeled as generators in the load flow base cases utilized for the stability testing

- For N-0 and N-1 conditions, transmission overloads above 100kV found after dispatching the DER against generation in Connecticut, the DER may be redispatched against existing local non-DER generation in western MA, directly connected to the 115 kV system or above, pre-contingency, to remove such overloads[2].

- For N-1-1 conditions, it was assumed that existing generators, connected directly to the 115 kV system and above, can be redispatched, or tripped, between N-1 and N-1-1 contingencies, to eliminate a post N-1-1 thermal overloads above 100 kV.

- No DER generation can be redispatched between contingencies to eliminate N-1-1 overloaded elements above 100 kV.

* Treatment of transmission overloads below 100 kV in study:

  - For N-0 and N-1 conditions, the new DER can't be dispatched against existing generation directly connected to the 69 kV system to eliminate N-0 or N-1 69 kV overloads.

  - For N-1-1 conditions, it was assumed that any generator directly connected to the 69 kV system in Western MA, and under the control National Grid's control center can be redispatched between N-1 and N-1-1 contingencies to prevent post N-1-1 contingency 69 kV overloads from occurring. Also, Bear Swamp generation/pump can be redispatched between N-1 and N-1-1 contingencies to prevent post N-1-1 contingency 69 kV overloads. Generators that were assumed to be redispatched between contingencies by National Grid operators to prevent post N-1-1 69 kV overloads are shown in the table below.

[2] This is consistent with the Mininum Interconnection Standard (MIS) outlined by FERC Order 2003.

Table 6 - Generators Available for Redispatch To Prevent N-1-1 69 kV Overloads

PSSE Bus number	Generator Name
109296	Sears Wind_E
109297	Sears Wind_W
109403	Drfld East G
109404	Drfld West G
109503	Harriman G3
109504	Harriman G2
109505	Harriman G1
109517	Sears Hydro
109529	Vernon Hyd A
109530	Vernon Hyd B
109531	Vernon Hy T1
109532	Vernon Hy T2
113098	Deerfield 2g
113099	Deerfield 3g
113100	Deerfield G4
113101	Deerfield G5
113102	Fife Brook
113104	Sherman Hyd
113123	Hoosac Clr1
113125	Hoosac Clr2
113138	Vuelta_Gen
113139	Old_Wardour
909528	Vernon Solar
113096	Bearswamp G1
913096	Bearswamp P1
113097	Bearswamp G2
913097	Bearswamp P2

- No DER generation can be redispatched between contingencies to eliminate 69 kV N-1-1 overloaded elements.

- It is assumed that N-1-1 contingencies involving 69 kV double circuit towers, or 69 kV breaker failures will not cause a significant adverse impact outside the local area (i.e. NPCC criteria violation), and therefore were not tested.

- Hydro Generation that is defined as "Daily Cycle Pondage" or "Weekly Cycle" in the CELT report can be ramped up to nameplate capability, according to the ISO-NE Planning Technical Guide, between N-1 and N-1-1 contingencies to prevent post N-1-1 contingency thermal overloads or voltage violations. However, this generation can't be assumed to ramp up between contingencies post Group 2, if ramping up solves N-1-1 voltage or thermal problems that did not exist prior to Group 2 going in-service (Per ISO-NE PP5-6 document, section 3.4: "No Increase in Conditional Dependence").

Table 7 - Hydro Generation Available to Ramp Up between Contingencies

RESOURCE NAME	GEN TYPE ID	PRIM FUEL TYPE	FUEL GEN TYPE DESC	STATE	RSP AREA	NAMEPLATE (MW)	WINTER SCC (MW) Jan 1, 2019	ACTUAL WINTER PEAK SCC (MW) Jan 21, 2019	EXPECTED SUMMER PEAK SCC (MW) JUL 1, 2019
BELLOWS FALLS	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	VT	VT	45.900	47.216	47.216	47.216
COBBLE MOUNTAIN	HW	WAT	HYDRO (WEEKLY CYCLE)	MA	WMA	23.100	27.431	27.431	31.989
DEERFIELD 5	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	MA	WMA	17.550	13.990	13.990	13.965
HARRIMAN	HW	WAT	HYDRO (WEEKLY CYCLE)	VT	WMA	33.600	38.471	38.471	40.798
JACKMAN	HW	WAT	HYDRO (WEEKLY CYCLE)	NH	NH	3.200	3.459	3.459	3.600
DEERFIELD 2 LWR DRFIELD	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	MA	WMA	9.600	18.667	18.667	18.580
SEARSBURG	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	VT	WMA	4.500	4.567	4.567	4.451
SHERMAN	HW	WAT	HYDRO (WEEKLY CYCLE)	MA	WMA	8.100	6.220	6.220	6.154
VERNON	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	VT	WMA	34.560	32.000	32.000	32.000
WILDER	HW	WAT	HYDRO (WEEKLY CYCLE)	VT	VT	35.640	40.674	40.674	40.920
CABOT TURNERS FALLS	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	MA	WMA	61.920	61.800	61.800	61.800
CABOT TURNERS FALLS	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	MA	WMA	6.400	6.400	6.400	6.400

- Pumped Storage Generation in the study area (Northfield and Bear Swamp) can be ramped up to 1/2 nameplate capability (two units at Northfield and 1 unit at Bear Swamp) between N-1 and N-1-1 contingencies to prevent post N-1-1 contingency thermal overloads or voltage violations. Note that this can only be assumed if the units are off or in generating mode in the base case (N-0). If units are in pumping mode in the base case, it cannot be assumed that units can be ramped up into generating mode between contingencies.

- "Smart Capacitor" Control Additions in Western Massachusetts, required for the addition of the Group 1 DER interconnections, were assumed in-service for the Group 2 analysis. These "smart capacitor" controls automatically switch off distribution feeder capacitors during light load and minimum load conditions. These "smart capacitor" automation schemes are itemized in the following table.

Table 8 - "Smart Capacitor" Control Additions in Western Massachusetts

Substation Bus	Feeder Capacitor MVAR
E Winchendon1 13.8	0.6
Crystal Lk1 13.8	2.7
Crystal Lk2 13.8	3.8
E Wstmstr T1 13.8	0.6
E Wstmstr T2 13.8	0.6
E Longmeadow 1 13.2	0.9
N Hampden T1 13.2	1.2
Palmer 13.2	1.5
Wilbraham 13.2	0.3
Lashaway 13.2	1.5
W Charlton 13.2	0.9
Litl Rest Rd 13.2	0.9
Thorndike 13.2	0.8
Treasure Vly 13.8	1.8
Chesnut Hl T1 13.8	1.5
Chesnut Hl T2 13.8	1.2
Total	**20.8**

Presently, in the existing system, the feeder capacitors listed in the preceding table are fixed capacitors; meaning that they are not switched automatically, and are in service all the time unless switched out manually in the field. After the automatic switching schemes are installed, these feeder capacitors will be switched out automatically if the feeder loading becomes less than 45% of peak feeder load. From a loadflow perspective, switching out these capacitors during light load and minimum load conditions was modeled by placing an equivalent amount of MVAR lagging load at each the substation busses listed in the table. These smart capacitor controls will be installed before Group 1 of the DER cluster goes into service. The new smart capacitors will have radios for status monitoring and control. The system operators will have the ability to put the capacitors in manual operation to either open or close as needed.

- The E Winchendon 115 kV Tap line, currently connected to the J-136N line (4/0 Cu), will not be swapped to the I-135 line (795 ACSR), by changing the status of the switches at the ROW (e.g. from normally open to normally closed). For the Group 1 study, it was assumed that the additional DER on the E Winchendon would overload the 4/0 Cu on the J-136N line (Bellows Falls to Flagg Pd). However, this was found not to be the case, and therefore the E Winchendon tap line will be left on the J-136N line.

- H-134 115 kV project (RSP #951) (E Winchendon to Otter River) not in-service (PPA withdrawn)

- All the transmission and generation projects with approved PPA's are included in the base case. Additionally, the following relevant generators in the ISO-NE Interconnection Queue were modeled in the base case. Note that some of these projects that were withdrawn during the course of this study were placed out of service in the base case.

    - QP660 ("Vernon Solar" 20 MW PV unit connecting directly to D-4 69 kV line between Deerfield 4 and Vernon), was assumed to be in-service, and can be tripped between N-1 and N-1-1 contingencies to eliminate any Post N-1-1 thermal or voltage problems. Vernon Solar will maintain a 1.00 pu voltage schedule at its 69 kV point of interconnection, per the requirement of the National Grid New England Control Center.

- QP592 Bear Swamp Unit 1 and 2 Uprate and associated upgrades In-Service
- QP-508 [redacted] HVDC Project Not In-Service (Withdrawn)
- QP-651 [redacted] Phase Shifting Transformer Not In-Service (Withdrawn).
- QP697 (5.97 MW) and QP698 (8.04 MW), both connected at the E Winchendon 13.8 kV, in-service
- QP 535 (Holiday Hill Wind Farm) in-service
- QP 686 ([redacted] – Adams MA, connected to F-132 115 kV line) (Withdrawn)
- QP 797 ([redacted] – Meadow St) in-service
- QP 754 ([redacted] – connected to I-135N 115 kV line) In-service
- QP 779 ([redacted] - Northbridge) In-service (Not relevant for this study)

4 STUDY CRITERIA

This analysis was conducted in accordance with the following criteria.

- NERC Transmission Planning Standards TPL-001-4, "*Transmission System Planning Performance Requirements*",
- Northeast Power Coordinating Council (NPCC) Directory 1, "*Design and Operation of the Bulk Power System*".
- ISO New England Planning Procedure #3 (PP3) – "*Reliability Standards for the New England Area Bulk Power System*".
- ISO New England Planning Procedure #5 (PP5) – "Proposed Plan Application Procedure".
- National Grid Transmission Group Procedure (TGP) #28 – "*Transmission Planning Guide for the National Grid USA Service Company*".

5 STEADY STATE ANALYSIS

The following tables identify the steady state voltage criteria that were applied in the study:

Table 9 - Steady State Voltage Limits

Facility Owner	Voltage Level	Bus Voltage Limits (Per-Unit)	
		Pre-Contingency	Post-Contingency
National Grid	230 kV and above	0.98 to 1.05	0.95 to 1.05
	115 kV and below	0.95 to 1.05	0.90 to 1.05[3]
Eversource	115 kV and above	0.95 to 1.05	0.90 to 1.05 (before system adjustments) 0.95 to 1.05 (after system adjustments)
GMP	115 kV and below	0.95 to 1.05	0.90 to 1.10
VELCO	230 kV and above	0.98 to 1.05	0.95 to 1.05
	115 kV and below	0.95 to 1.05	0.95 to 1.05

Table 10 - Maximum Percent Voltage Variation at Delivery Points

CONDITION	345 & 230 kV (%)	115 kV[1] & Below (%)
Post Contingency & Automatic Actions	5.0	10.0
Switching of Reactive Sources or Motor Starts (All elements in service)	2.0 *	2.5 *
Switching of Reactive Sources or Motor Starts (One element out of service)	4.0 *	5.0 *

* These limits are maximums which do not include frequency of operation. Actual limits were considered on a case-by-case basis and will include consideration of frequency of operation and impact on customer service in the area.

Notes on two preceding Tables:

a. Voltages apply to facilities which are still in-service post-contingency.
b. Site specific operating restrictions may override these ranges.
c. These limits do not apply to automatic voltage regulation settings which may be more stringent.

[3] National Grid Buses that are part of the bulk power system, and other buses deemed critical by Network Operations, shall meet requirements for 345 kV and 230 kV buses

The following table identifies the thermal criteria that was applied in the study.

Table 11 - Thermal Criteria Applied in Study

SYSTEM CONDITION	TIME FRAME	MAXIMUM ALLOWABLE FACILITY LOADING
Pre-contingency (All lines in)	Continuous	Normal Rating
Post-contingency	Less than 15 minutes after contingency occurs	STE Rating
	More than 15 minutes after contingency occurs	LTE Rating

Steady State Solution Parameters

The steady state analysis was performed with pre-contingency solution parameters that allowed adjustment of load tap-changing transformers (LTCs), static VAR devices (SVDs including automatically-switched capacitors. Post-contingency solution parameters were locked, and the area interchange control was disabled. The following table shows the pre- and post-contingency solution parameters that were used in this study.

Table 12 - Steady State Study Solution Parameters

Case	Area Interchange	Transformer LTCs	Phase Angle Regulators	Switched Shunts
Base	Disabled	Stepping	Locked	Regulating
Post Contingency	Disabled	Locked	Locked	Locked

5.2 Steady State Base Case Development

In order to investigate the impact of the proposed projects to the New England transmission system, a total of seven base cases were developed representing various load levels and interface transfer levels.

Study Year Tested

Since Group 2 of the DER will be installed by 2023, the year 2022 and 2023 ISO-NE base cases, released in September 2018, were used for the steady state assessment.

Load Levels Tested

Four load levels were tested for steady state analysis. These cases are based on the loads contained in the CELT 2018 forecast.

1. Summer Peak Load (2023)
2. Shoulder Peak Load (2022)
3. Light Load (2022)

4. Minimum Load (8000 MW)

Interface Transfer Levels Tested

For each of the three load levels – Summer Peak Load, Shoulder Peak Load and Light Load, two base cases were developed for steady state testing:

1. High East to West Stress (3500 MW), with High NE-NY transfers (1200 MW), High Sandy Pond HVDC Import
2. High West to East Stress (3000 MW), with High NY-NE transfers (1600 MW), Low Sandy Pond HVDC Import

For Minimum Load level, one base case was developed for steady state testing.

To test the impact of the DER, both Group 1 and 2 DER were added to each case and dispatched against Millstone 2 in Connecticut. Sensitivity bases cases were also developed at peak load, with all DER in the study area at 26% output (of nameplate). The following tables summarize the interface levels and generation dispatches for the steady state base cases.

Table 13 - Steady State Base Case Summaries

Base Case Load Flows (MW)							
Name	23pk-ew	23pk-we	22sh-ew	22sh-we	22ll-ew	22ll-we	Min-load
Year/Load Level	2023 Summer peak		2022 Shoulder peak		2022 Light Load		2022 Min Load
Bias	East-West	West-East	East-West	West-East	East-West	West-East	
Total Load	23828	23768	18132	17958	12615	12514	9034
Total Losses	824	683	566	562	507	322	222
Total Generation	22988	21453	16775	14866	11046	8978	8962
Scaling Load	31563		16768		11453		7898
Non-Scaling Load	466		465		408		408
DR passive	0		0		0		0
DR active	-479		0		0		0
EE	-4262		0		0		0
Station Service	603	543	590	417	443	344	395
NON CELT LOAD	318		318		318		318
New England Transmission Interface Transfers (MW)							
Sandy Pd HVDC Import	2000	1000	2000	1000	2000	1000	0
E-W	3532	-3001	3514	-3036	3472	-3002	-5
NY-NE	-1210	1628	-1235	1599	-1204	1602	41
North-South	2831	1683	2546	2841	2787	1584	1830
CT Export	-847	-653	-209	-163	-1299	336	-20
Area Generation (MW)							
Northfield (MA) – 1180 MW (Max)	0	1180	-1100	1180.0	-1100	0	0
Bear Swamp 666 MW (Max)	0	666	-666	666	-666	0	0
Altresco (MA) – 164 MW (Max)	0	164	73	164	164	164	0
Cabot Hydro (MA) – 65 MW (Max)	11* (minimum)	65	11* (minimum)	65	11* (minimum)	65	11* (minimum)
Harriman Hydro (VT) – 41 MW (Max)	5* (minimum)	41	5* (minimum)	41	5* (minimum)	41	5* (minimum)
Vernon Hydro (VT) – 32 MW (Max)	5* (minimum)	32	5* (minimum)	32	5* (minimum)	32	5* (minimum)
Vernon Solar	20	20	20	20	20	20	0
Deerfield Hydro 2+3 +4 (20 MW Max)	5* (minimum)	20	5* (minimum)	20	5* (minimum)	20	5* (minimum)
Harrington St Solar (10 MW Max)	10	10	10	10	10	10	10
Warren Solar (Little Rest Rd) (14 MW Max)	14	14	14	14	14	14	14
Treasure Valley Solar (16 Max)	16	16	16	16	16	16	16
Millennium	0	360	361	0	361	360	0
Stony Brook	0	483	0	483	483	483	0
Bellows Fall	49	49	0	49	0	0	0
WMI	45	45	0	0	0	45	0
QP697&QP698 (14MW PV at E. Winchendon)	14	14	14	14	14	14	14

Table 14 - Steady State Base Case Summaries: Sensitivity to DER = 26% Output

Base Case Load Flows (MW)		
Name	23pk-ew-26%	23pk-we-26%
Year/Load Level	2023 Summer peak	
Bias	East-West	West-East
Total Load	24071	24007
Total Losses	806	678
Total Generation	22988	21453
Scaling Load	31563	
Non-Scaling Load	466	
DR passive	0	
DR active	-479	
EE	-4262	
Station Service	603	543
NON CELT LOAD	318	
New England Transmission Interface Transfers (MW)		
Sandy Pd HVDC Import	2000	1000
E-W	3563	-3023
NY-NE	-1153	1645
North-South	2390	1695
CT Export	-640	-298
Area Generation (MW)		
Northfield (MA) – 1180 MW (Max)	0	1180
Bear Swamp 666 MW (Max)	0	666
Altresco (MA) – 164 MW (Max)	0	164
Cabot Hydro (MA) – 65 MW (Max)	11* (minimum)	65
Harriman Hydro (VT) – 41 MW (Max)	5* (minimum)	41
Vernon Hydro (VT) – 32 MW (Max)	5* (minimum)	32
Vernon Solar	20	20
Deerfield Hydro 2+3 +4 (20 MW Max)	5* (minimum)	20
Harrington St Solar (10 MW Max)	10	10
Warren Solar (Little Rest Rd) (14 MW Max)	14	14
Treasure Valley Solar (16 Max)	16	16
Millenium	0	360
Stony Brook	0	483
Bellows Fall	49	49
WMI	45	45
QP697&QP698 (14MW PV at E. Winchendon)	14	14

5.3 Steady State Contingency Analysis

N-1 and N-1-1 contingency conditions were tested in steady state analysis on the load flow base cases with and without the new DER added to the cases.

5.3.1 N-1 Contingency List

The N-1 Contingency list is shown in the table below.

Table 15 - N-1 Steady State Contingency List

CONTINGENCY NAME	kV	DESCRIPTION
HVDC Facilities		
Sandy Pond HVDC Phase II	-	Sandy Pond HVDC Converter – 2000 MW Maximum
345 kV Transmission Lines		
301/302	345	Millbury – Carpenter Hill – Ludlow
308	345	Wachusett – Millbury
312	345	Berkshire – Northfield (Post Alps-Berkshire ETU)
393	345	Alps – Berkshire (Post Alps-Berkshire ETU)
313	345	Wachusett – Millbury
314	345	Sandy Pond – Wachusett
326	345	Scobie – Sandy Pond
320	345	Lake Rd – Card St
343	345	Sandy Pond – Wachusett
354	345	Northfield – Ludlow
367	345	Amherst – Fitzwilliam
3195	345	Amherst – Eagle
380	345	Eagle – Scobie Pd
368	345	Manchester – Card St
379	345	Vernon – Fitzwilliam
381	345	Vernon – Northfield
398	345	Long Mt – Pleasant Valley (NY)
3340	345	Vernon – Vermont Yankee
3381	345	Vernon – Vermont Yankee
345 kV Transformers		
Wachusett T5	345/115	Wachusett Transformer #5
Wachusett T6	345/115	Wachusett Transformer #6
Wachusett T7	345/115	Wachusett Transformer #7
Fitzwilliam T1	345/115	Fitzwilliam Transformer #1
Ludlow T2	345/115	Ludlow Transformer #2
Ludlow T3	345/115	Ludlow Transformer #3
Northfield T1	345/115	Northfield Transformer #1 (post Pittsfield-Greenfield upgrades)
Berkshire T1	345/115	Berkshire Transformer #1
Carpenter Hill T1	345/115	Carpenter Hill Transformer #1
Agawam T1	345/115	Agawam T1
Agawam T2	345/115	Agawam T2
345 kV Breaker Failures		
Berkshire F BF	345	312 + Berkshire Auto (Post Alps-Berkshire ETU)
Berkshire E BF	345	393 + Berkshire Auto (Post Alps-Berkshire ETU)
Alps BF	345	ETU + 393 (Post Alps-Berkshire ETU)
Fitzwilliam 3791 BF	345	379 + Fitz T1
Fitzwilliam 671 BF	345	367 + Fitz T1
Wachusett 7T BF	345	308 + Wachusett T7
Wachusett 6T BF	345	313 + Wachusett T6
Wachusett43-6T BF	345	343 + Wachusett T6
Wachusett 14-7T BF	345	314 + Wachusett T7
Ludlow 1T BF	345	334 + Ludlow T2
Ludlow 2T BF	345	334 + Ludlow T3

CONTINGENCY NAME	kV	DESCRIPTION
Ludlow 3T BF	345	Ludlow T3
Ludlow 4T BF	345	354 + Ludlow T2
Ludlow 5T BF3t19	345	3196 + 354
Ludlow 6T BF	345	3196
Ludlow 7T BF	345	301/302 + Ludlow T2+ Carpenter Hill Auto
Ludlow 8T BF	345	3419 + 301/302 + Ludlow T2+ Carpenter Hill Auto
Ludlow 9T BF	345	3419
Millbury 308+302 BF	345	301/302 + 308
Northfield 2T BF	345	312 + Northfield G1 + G2 (post Pittsfield-Greenfield upgrades)
Northfield 5T BF	345	354 + Northfield G3 + G4 (post Pittsfield-Greenfield upgrades)
Vernon 3TB4-B1 BF	345	381 + Vernon Reactor
Vernon 3TB3-B1 BF	345	379 + 3381
Vernon 3TB1-B1 BF	345	3320 + 3340
Vernon 3TB2-B1 BF	345	340 + Vernon T1
Vermont Yankee 1T	345	Vermont Yankee GSU
Vermont Yankee 381	345	3381 + Vermont Yankee Auto
Vermont Yankee 81-1T	345	3381 + Vermont Yankee GSU
Vermont Yankee 79-40	345	3340 + Vermont Yankee Auto
345 kV Double Ckt Towers		
-	-	-
230 kV Transmission Lines		
E-205E	230	Bear Swamp – Pratts Jct.
E-205W	230	Bear Swamp – Eastover Rd (NY)
38	230	Rotterdam (NY) – Eastover Rd (NY)
230 kV Double Ckt Towers		
-	-	-
230/115 kV Transformers		
Bear Swamp T4	230/115	Bear Swamp Transformer #4
Bear Swamp T5	230/115	Bear Swamp Transformer #5
PrattsJct T8 + T8A	230/115	PrattsJct Transformer #8 + 8A
Eastover Rd T1	230/115	Eastover Rd Transformer #1
Eastover Rd T2	230/115	Eastover Rd Transformer #2
230 kV Breaker Failures		
Bear Swamp 2205E BF	230	Bear Swamp G2 + T4 (230-115 kV) + E-205E
Bear Swamp 2205W BF	230	Bear Swamp G2 + T4 (230-115 kV) + E-205W
Bear Swamp 1205E BF	230	Bear Swamp G1 + T5 (230-115 kV) + E-205E + 115 kV Cap
Bear Swamp 1205W BF	230	Bear Swamp G1 + T5 (230-115 kV) + E-205W + 115 kV Cap
Eastover Rd RE205 BF	230	E-205W + Eastover Rd T1
Eastover Rd RE215 BF	230	E-205W + Eastover Rd T2
Eastover Rd R38 BF	230	38 + Eastover Rd T1
Eastover Rd R48 BF	230	38 + Eastover Rd T2
115 kV Transmission Lines		
1242	115	Montague – Berkshire
1361	115	Montague – Cumberland (post Pittsfield-Greenfield upgrades)
1231	115	Berkshire – Cumberland
1551	115	Doreen – Berkshire
1662	115	Doreen – Berkshire
PV20	115	Plattsburg – South Hero
K6	115	Bennington – Hoosick (NY)
K7	115	Whitehall – Bliss Ville
A-127E	115	Millbury- Webster St – Erving (post Erving substation)
A-127W	115	Erving – Harriman (post Erving substation)
B-128	115	Harriman – Millbury
E-131	115	Bear Swamp – Harriman – Adams
F-132	115	Adams – Doreen
I-135	115	Fitzwilliam – Flagg Pd
I-135S	115	Flagg Pd – PrattsJct
J-136S	115	Flagg Pd – Litchfield Tap – PrattsJct
J-136N	115	Bellows Falls – Flagg Pd
O-141	115	Greendale – Nashua St
O-141N	115	PrattsJct – Wachussett
O-141S	115	Nashua St – Millbury
O-141W	115	Wachusett– Greendale
P-142	115	W Boylston – Rolfe Ave

CONTINGENCY NAME	kV	DESCRIPTION
P-142N	115	PrattsJct – Wachusett
P-142S	115	Rolfe Ave – Millbury
P142W	115	Wachusett – W Boylston
Q-117	115	Adams – Bennington
R-170	115	Palmer – W Hampden
1205	115	W Hampden - Ludlow
1976	115	W Hampden - Scitico
S-197	115	Bear Swamp – Deerfield
V-174W	115	Carpenter Hill – N Oxford
V-174	115	N Oxford – Millbury
W-175	115	Carpenter Hill – Palmer
X-176	115	Palmer – Ludlow
Y-177	115	Harriman – Montague (NU)
Z-126	115	Millbury – Tower 510 – Webster St
115 kV Double Ckt Towers		
1161+1211 DCT	115	1161 + 1211 + 1662
1231+1242 DCT	115	1231 + 1242
1551+1662 DCT	115	1551 + 1662 + 1211
1715+1816 DCT	115	1715 + 1816 + Altresco Gen
A127E+B128 DCT	115	A-127E + B-128 (Millbury – Erving) (post Erving substation)
A127W+B128 DCT	115	A-127W + B-128 (Erving – Harriman) (post Erving substation)
141W+142 DCT	115	O-141W + P-142
O141S+P142 DCT	115	O-141S + P-142
O141N+P142N DCT	115	O-141N + P-142N
O141S+142S DCT	115	O-141S + P-142S
O141W+P142W DCT	115	O-141W + P-142W
I135S+J136S DCT	115	I-135S + J-136S
I135N+J136N DCT		I-135N + J-136N
I135+J136N DCT		I-135 + J-136N
115/69 kV Transformers		
Millbury T1	115/69	Millbury Transformer #1 (56 MVA)
Millbury T2	115/69	Millbury Transformer #2 (56 MVA)
Millbury T3	115/69	Millbury Transformer #3 (45 MVA) + 63 Mvar Cap Bank
Pratts Jct T5 +T6 + T7	115/69	PrattsJct Transformer bank #1
PrattsJct T3+T4	115/69	PrattsJct Transformer bank #2
Deerfield 4 T3 + T4	115/69	Deerfield4 transformer #3 + T4
Adams Autotransformer	115/69	Adams Autotransformer
Bennington T69	115/69	Bennington VT 115-69 kV transformer
Harriman Autotransformer	115/69	Harriman Autotransformer
Palmer Transformer bank #1	115/69	Palmer T3 + T5
Palmer Transformer bank #1	115/69	Palmer T4 + T6
W Hampden T1	115-69	West Hampden T1
115 kV Breaker Failures		
Adams 731 BF	115	E-131 + Q-117 (Post Adams Upgrade)
Adams 217 BF	115	F-132 + Q-117 (Post Adams Upgrade)
Adams T3T BF	115	F-132 + Adams Auto (Post Adams Upgrade)
Adams T5T BF	115	E-131 + Adams Auto (Post Adams Upgrade)
Bear Swamp 131 BF	115	E-131 + Bear Swamp T4 + Bear Swamp GSU #1
Bear Swamp 197 BF	115	S-197 + Bear Swamp T4 + Bear Swamp GSU #1
Bear Swamp T31 BF	115	E-131 + Bear Swamp Fut Xfmr + Bear Swamp 115 kV Cap + Bear Swamp GSU #2 (Post Bear Swamp Upgrade)
Bear Swamp T97 BF	115	S-197 + Bear Swamp Fut Xfmr + Bear Swamp 115 kV Cap + Bear Swamp GSU #2 (Post Bear Swamp Upgrade)
Bennington K4 BF	115	Q-117 + Bennington 115 kV Cap #1
Bennington KT1 BF	115	Bennington Auto + Bennington 115 kV Cap #2
Berkshire 12T BF	115	1551 + Berkshire T2
Berkshire 13T BF	115	1551 + 1231
Berkshire 16T BF	115	1662 +1242
Doreen 6T BF	115	1161 + 1662
Doreen 7T BF	115	1211 + 1662
Doreen 8T BF	115	1211 + 1551
Doreen 9T BF	115	1551 + 1816
Doreen 12T BF	115	1715 + F-132
Erving A BF	115	A-127W + A-127E open ended + Northfield T1
Erving B BF	115	A-127E + A-127W open ended + Northfield T1

CONTINGENCY NAME	kV	DESCRIPTION
Erving C BF	115	A-127E + A-127W + Northfield T1
Harriman A127 BF	115	A-127W + B-128 open ended
Harriman B128 BF	115	A-127W open ended + B-128
Harriman E131 BF	115	E-131 + Y177 open ended + Harriman G1 + G2 +G3
Harriman Y177 BF	115	E-131 open ended + Y177 + Harriman G1 + G2 +G3
Harriman TIE BF	115	A-127W open ended + B-128 open ended + E-131 open ended + Y177 open ended + Harriman G1 + G2 +G3
Montague 1T BF	115	1632 + Cabot Gen
Montague 3T BF	115	1044 + Y-177 open ended
Montague 7T BF	115	1361 + A-127W open ended
Montague 8T BF	115	1361 + 1242
Montague 10T BF	115	1242 + Cabot Gen
PrattsJct O141 BF	115	Pratts T3 + T4 115-69 kV autos + O-141N + Pratts 63 MVAR capacitor
PrattsJct 801 BF	115	Pratts T3 + T4 115-69 kV autos + E-205E + Pratts 63 MVAR capacitor
PrattsJct I135 BF	115	Pratts T3 + T4 115-69 kV autos + I-135S + Pratts 63 MVAR capacitor
PrattsJct 1110 BF	115	Pratts T3 + T4 115-69 kV autos + Pratts 63 MVAR capacitor
PrattsJct P142 BF	115	Pratts T3 + T4 115-69 kV autos + P-142N + Pratts 63 MVAR capacitor
PrattsJct 802 BF	115	Pratts T5 + T6 + T7 115-69 kV autos + E-205E + J-136 (PJ – Litch Tap)
PrattsJct L138 BF	115	Pratts T5 + T6 + T7 115-69 kV autos + L-138 + J-136 (PJ – Litch Tap)
PrattsJct K137 BF	115	Pratts T5 + T6 + T7 115-69 kV autos + K-137 + J-136 (PJ – Litch Tap)
PrattsJct J136 BF	115	Pratts T5 + T6 + T7 115-69 kV autos + J-136S
PrattsJct 2110 BF	115	Pratts T5 + T6 + T7 115-69 kV autos + J-136 (PJ – Litch Tap)
PrattsJct 38-42 BF	115	L-138W + P-142N
PrattsJct 37-41 BF	115	K-137W + O-141N
115 kV Capacitor Banks		
Bear Swamp Cap #1	115	Bear Swamp 50 Mvar Cap Bank (Post Bear Swamp project)
115 kV Line-End Open Contingencies		
1242 Mont-open	115	Montague – Berkshire
1242 Berk-open	115	Montague – Berkshire
1231 Berk-open	115	Berkshire – Cumberland
1231 Cumb-open	115	Berkshire – Cumberland
A-127 Harr-open	115	A-127 (Harriman – Cabot Tap)
A-127 Millb-open	115	A-127 (Millbury – Tower 510)
B-128 Harr-open	115	B-128 (Harriman – Cabot Tap)
B-128 Millb-open	115	B-128 (Millbury – Tower 510)
I135 Flagg-open	115	I-135 (Flagg Pd – Ashburnham)
I-135 Fitz-open	115	I-135 (Fitzwilliam – Ashburnham)
J136S Pratts-open	115	J-136S (PrattsJct – Litchfield St Tap)
J136S Flagg-open	115	J-136S (Flagg Pd – Litchfield St Tap)
O141N Wach-open	115	O-141N (Wachusett – Sterling)
O141N Pratts-open	115	O-141N (PrattsJct – Sterling)
P142N Wach-open	115	P-142N (Wachusett – Sterling)
P142N Pratts-open	115	P-142N (PrattsJct – Sterling)
P142S Milb-open	115	P-142S (Millbury – Wyman Gordon)
P142S Bloom-open	115	P-142S (Rolfe Ave. – Bloomingdale Tap)
P142S Rolfe-open	115	P-142S (Rolfe Ave – Bloomingdale Tap)
E131 Harr-open	115	E-131 (Harriman – Bear Swamp Jct)
E131 Bear-open	115	E-131 (Bear Swamp – Bear Swamp Jct)
E131 Adams-open	115	E-131 (Adams – Bear Swamp Jct)
F132 Doreen-open	115	F-132 (Doreen – Partridere)
W-175 Carp-open	115	W-175 (Carpenter Hill – W Charlton)
W-175 Palm-open	115	W-175 (Palmer – Little Rest Rd)
X-176 Palm-open	115	X-176 (Palmer – Thorndike)
X-176 Ludlow-open	115	X-176 (Ludlow – Thorndike)
115 kV Bus Faults		
Harriman Bus #1	115	A-127 open ended + B128 open ended + GSU # 1 + #2 (Post-Harriman Tie breaker)
Harriman Bus #2	115	E-131 open ended + Y-177 open ended + T3 open ended (Post-Harriman Tie breaker)
Pratts Bus #1	115	
Pratts Bus #2	115	
69 kV Transmission Lines		
A-1	69	Otter River – Chestnut Hill
A-1N	69	Chestnut Hill – Vernon
A-1S	69	PrattsJct – Otter River

CONTINGENCY NAME	kV	DESCRIPTION
B-2N	69	Park St – Vernon
B-2S	69	PrattsJct – Park St (Gardner)
D-4N	69	Vernon – QP660
D-4S	69	QP660- Deerfield 4
E-5	69	Meadow St. – Ware
E-5D	69	ShutESBury – Deerfield 4
E-5E	69	Millbury – Meadow St
E-5W	69	Ware – ShutESBury
F-6	69	Meadow St. – Ware
F-6E	69	Millbury – Meadow St
F-6W	69	Ware – Deerfield 4
J-10	69	Adams – Deerfield 5
M-39	69	Fitch Rd – Wachusett
N-40	69	Fitch Rd – PrattsJct
N-14	69	Palmer – E Longmeadow
O-15N	69	Palmer – Ware
O-15S	69	W hampden - E Longmeadow
Y-25N-1	69	Searsburg – Searsburg Wind
Y-25N-2	69	Bennington – Deerfield Wind
Y-25S	69	Deerfield 5 – Harriman – Searsburg
69 kV Breaker Failures		
Pratts A1S BF	69	A-1S + U-21S + N-40 + open end 69 kV side of Pratts 115/69 kV transformer bank #1
Pratts B2S BF	69	B-2S + V-22S + open 69 kV side of Pratts 115/69 kV transformer bank #2
Pratts 160 BF	69	Pratts 115/69 kV transformer bank #2 + Open end A-1S + N-40 + U-21S
Pratts 260 BF	69	Pratts 115/69 kV transformer bank #2 + Open end B-2S + V-22S
Pratts Tie BF	69	PrattsJct 69 kV busses #1 and #2 (open all lines and transformers at PrattsJct 69 kV)
Pratts U21 BF	69	U-21S + N-40 + open end 69 kV side of Pratts 115/69 kV transformer bank #1 + open end A-1S
Pratts V22 BF	69	V-22S + open end B-2S + open 69 kV side of Pratts 115/69 kV transformer bank #2
Deerfield #4 540	69	E-5D + Deerfield 69 kV bus (open end all other facilities out of Deerfield 69 kV)
Deerfield #4 640	69	F-6W + Deerfield 69 kV bus (open end all other facilities out of Deerfield 69 kV)
Crystal Lake B2S BF	69	B-2S + Crystal Lake T1 (69/13kV)
Crystal Lake B2N BF	69	B-2N + Crystal Lake T2 (69/13kV)
Searsburg Y25 BF	69	Y-25N-1 + Y25S
Deerfield Wind Y25-1 BF	69	Searsburg Wind + Y-25N-1 + Y-25N-2 open ended
Deerfield Wind Y25-2 BF	69	Searsburg Wind + Y-25N-2 + Y-25N-1 open ended
Deerfield Wind Y25-Tie BF	69	Searsburg Wind + Y-25N-1 + Y-25N-2
Adams 360 BF	69	Adams 115/69kV Autotransformer + J-10
Chestnut Hill 230 BF	69	A-1N + A-1 open ended + T2
Chestnut Hill 130 BF	69	A-1 + A-1N open ended + T1
Otter River A1 BF	69	A-1 + A-1S open ended
Otter River A1S BF	69	A-1S + A-1 open ended
Harriman 3810 BF	69	Y-25S + Harriman G3 + Harriman 115/69kV Autotransformer
Vernon A1 BF	69	A-1N + GSU #1
Vernon B2 BF	69	B-2N + D-4 open ended + GSU #2
Vernon D4 BF	69	B-2N + D-4 open ended + GSU #2
Vernon Tie BF	69	All lines (A-1N, B-2N, D-4) open ended + GSU #1 & #2
Bennington Y25 BF	69	Y-25N-2 + Benn 115/69kV Autotransformer + Benn Cap #2
69 kV Line-End Open Contingencies		
A-1 Chest-open	69	Chestnut Hill – Roylston
A-1 Ott-open	69	Royalston – Otter River
A-1S Ott-open	69	Otter River – E Westminster
A-1S Pratts-open	69	E Westminster – PrattsJct
B-2S Park open	69	Park St (Gardner) – Westminster
B-2S Pratts-open	69	E Westminster – PrattsJct
E-5E Mill-open	69	Millbury – Pondville
E-5 Meadow-open	69	Meadow St – Harrington St
E-5W Ware-open	69	Ware - ShutESBury
E-5D Deer4-open	69	Deerfield 4 – Deerfield 3
F-6E Mill-open	69	Millbury - Pondville
F-6 Meadow-open	69	Meadow St. – Lashaway
F-6W Deer4-open	69	Deerfield 4 – Deerfield 3
F-6W Ware-open	69	Ware – Belchertown
Y-25N Sears-open	69	Searsburg – Bennington

CONTINGENCY NAME	kV	DESCRIPTION
Y-25S Deer5-open	69	Deerfield 5 – Harriman – Searsburg
Y-25S Harr-open	69	Deerfield 5 – Harriman – Searsburg
Y-25S Hoos-open	69	Deerfield 5 – Harriman – Searsburg
69 kV Bus Faults		
Pratts Bus #1	69	
Pratts Bus #2	69	
Vernon #1	69	A-1 open ended at Vernon + GSU #1
Vernon #2	69	B-2 and D-4 open ended at Vernon + GSU #2
Deerfield #4	69	All lines open ended at Deerfield 4 (E-5, F-6, D-4)
69 kV Double Ckt Towers		
A1S+B2S	69	
A1S+B2N	69	
A1+B2N	69	
A1N+B2N	69	
E5E+F6E DCT	69	
E5+F6 DCT	69	
E5W+F6W DCT	69	
E5D+F6W DCT	69	
Generators/GSU		
Harriman Hydro (VT)	115/6.9	GSU 1
Harriman Hydro (VT)	115/6.9	GSU 2
Harriman Hydro (VT)	115/6.9	GSU 3
Cabot Hydro (MA)	115/13.8	Cabot GSU
Northfield (MA)	345/13.8	GSU #1 Unit 1 + Unit 2
Northfield (MA)	345/13.8	GSU #2 Unit 3 + Unit 4
Altresco (MA)	115/13.8	Unit 1 + Unit 2
Altresco (MA)	115/13.8	Unit 3 + Unit 4
Vernon Hydro #1 (VT)	69/13.8	GSU #1
Vernon Hydro #2 (VT)	69/13.8	GSU #2
Seabrook	345	
Bear Swamp G1/P1	230 kV	Bear Swamp Generator/Pump #1
Bear Swamp G2/P2	230 kV	Bear Swamp Generator/Pump #2
Millenium GT + ST	115 kV	Millennium Gas Turbine + Steam Turbine Unit

5.3.2 N-1-1 Contingency List

The following table lists the contingencies that was tested as the first line out in N-1-1 contingency analysis. In each line-out case, all contingencies described in previous section was tested as the second contingency.

Table 16 - N-1-1 Contingency List

Initial facility out (N-1), one at a time	Second Contingency (N-1-1)
Each transmission circuit (69 kV and above) tested in N-1 analysis Each transmission transformer (115/69 kV and above) tested in N-1 analysis Loss of Seabrook G1 Loss of Sandy Pond HVDC Pole 1 Loss of Sandy Pond HVDC Pole 2 Shunt Device	All contingencies listed in Table 15 except: 115 kV Double Circuit Towers 115kV Breaker Failures 69 kV Double Circuit Towers 69 kV Breaker Failures 69 kV Bus sections

5.4 Steady State Results

5.4.1 N-0 Thermal and Voltage Results

N-0 Thermal Results

Simulation results indicate that addition of the Group 2 DER, on top of the Group 1 DER, results in several transmission facility overloads during all-lines-in conditions as shown in table below.

Table 17 - N-0 Thermal Overloads

Worst case Loading at or above 100% of LTE Rating				Base case
Overloaded Facility	KV	LTE Rating (MVA)	Loading (% LTE)	
B-2 [Pratts Jct – E Westminster] (2/0 Cu O/H line)	69	43	160	22sh-we

N-0 Voltage Results

No N-0 voltage violations were found for any of the conditions tested.

5.4.2 N-1 Thermal and Voltage Results

N-1 Thermal Results

Simulation results indicate that addition of the Group 2 DER, on top of the Group 1 DER, results in several transmission facility overloads following N-1 contingencies as shown in table below.

Table 18 - N-1 Thermal Overloads

Worst case Loading at or above 100% of LTE Rating				Base case	CONTINGENCY (Loss of)
Overloaded Facility	**KV**	**LTE Rating (MVA)**	**Loading (% LTE)**		
B-2 [Pratts Jct – E Westminster] (2/0 Cu O/H line)	69	53	144	22sh-we	A-1S 69 kV line (Pratts – Otter River)
B-2 [Crystal Lake – Vernon] (2/0 Cu O/H line)	69	53	114	22-min	Pratts 69 kV tie breaker failure
A-1 [Otter River - Royalston] (2/0 Cu O/H line)	69	43	126	23pk-we	Pratts 69 kV 260 breaker failure
D-4 [Vernon Solar -Deerfield 4] (336 ACSR O/H line)	69	82	124	22LL-WE	Pratts 69 kV tie breaker failure
E-5 [Meadow St – Harrington St] (477 ACSR)	69	98	113	22sh-we	Ware 69 kV 612 Breaker Failure
E-5 [Harrington St - Lashaway] (477 ACSR)	69	98	105	22sh-we	Ware 69 kV 612 Breaker Failure
F-6 [Harrington St - Lashaway] (477 ACSR)	69	98	107	22sh-we	Ware 69 kV 512 Breaker Failure

N-1 Voltage Results

Simulation results indicate that the addition of the Group 2 DER, on top of the Group 1 DER, results in several high voltage conditions following N-1 contingencies as shown in table below.

Table 19 - N-1 Voltage Violations

BUSSES W/ VOLTAGE VIOLATIONS		Voltage	BASE CASE	CONTINGENCY
Bus	KV	Pu		(Loss of)
E Westminster (B2)	69	1.09	22sh-ew	Pratts 69 kV tie breaker failure
Crystal Lake (B2)	69	1.09	22sh-ew	Pratts 69 kV tie breaker failure
[redacted])	115	1.051	22-min	[redacted]

Appendix D provides the full N-0 and N-1 thermal and steady state voltage results.

5.4.3 N-1-1 Thermal and Voltage Results

N-1-1 Thermal Results For 69 Kv Facilities as The First Facility Out

N-1-1 simulations were first run for 69 kV facilities taken out of service, one at a time, followed by all second contingencies. During these simulations, only 69 kV connected generation, and Bear Swamp, were allowed to be redispatched in between contingencies to eliminate post N-1-1 contingency overloads. This methodology accurately reflects how the 69 kV transmission system in Western MA is secured for N-1-1 contingencies involving 69 kV facilities as the first contingency. All "smart capacitors" discussed in the previous section were assumed in-service (i.e. feeder capacitors turned off automatically) at minimum load and light load conditions.

Simulation results indicates that the addition of Group 2 DER causes the following transmission facilities overload for N-1-1 conditions, with the first contingency consisting of a 69 kV facility.

- All sections of A1/B2 69 kV circuits (approximately 110 circuit miles total) were found to overload (up to 180% of respective summer LTE ratings) for various N-1-1 contingencies, for various load conditions. Terminal equipment at some substations are overloaded as well.

Full N-1-1 thermal results can be seen in the following table.

Table 20 - N-1-1 Thermal Results for first contingencies only involving 69 kV facilities

Monitored Facility	22ll-ew-pump		22ll-we		22sh-ew-pump		22sh-we		23pk-ew		23pk-we+		22min	
	N-2 % of LTE	N-1-1 % of LTE	N-2 % of LTE	N-1-1 % of LTE	N-2 % of LTE	N-1-1 % of LTE	N-2 % of LTE	N-1-1 % of LTE	N-2 % of LTE	N-1-1 % of LTE	N-2 % of LTE	N-1-1 % of LTE	N-2 % of LTE	N-1-1 % of LTE
113330 E WSTNSTR_B2 69.0 113346 PRATTS JCT 69.0 1	116.92	114.58	159.39	145.5	99.65	99.54	178.62	148.91					112.34	105.64
113330 E.WESTMIN B2 69.0 113346 PRATTS JCT 69.0 1									100.48	100.32	178.07	148.11		
113032 N BLDWNVL_A1 69.0 113038 ROYALSTON 69.0 1	103.38	103.29	144.38	131.87			168.9	139.11			168.06	137.78	95.61	93.73
113342 CRYSTAL LAKE 69.0 113352 WESTMNSTR_B2 69.0 1	103.24	103.14	144.21	131.71			168.74	138.97					95.5	93.58
113330 E WSTNSTR_B2 69.0 113352 WESTMNSTR_B2 69.0 1											167.9	137.62		
113330 E.WESTMIN B2 69.0 113352 WESTMNSTR_B2 69.0 1			127.18	102.13			143.61	115.92			151.66	124.13		
113329 E WSTNSTR_A1 69.0 113346 PRATTS JCT 69.0 1	113	106.05	98.5	99.11	111.25	99.92	91.88	43.95	121.66	113.85	95.25	47.97	108.33	109.07
113055 N BLDWNVL_B2 69.0 113342 CRYSTAL LAKE 69.0 1			94.72	88.35			126.48	109.27			122.07	90.11		
109528 VERNON VT 69.0 113055 N BLDWNVL_B2 69.0 1	112.93	105.94	98.32	98.58	111.2	99.84	92.43	44.74			95.81	48.8	108.19	108.92
113032 N BLDWNVL_A1 69.0 113351 WESTMNSTR_A1 69.0 1			91.45	88.65			148.8	101.68			140.03	99.95		
113329 E WSTNSTR_A1 69.0 113351 WESTMNSTR_A1 69.0 1	116.92	114.58	159.39	145.5	99.65	99.54	178.62	148.91					112.34	105.64
113038 ROYALSTON 69.0 113041 CHESNUT HILL 69.0 1									100.48	100.32	178.07	148.11		
109528 VERNON VT 69.0 113041 CHESNUT HILL 69.0 1	103.38	103.29	144.38	131.87			168.9	139.11			168.06	137.78	95.61	93.73

N-1-1 Voltage Results for 69 kV Facilities as the first Facility out

Simulation results indicate that the addition of Group 2 DER causes the following transmission substations to experience voltage violations for N-1-1 conditions, with the first contingency consisting of a 69 kV facility.

- High voltages (>1.05 pu) can occur all along the A-1/B-2 69 kV lines at all load levels, for several different N-1-1 contingency combinations. These high voltages can exceed 1.09 pu.
- As seen during the Group 1 analysis, high voltages (>1.05 pu) can occur along the F-6 69 kV line at Deerfield 2 substation for loss of the O-15N 69 kV line following by the F-6W 69 kV breaker open contingency at Deerfield 4. This high voltage problem can be eliminated by ramping down existing synchronous generation at Deerfield 2 and 3 between contingencies.

Full N-1-1 voltage results for 69 kV facilities as the first line out are provided in the following table.

Table 21 - N-1-1 Voltage Results for first contingencies only involving 69 kV facilities

Monitored Facility	22ll-ew-pump		22ll-we		22sh-ew-pump		22sh-we		23pk-ew		23pk-we+		22min	
	Base V	Cont V	Base V	Cont V	Base V	Cont V	Base V	Cont V	Base V	Cont V	Base V	Cont V	Base V	Cont V
E.WESTMIN B2									1.0232	1.0943			1.0185	1.0933
E WSTNSTR_B2	1.0077	1.0508	1.0201	0.6478	1.0211	1.0937	1.0119	1.0928			1.0113	1.0549		
WSTMNSTR MA	1.0106	0.9456	1.025	0.9131	1.0257	1.0925	1.0174	1.0915	1.028	1.0929	1.015	1.0537	1.0234	1.092
WESTMNSTR_B2	1.0106	0.937	1.025	0.6466	1.0257	1.0925	1.0174	1.0915	1.028	1.0929	1.015	1.0537	1.0234	1.092
CRYSTAL LAKE	1.0212	0.9492	1.043	1.0549	1.051	1.0896	1.0419	1.0885	1.0548	1.0896	1.0239	1.051	1.0514	1.0889
N BLDWNVL_B2	1.0176	0.9428	1.0431	1.055	1.0511	1.0693	1.042	1.0684	1.0549	1.0681			1.0515	1.0674
VERNON VT	1.0005	0.9495	1.0215	0.9494	0.9959	0.9467			1	1.0632				
E WSTNSTR_A1	0.9933	0.9434	1.0082	1.0591	0.9894	0.9345	0.9752	0.933			0.9868	0.9474		
WESTMNSTR_A1	0.993	0.9456	1.0087	1.0581	0.9889	0.9367	0.9738	0.9354	0.9922	0.9342	0.9853	0.9496	0.984	0.9359
CHESNUT HILL	0.9902	0.9499	1.0112	0.9431	0.9868	0.9486	0.9683	0.9493	0.9948	1.0547				
OTTER RIVER	0.9916	0.9413	1.0104	1.0541	0.9871	0.9446	0.9698	0.9438	0.9926	0.9456			0.9817	0.9472
N BLDWNVL_A1	0.9916	0.9413	1.0104	1.0541	0.9871	0.9446	0.9698	0.9438	0.9926	0.9456			0.9817	0.9472
ROYALSTON	0.9925	0.9489	1.0123	1.0528	0.9884	0.9405								
DEERFLD 3_F6	0.992	0.9499	1.0241	1.0521	0.9927	0.9479								
DEERFLD 2_F6	0.9926	0.9496	1.0255	1.0521	0.9928	0.9499								
DEERFIELD 2	0.9926	0.9496	1.0255	1.0521	0.9928	0.95								

N-1-1 Thermal results for 345, 115, and 230 kV facilities as the first facility out

N-1-1 simulations were then run for all 345 kV, 115 kV, and 230 kV facilities taken out of service as the first contingency, one at a time, followed by all second contingencies. During these simulations, all generation in the study area, including generation connected to the 69 kV transmission system, was allowed to be redispatched in between contingencies to eliminate post N-1-1 contingency overloads, including 69 kV overloads. This assumption reflects the fact that the National Grid Control Center will attempt to secure the 69 kV transmission system prior to the second contingency, after any 345, 230, or 115 kV facility is lost. All “smart capacitors” discussed in the previous section were assumed in-service (i.e. feeder capacitors turned off automatically) at minimum load and light load conditions.

No additional N-1-1 overloads, over and above those identified for 69 kV facilities as the first facility out, were found for this analysis. Full N-1-1 thermal results for 345, 230, and 115 kV facilities as the first line out are provided in the following table.

Table 22 - N-1-1 Thermal Results for First Contingencies Involving 345, 230 and 115 kV Facilities

Monitored Facility	22ll-ew-pump		22ll-we		22sh-ew-pump		22sh-we		23pk-ew		23pk-we+		22min	
	N-2 % of LTE	N-1-1 % of LTE	N-2 % of LTE	N-1-1 % of LTE	N-2 % of LTE	N-1-1 % of LTE	N-2 % of LTE	N-1-1 % of LTE	N-2 % of LTE	N-1-1 % of LTE	N-2 % of LTE	N-1-1 % of LTE	N-2 % of LTE	N-1-1 % of LTE
113330 E WSTNSTR_B2 69.0 113346 PRATTS JCT 69.0 1	116.92	114.58	159.39	145.5	99.65	99.54	178.62	148.91					112.34	105.64
113330 E.WESTMIN B2 69.0 113346 PRATTS JCT 69.0 1									100.48	100.32	178.07	148.11		
113342 CRYSTAL LAKE 69.0 113352 WESTMNSTR_B2 69.0 1	103.38	103.29	144.38	131.87			168.9	139.11			168.06	137.78	95.61	93.73
113330 E WSTNSTR_B2 69.0 113352 WESTMNSTR_B2 69.0 1	103.24	103.14	144.21	131.71			168.74	138.97					95.5	93.58
113330 E.WESTMIN B2 69.0 113352 WESTMNSTR_B2 69.0 1											167.9	137.62		
113032 N BLDWNVL_A1 69.0 113038 ROYALSTON 69.0 1			127.18	102.13			143.61	115.92			151.66	124.13		
113055 N BLDWNVL_B2 69.0 113342 CRYSTAL LAKE 69.0 1	113	106.05	98.5	99.11	111.25	99.92	91.88	43.95	121.66	113.85	95.25	47.97	108.33	109.07
107440 NE_PV20_NY 115 147852 PLAT T#3 115 1			94.72	88.35			126.48	109.27			122.07	90.11		
109528 VERNON VT 69.0 113055 N BLDWNVL_B2 69.0 1	112.93	105.94	98.32	98.58	111.2	99.84	92.43	44.74			95.81	48.8	108.19	108.92
116356 WOODLAND 115 116360 PLEASANT 115 1			91.45	88.65			148.8	101.68			140.03	99.95		

N-1-1 Voltage results for 345, 115, and 230 kV facilities as the first facility out

No additional N-1-1 voltage violations, over and above those identified for 69 kV facilities as the first facility out, were found for this analysis.

Full N-1-1 voltage results for 345, 230, and 115 kV facilities as the first line out are provided in the following table.

Table 23 - N-1-1 Voltage Results for First Contingencies 345, 230 and 115 kV Facilities

Monitored Facility	22ll-ew-pump		22ll-we		22sh-ew-pump		22sh-we		23pk-ew		23pk-we+		22min	
	Base V	Cont V	Base V	Cont V	Base V	Cont V	Base V	Cont V	Base V	Cont V	Base V	Cont V	Base V	Cont V
E.WESTMIN B2											1.0249	1.0947	1.0232	1.0935
E WSTNSTR_B2	1.0064	1.0508	1.016	1.0549			1.0254	1.0937	1.0146	1.0928				
WSTMNSTR MA			1.0193	1.0537			1.0289	1.0924	1.0196	1.0915	1.0294	1.0933	1.0275	1.092
WESTMNSTR_B2			1.0193	1.0537			1.0289	1.0924	1.0196	1.0915	1.0294	1.0933	1.0275	1.092
CRYSTAL LAKE	1.0092	0.9478	1.0283	1.051	1.0415	1.052	1.038	1.0895	1.0325	1.0885	1.04	1.0899	1.0388	1.0889
N BLDWNVL_B2	0.9994	0.9283					1.03	1.0692	1.0267	1.0684	1.0323	1.0682	1.0316	1.0674

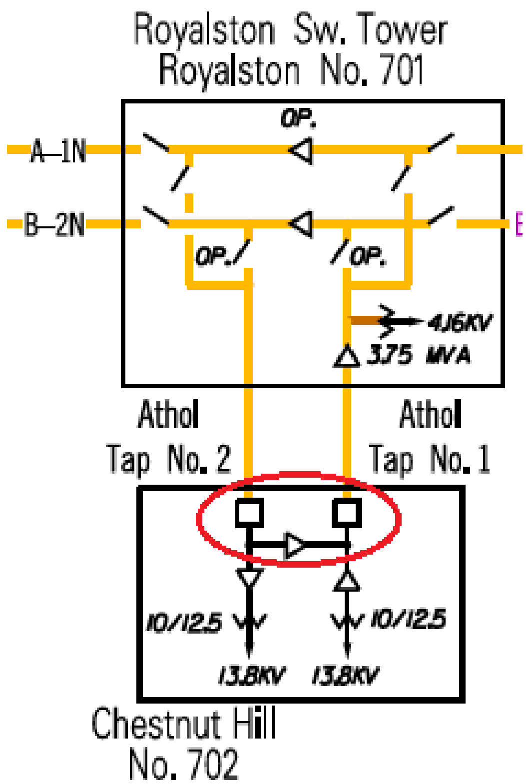
5.5 Proposed Transmission Upgrades

- **A1/B2 line rebuild/reconductor:** The thermal overloads on the A1/B2 69 kV transmission lines themselves will be eliminated following the refurbishment of both lines due to asset condition with the inclusion of a 795 ACSS conductor.

- **Vernon 69 kV substation rebuild**: 69 kV equipment at Vernon substation must be upgraded to eliminate overloads on the A-1N and B-2N 69 kV circuits (in addition to the line reconductorings). There is an asset condition project already planned for Vernon station which will eliminate the overloads.

- **Chestnut Hill 69 kV substation upgrades**: 69 kV equipment at Chestnut substation must be upgraded to eliminate overloads on the A-1N 69 kV circuit (Vernon – Chestnut Hill) and A-1 69 kV circuit (Chestnut Hill – Otter River), in addition to the A-1 line reconductoring. The diagram below shows the substation equipment that needs to be upgraded. There is an asset condition project already planned for Chestnut Hill substation which will eliminate the overloads.

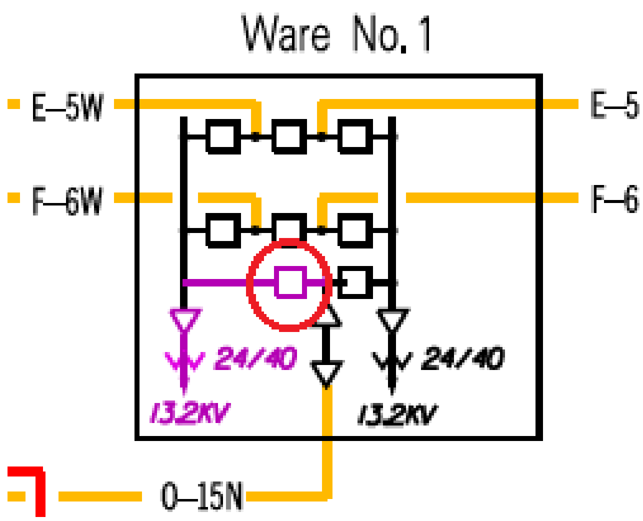
Figure 8 - Chestnut Hill 69 kVsSubstation Upgrades Required for DER Group 2 Interconnection



- **Deerfield 69 kV substation rebuild**: 69 kV equipment at Deerfield 4 substation must be upgraded to eliminate overloads on the D-4W 69 kV circuit (between Vernon Solar and Deerfield 4). There is an asset condition project already planned for Deerfield 4 substation which will eliminate the overloads.

- **Ware 69 kV breaker addition**: A 69 kV breaker needs to be added at Ware substation, to prevent the Ware 512 and 612 breaker failure contingencies from removing the O-15N 69 kV from service. The upgrade is shown in the following figure.

Figure 9 - Ware 69 kV Breaker Addition Required for DER Group 2 Interconnection

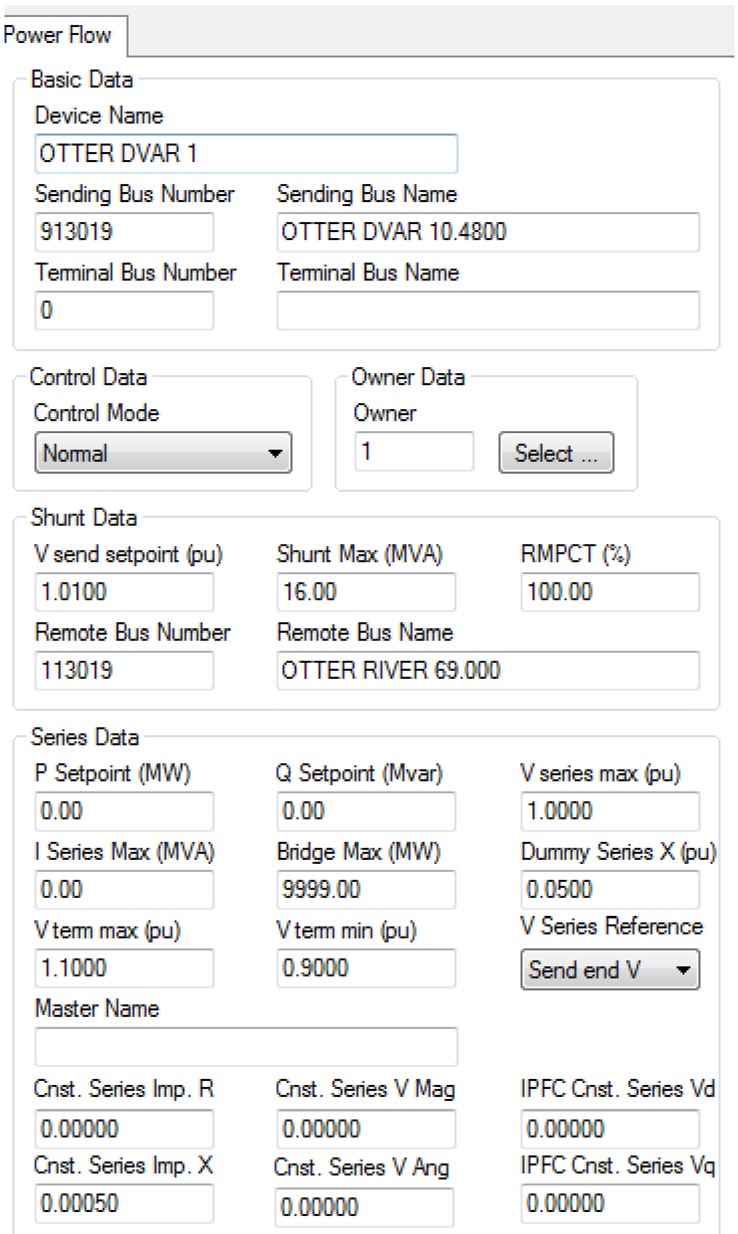


- **Otter River 69 kV DVAR**: Two 16 MVAR DVARs are required at Otter River 69 kV station to eliminate voltage violations along the A-1/B-2 lines caused by the addition of the Group 2 DER. A station expansion at Otter River is also required (69 kV breaker and ½ arrangement). The station expansion will also connect the A-1 and B-2 69kV lines together at Otter River.

[redacted]

Below are the input parameters utilized for the Otter River DVAR steady state model.

Figure 11 - Otter River DVAR Steady State Model



- **Wendell Depot 13.8 kV Reactor**: One 3.6 MVAR reactor is required at Wendell Depot 115/13.8 kV substation to eliminate the high voltage violations at Wendell Depot 115 kV bus caused by the addition of the Group 2 DER.

All transmission upgrades required for the interconnection of Group 2 DER are shown on the following one-line diagram.

[redacted]

5.6 Group 2 DER Interconnections Contingent on Transmission Upgrades

The Group 2 DER that will connect into the A-1/B-2 69 kV transmission lines (approximately 50 MW) can't be interconnected until the following upgrades are completed:

- Refurbishment of the A-1/B-2 69 kV transmission lines
- Upgrade of the Deerfield 4 69 kV buswork and Switches.
- Upgrade of the Vernon 69 kV buswork and Switches.
- Upgrade of the Chestnut Hill 69 kV buswork and Switches.
- Installation of the Otter River DVAR and associated 69 kV breaker and ½ station

The following Group 2 DER can't be interconnected until the Ware 69 kV breaker addition is completed:

- Ware – 1.8 MW
- Ware - 5 MW
- Belchertown – 5 MW
- Lashaway – 5 MW
- Lashaway – 1.8 MW
- Ware – 4.8 MW
- Shutesbury – 5 MW

The following Group 2 DER can't be interconnected until the Wendell Depot 3.6 MVAr reactor is installed:

- 15.5 MW at Wendell Depot
- 10 MW at Lost Town.

6 STABILITY ANALYSIS

Stability testing was performed with all Group 1 and Group 2 DER in-service, along with the transmission upgrades required for the interconnection of Group 2 DER, described in the previous sections. The stability testing was performed according to all applicable reliability standards. The purpose of the testing is to verify that the addition of the Group 2 DER and associated transmission upgrades do not cause significant adverse impact on the stability of the New England transmission system.

6.1 Stability Performance Criteria

Normal Contingency (NC) Criteria

- Both system wide stability and individual unit stability must be maintained for all normal design contingencies. All units must be transiently stable except for units tripped for fault clearing.
- A 53% reduction in the magnitude of system oscillations must be observed over four periods of the oscillation.

Bulk Power System (BPS) Testing

BPS testing was performed to determine the impact of the Project on facilities classified as part of the Bulk Power System (BPS), in accordance with the December 1, 2009, NPCC Document A-10, "Classification of Bulk Power System Elements". The criteria for BPS testing are as follows.

Acceptable BPS Reponses

- A 53% reduction in the magnitude of system oscillations observed over four periods.
- Loss of source up to 1200 MW

Unacceptable BPS Reponses

- Transiently unstable, with wide spread system collapse.
- Transiently stable, with undamped or sustained power system oscillations.
- Loss of source greater than 1200 MW.

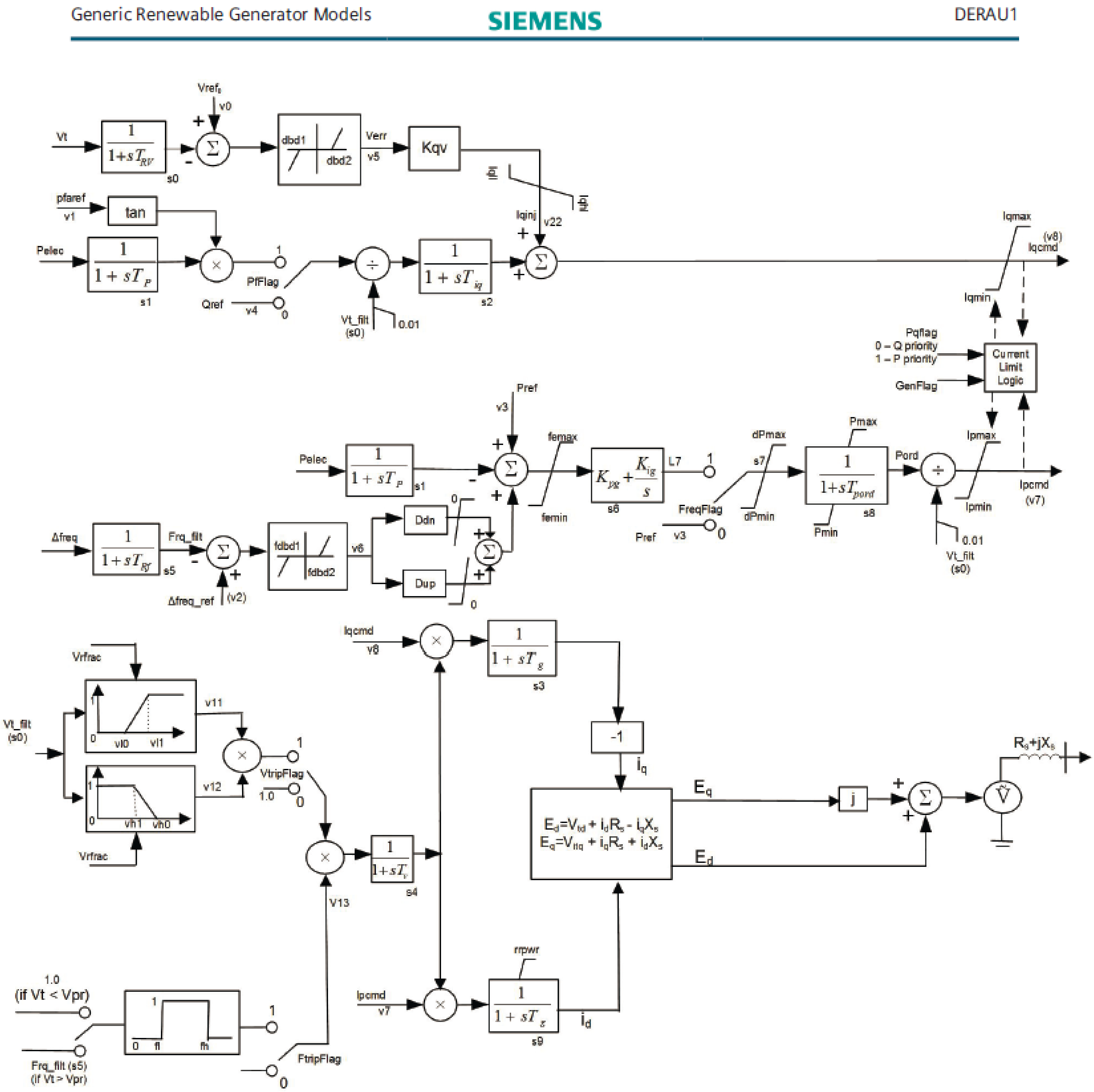
NEPOOL Voltage SAG Guidelines

For NC's the minimum post-fault positive sequence voltage sag must remain above 70% of nominal voltage and must not exceed 250 milliseconds below 80% of nominal voltage within 10 seconds following a fault. These limits are supported by the typical sag tolerances shown in IEEE Standard 1346-1998.

6.2 Stability Modeling of New DER Between 1MW and 5MW

For the additional DER that is greater than 1 MW, and less than 5 MW, this generation was modeled with the new DER_A model. The block diagram of the DER_A model is shown in the following figure.

Figure 13 - DER_A Model Block Diagram



The input data that was used for the DER_A model is shown below. The parameters related to inverter dynamics characteristics are selected based on the latest guideline document from NERC.[4] The parameters related to voltage and frequency trip settings are selected such that the inverter complies with the voltage and frequency ride-through requirement of National Grid SRD.

Table 24 - DER_A Model Parameters Assumed for Study

Param	Value	Notes
trv	0.02	Voltage Transducer Time constant (default)
trfs	0.02	Frequency measurement transducer time constant (not in NERC guidance document, but assumed 0.02, same as Voltage Transducer Time constant)
dbd1	-99	No voltage control will be modeled (default)
dbd2	99	No voltage control will be modeled (default)
kqv	0	No voltage control will be modeled (default)
vref0	0	No voltage control will be modeled (default)
tp	0.02	Power Transducer Time constant (default)
tiq	0.02	Q control Transducer Time constant (default)
ddn	0	Over freq droop
dup	0	Under freq droop
fdbd1	-99	deadband (default)
fdbd2	99	deadband (default)
femax	0	Freq error up limit (default)
femin	0	Freq error low limit (default)
pmax	1	
pmin	0	
dpmax	99	Power reference max ramp rate (default)
dpmin	-99	Power reference min ramp rate (default)
tpord	.02	Power Filter Open loop time constant (default)
kpg	0	Not mappable to interconnection standards (0, for no frequency control)
kig	0	Not mappable to interconnection standards (0, for no frequency control)
imax	1.2	Maximum converter current (typical inverter max output)
vl0	0.50	Voltage at head of feeder at which DER at head of feeder starts tripping.
vl1	0.55	Voltage at head of feeder at which DER at tail of feeder trips. Assume 5% voltage drop across Feeder. Amount of DER dropped will follow a linearly increasing amount until vl0, when all will be dropped
vh0	1.25	Voltage at head of feeder at which DER at tail of feeder trips. Assume 5% voltage drop across feeder
vh1	1.2	Voltage at head of feeder at which DER at head of feeder starts tripping. Amount of DER dropped will follow a linearly increasing amount until vh0, when all will be dropped
tvl0	1.1	low voltage cut-out timer corresponding to voltage vl0
tvl1	1.1	low voltage cut-out timer corresponding to voltage vl1
tvh0	0.01	High voltage cut-out timer corresponding to voltage vh0

[4] https://www.nerc.com/comm/PC_Reliability_Guidelines_DL/Reliability_Guideline_DER_A_Parameterization.pdf

Param	Value	Notes
tvh1	0.01	High voltage cut-out timer corresponding to voltage vh1
vrfrac	1	Per unit of DER that comes back after tripping (1 = 100% of DER comes back online if terminal voltage recovers above vlo (0.5 pu)[5] within 1.1 seconds; 0 = 100% of DER is tripped permanently if terminal voltage does not recover above vlo (0.5 pu) within 1.1 seconds). The same logic holds true for voltages that exceed vh1.
fltrp	57.0	Frequency trip settings per National Grid SRD
fhtrp	61.8	
tfl	0.01	
tfh	0.01	
tg	0.02	† current control time constant (inner control loops) (default)
rrpwr	2.0	Ramp rate for real power increase following a fault (pu/S) as per 1547-2018 to achieve 80% recovery in 0.4 sec
tv	0.02	time constant on the output of the multiplier (time delay for partial tripping) (default value)
vpr	0.7	Low voltage inhibit on frequency tripping (due to spurious spikes that occur in positive sequence stability models)
iqh1	0	No voltage control
iql1	0	No voltage control
pfflag	1	Constant power factor (based on initial value from steady state model)
frqflag	0	Freq control disabled (power reference from steady state model)
pqflag	1	Active current (P) priority (during large disturbances)
typeflag	1	1 for Generator (0 is for storage device)
vtripflag	1	Enables voltage trip logic
ftripflag	1	Enables frequency trip logic

All DER greater than 1 MW, but less than 5 MW, was modeled aggregately as a single equivalent generator, at the distribution bus of each substation to which it was connected. The MW size of the single equivalent generator, at a specific substation, was equal to the total amount of DER (greater than 1 MW but less than 5 MW) to be connected to that substation. No distribution feeder impedance was modeled between the equivalent generator and the distribution bus to which it is connected.

[5] Vlo chosen to be 0.5 pu so as to model the beginning of the low voltage momentary cessation region of the National Grid SRD

6.3 Stability Modeling of New DER Equal to 5MW and Greater

The additional DER in Groups 1 and 2, equal to, or greater than 5 MW, were modeled with standard PSS/E library models, approved by ISO-NE, utilizing specific modeling data provided by the developer.

These models were tested individually for acceptable performance, before conducting the overall stability study.

These generators were modeled as individual generators at the low side of the substation to which they were connected.

The following projects below exceeded 5 MW for Group 2.

Table 25 - Group 2 DER Greater than 5MW

Substation	Size (MW)
Crystal Lake	25.0
E. Winchendon	10.0
Five Corners	5.7
Little Rest Rd -1	9.5
Little Rest Rd -2	10.0
Powder Mill -1	8.8
Powder Mill -2	22.0
Shutesbury	10.0
Wendell Depot	10.0

The following projects below exceeded 5 MW for Group 1.

Table 26 - Group 1 DER Greater than 5MW

Substation	Size (MW)
Belchertown	8
Lashaway	6
Snow Street	12
Ware[6]	9
Wendell Depot	5

These generators were modeled with a standard PSS/E library model set consisting of the following modules:

REGCA – Renewable Energy Generator/Converter Model
REECA – Renewable Energy Electrical Model
REPCA – Plant Controller model

[6] Note that a valid PSS/E standard library model was not provided by the developer of this project at the time of this study. Therefore, a DERA model was used as a placeholder to represent the dynamics behavior of this project.

The REECA model type was utilized for these units because the REECA has the ability to model momentary cessation, and the National Grid SRD requires DER to go into momentary cessation for terminal voltages below 0.50 pu.

The block diagram for model REECA, and accompanying input parameters for these projects, are provided in Appendix C.

6.4 Stability Modeling of D-VAR at Otter River 69kV Substation

Two 16 MVAR DVARs are required at Otter River 69 kV station to eliminate steady-state voltage violations along the A-1/B-2 lines caused by the addition of the Group 2 DER. The following data, shown below is used for defining the PSS/E DYRE parameters for the D-VAR STATCOM CDVAR6 user model.

Table 27 - CDVAR6 Model Definition

993019/ 913019	D-VAR STATCOM PSSE Bus ID
OTTERDVAR1	FACTS Device Name (12 characters)
CDVAR6	User Model Name
34	**ICON**s (Integer Constants)
70	**CON**s (Constants)
1	**STATE**s
124	**VAR**iables

For defining the installation configuration and primary control objectives, the following are the D-VAR STATCOM user model's ICON parameter values and descriptions.

Table 28 - CDVAR6 Model ICONS

ICONs	Value	Description
M + 0	**0**	**Control Mode** 0 - Voltage Control; 1 - Power Factor Control; 2 - Constant Susceptance Output; 3 - Constant VAR Output
1	**113019**	**REG_Bus** is bus number for **Regulation Voltage control**
2	**113019**	**Bus_01** is bus number for **D-VAR MV Bus**
3	**113019**	**Trans_Bus** is bus number for **Transient Voltage control**
4	**0**	**CT01_Frm-Bus,** This is the **From** bus number for defining the CT01 flow. It is only needed if the Power Factor or Constant VAR regulation modes are desired. A value of '0' means to ignore CT inputs.
5	**0**	**CT01_To-Bus,** This is the to bus number for defining the CT01 flow. It is only needed if the Power Factor or Constant VAR regulation modes are desired.

ICONs	Value	Description
6	**-1**	**CT01_CKT-ID,** This is the circuit id to use for CT01. A value of -1 means to use the cumulative current flowing from the FROM bus to the TO bus. This is only needed if the Power Factor or Constant VAR regulation modes are desired.
7	**0**	**TRSN ONLY FLAG**: Default = 0; Enable = 1 (also set Control Mode ICON(M+0)=2)
8	**0**	**UK_DROOP**, Droop based on measured Vars (add 0 or 1)
9	**0**	**DRP_INCL_SVAR,** 0 include SVAR (0 = Default, 1 = do not include)

For further defining the D-VAR® system control functions, the following are the D-VAR STATCOM user model's CON parameter values and descriptions.

Table 29 - CDVAR6 Model CONS

		CONs	Value	Description
Voltage Control	**Slow Regulation**	J + 0	**0.000**	**VREF:** This is the D-VAR STATCOM's regulation voltage target (pu). For a flat STRT, set **VREF** to **0.0.**
		1		RG_BST_DRP : Droop for Boost Regulation Mode (puV/puA)
		2	**0.010**	RG_BST_ON: Turn On Delta for Boost Regulation Mode (puV)
		3	**0.005**	RG_BST_TRG: Target Delta for Boost Regulation Mode (puV)
		4		RG_BCK_DRP : Droop for Buck Regulation Mode (puV)
		5	**0.010**	RG_BCK_ON: Turn On Delta for Buck Regulation Mode (puV)
		6	**0.005**	RG_BCK_TRG: Target Delta for Buck Regulation Mode (puV)
		7	**2**	RG_KP : Proportional Gain
		8	**200**	RG_KI : Integral Gain
		9	**16**	SRATED - D-VAR STATCOM MVAr Rating (MVAr)
		10		UK_DRP_MVAR : Range for applying Measured Droopo (MVAr)
	Fast Transient	11	**0.040**	TRSN_BST_DRP : Droop for Boost Transient Mode (puV/puA)
		12	**0.100**	TRSN_BST_ON: Turn On Delta for Boost Transient Mode (puV)
		13	**0.050**	TRSN_BST_TRG: Target Delta for Boost Transient Mode (puV)
		14	**0.870**	TRSN_BST_HLIM: Hard Limit for Boost Transient Mode (puV)
		15	**0.040**	TRSN_BCK_DRP : Droop for Buck Transient Mode (puV)
		16	**0.100**	TRSN_BCK_ON: Turn On Delta for Buck Transient Mode (puV)
		17	**0.050**	TRSN_BCK_TRG: Target Delta for Buck Transient Mode (puV)
		18	**1.115**	TRSN_BCK_HLIM: Hard Limit for Buck Transient Mode (puV)
		19	**2**	TRSN_KP : Proportional Gain for Transient Mode
		20	**400**	TRSN_KI : Integral Gain for Transient Mode
		21	**1.500**	KOL : Maximum D-VAR Overload Rating (puA)
		22	**2.0**	TOVLD : Maximum duration of available Overload (s)
		23	**0.50**	TBACK: Time for ramping back maximum overload to continuous rating (s)
		24	**0.20**	VINHIBIT: Minimum voltage for operation of D-VAR (puV)
PF, Q & Suscep Control		25	**1**	PFREF : Power Factor Target. For a flat STRT, set PFREF to 0.0.
		26	**0.01**	PF_KP : Proportional Gain for Power Factor
		27	**4**	PF_KI : Gain for Power Factor

		28	**0**	QREF; Constant MVAR target at measured point (MVAr)
		29	**0**	SUSP_OFFSET: Constant Susceptance Target (MVAr)
Other		30	**0.004**	HL_Droop, Droop value below Transient hard limits, Default=0.005
		31	**0.25**	Fast_Timeout: Transition time from Transient to regulation (s)
		32	**1**	SUSP_RATE: Susceptance Slew Rate (puA/s)
		33	**0.1**	MVAR_RATE: Constant MVAR Slew Rate (puA/s)
Switched Shunts	**Switching Profile**	34	**-1.00**	ShuntI1 (I1<0) (puA)
		35	**0.20**	ShuntT1 (s)
		36	**-0.52**	ShuntI2 (I1<I2<0) (puA)
		37	**3.00**	ShuntT2 (s)
		38	**1.00**	ShuntI3 (I3>0) (puA)
		39	**0.20**	ShuntT3 (s)
		40	**0.52**	ShuntI4 (I3>I4>0) (puA)
		41	**3.00**	Shunt T4 (s)
	Switch Time	42	**120**	Shunt Switch Close-Delay (ms)
		43	**80**	Shunt Switch Open-Delay (ms)
Voltage Compliance		68	**0.936**	VC_LIMIT: Voltage Compliance Limit (puV)
		69	**12.39**	VC_SLOPE: Voltage Compliance Slope (puA/puV)

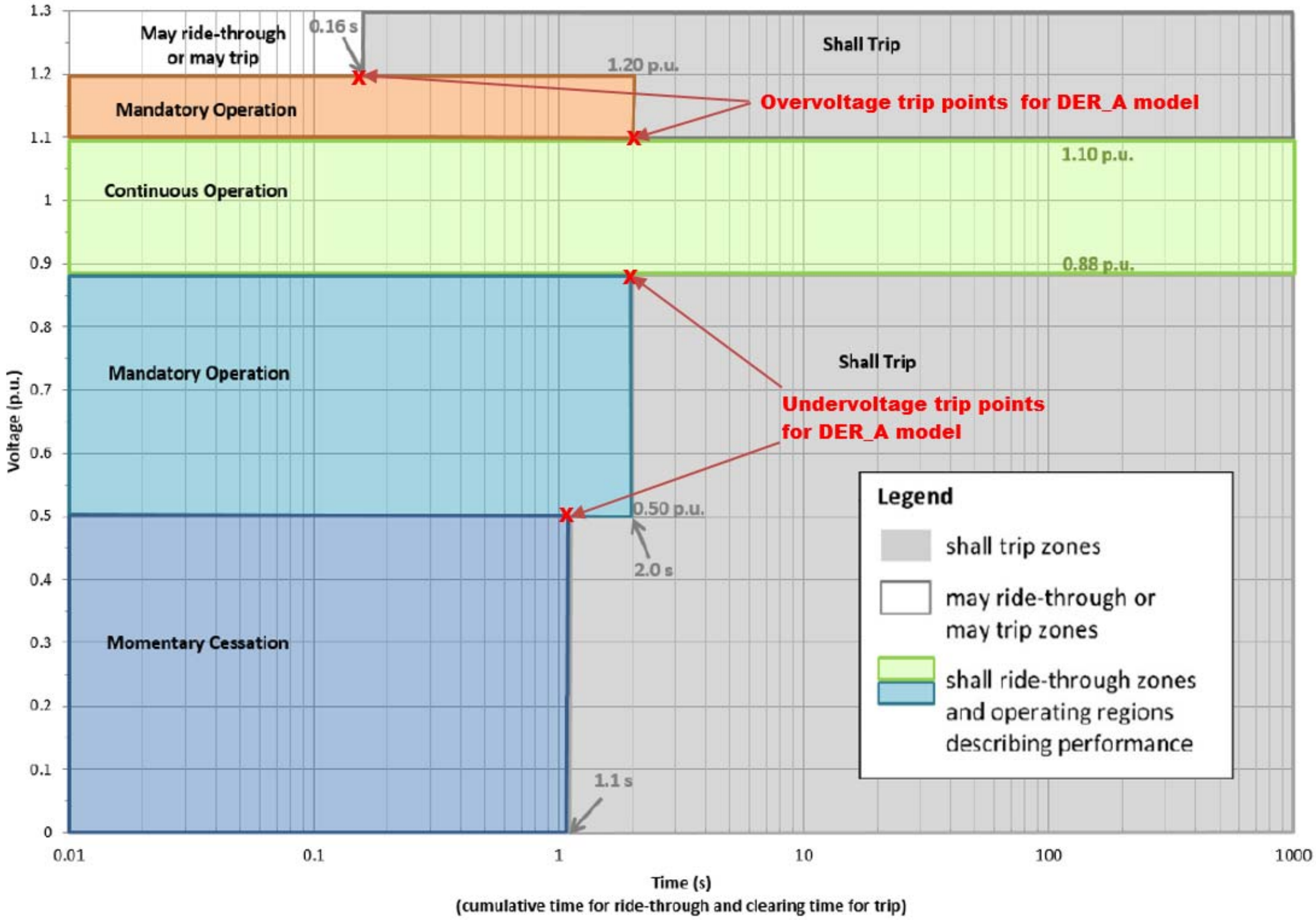
6.5 Ride-Through Capability of Additions DER

It was assumed that all additional DER modeled for this study (all DER > 1 MW) will meet the revised Energy Service Bulletin (ESB) for National Grid, for both frequency and voltage.

Further, it was assumed that the additional DER will ride through the "Continuous Operation Capability", "Mandatory Operation Capability", and "Momentary Cessation" regions of the SRD curves for both frequency and voltage. The DER was assumed to tripped permanently for frequencies and voltages outside those regions.

The voltage ride-through capability curve utilized for the study is shown below.

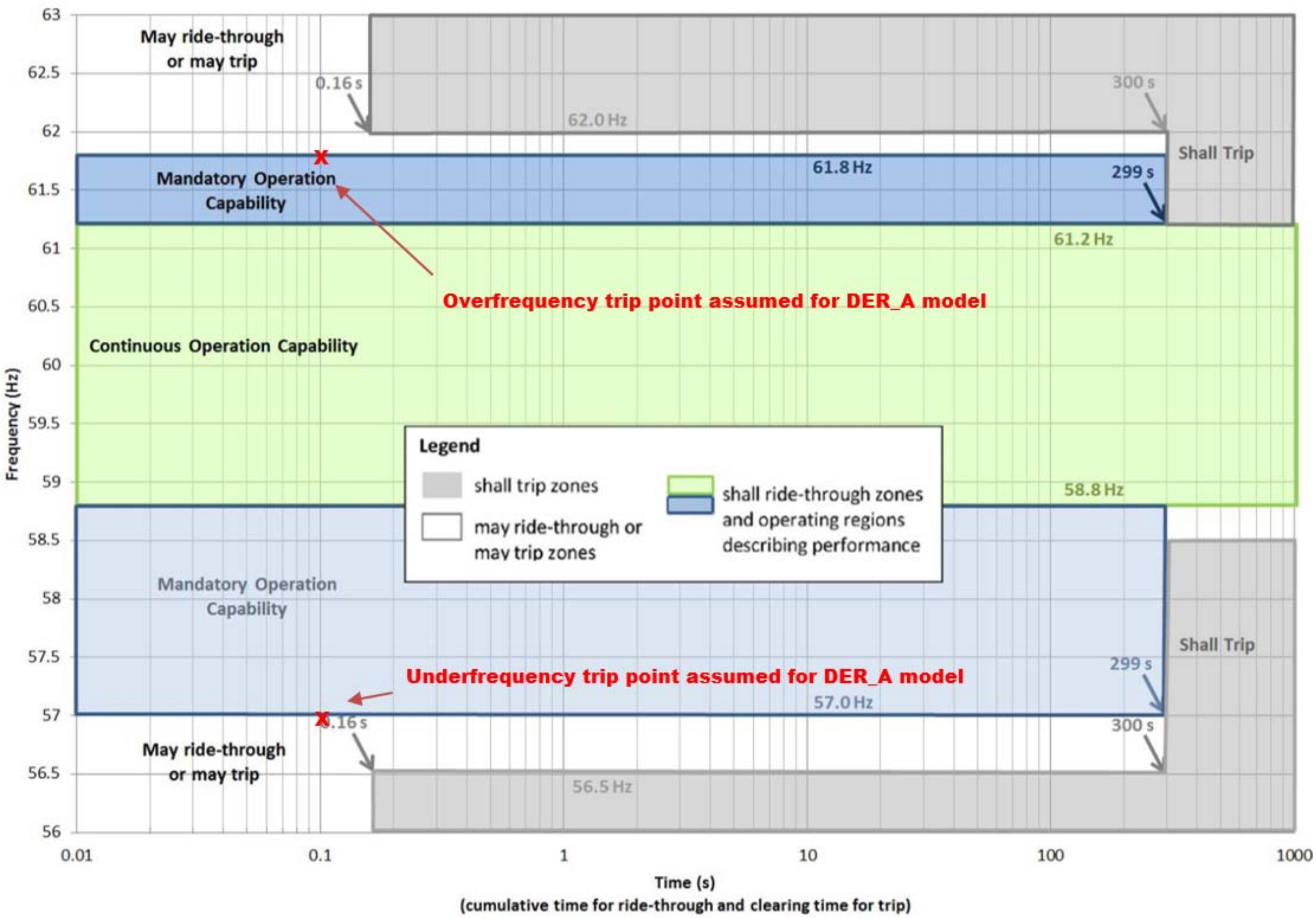
Figure 14 - National Grid SRD Voltage Ride-Through Capability Curve



The 4 under and overvoltage trip points was modeled for the VTGTPAT model. The momentary cessation regions of the SRD were modeled using the built-in under/over voltage function of the DER_A model.

The frequency ride-through capability curve utilized for the study is shown below.

Figure 15 - National Grid SRD Frequency Ride-Through Curve



The under/over frequency trip points of the SRD were modeled using the built-in under/over frequency function of the DER_A model.

6.6 Stability Analysis Case Development

In order to investigate the impact of the proposed projects to the New England transmission system, one base case representing the 2023 summer peak load levels and two base cases representing the 2023 light load levels, were developed for this study.

Since the in-service date of the entire 391 MW DER in this Group 2 cluster ranges from 2020 to 2023, the year 2023 ISO-NE base cases, released in 2019, were used for this transient stability assessment.

6.7 Stability Case Summaries

The following tables summarize the interface levels and generation dispatches for the stability cases.

Table 30 - Stability Case Summaries for Design Contingency Testing

Interface Name	Peak Load Case	Light Load Cases	
	23pk-ew	23ll-ew	23ll-we
NB-NE	1051	1052	1052
ORR_SOUTH	1386	1378	1378
SURW_SOUTH	1600	1613	1611
ME-NH	2004	2043	2045
EAST-WEST	3657	3562	-2940
NE-NY	1152	1152	-1327
NNE-SCOB+394	3629	3333	1658
NORTH-SOUTH	3486	3138	1702
SEMA/RI – NE	1360	1320	-1607
SBRK_SOUTH	1885	1737	539
HIGHGATE_IMP	218	223	224
SNDYPD_IMP	2000	2000	0
CT IMPORT	3219	2234	-87
Cross sound cable Export to NY	101	344	344
Bear Swamp	666	-666	0
Northfield	1180	-1000	0
Altresco	0	197	197
Millennium	412	412	412

Table 31 - Stability Case Summaries for BPS Simulations

Interface Name	Interface Flows (MW)			
	WMAVT	BOS	ME_C	SEMA
NB-NE	921	921	1052	921
SURW_SOUTH	1122	918	1143	926
ME-NH	1489	1288	1551	1297
EAST-WEST	-1532	3160	2707	3164
NE-NY	1119	1028	1040	1003
NNE-SCOB+394	3011	2844	3280	2844
NORTH-SOUTH	2767	2537	3100	2547
SEMA/RI - NE	-1132	2920	2292	3504
SBRK_SOUTH	1737	1615	1801	1635
HIGHGATE_IMP	223	223	223	223
SNDYPD_IMP	0	0	0	0
CT IMPORT	755	822	377	826
Cross sound cable Export to NY	346	346	346	346
Bear Swamp	666	-666	-666	-666
Northfield	1180	-1100	-1100	-1100
Alresco	197	0	0	0
Millenium	412	0	0	0

6.8 BPS Test Results

The following simulations were conducted to determine if any existing substations become Bulk Power System (BPS) substations as a result of the addition of Group 2 DER. Further, whether any of the new stations, required to accommodate the interconnection of the Group 2 DER, need to meet BPS design requirements. Results indicate that the addition of Group 2 DER introduces no new BPS stations.

Table 32 - Bulk Power System (BPS) Contingency Results

Contingency Name	Type	kV	Location	Clearing Times (cycles)	Protection Groups	Light Load Results			
						BOS	ME_C	SEMA	WMAVT
BS-230-BPS	BPS	230	Bear Swamp	[redacted]					
BS-115-BPS	BPS	115	Bear Swamp						
PJ-115-BPS	BPS	115	Pratts Jct						

Contingency Name	Type	kV	Location	Clearing Times (cycles)	Protection Groups	Light Load Results			
						BOS	ME_C	SEMA	WMAVT
				[redacted]					
PJ-230-BPS	BPS	230	Pratts Jct	[redacted]					
Palmer-115-BPS	BPS	115	Palmer	[redacted]					
Carp-115-BPS	BPS	115	Carpenter Hill	[redacted]					
Flagg-115-BPS	BPS	115	Flagg Pd	[redacted]					
Noxfd-115-BPS	BPS	115	North Oxford	[redacted]					

Contingency Name	Type	kV	Location	Clearing Times (cycles)	Protection Groups	Light Load Results			
						BOS	ME_C	SEMA	WMAVT
Stafford-115-BPS	BPS	115	Stafford St (new)	[redacted]					
Thorndike-115-BPS	BPS	115	Thorndike (new)	[redacted]					
NSalem-115-BPS	BPS	115	Lost town (new)	[redacted]					
LilRest-115-BPS	BPS	115	Littlerest Rd (new)	[redacted]					
Whitman-115-BPS	BPS	115	Whitmanville (new)	[redacted]					

6.9 N-1 Stability Test Results

Several Breaker Failure (BF) contingencies were tested. These Breaker Failures were first tested with a 3-phase initiating fault, which is categorized as an Extreme Contingency. If this test failed the performance requirements outlined in ISO-NE PP-3, a corresponding design contingency was tested (Breaker failure with single line to ground imitating fault); otherwise, no corresponding design contingency was tested. The system response was stable for all contingencies simulated, with minimal non-consequential source loss. Results are shown in the table below.

Table 33 - N-1 Breaker Failure Contingency Results

Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)	Protection Groups	Light Load Results		Peak Load Results
						EW	WE	EW
BS-1205E-BF	EC	230	[redacted]					
BS-T97-BF	EC	115						
ML-0802-BF	EC	345						
WM-105-BF	EC	345						

Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)	Protection Groups	Light Load Results		Peak Load Results
						EW	WE	EW
SP-3521-BF	EC	345	[redacted]					
CH-321-BF	EC	345	[redacted]					
CH-174W-BF	EC	115	[redacted]					
CH-175-BF	EC	115	[redacted]					
PJ-69kV-TIE-BF	EC	69`	[redacted]					
NFLD-2T-BF	EC	345	[redacted]					
PALM-X176-BF	EC	115	[redacted]					
AD-3T5T-BF	EC	115	[redacted]					

Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)	Protection Groups	Light Load Results		Peak Load Results
						EW	WE	EW
			[redacted]					
STAFF-2728E-BF	EC	115	[redacted]					
STAFF-B128E-BF	EC	115	[redacted]					
STAFF-2728W-BF	EC	115	[redacted]					
LRR-W175W-BF	EC	115	[redacted]					
THORNDK- X176W-BF	EC	115	[redacted]					
WHIT-I135E-BF	EC	115	[redacted]					
WHIT-I135E-BF2	EC	115	[redacted]					

Several design contingencies were tested on the transmission system facilities located along the Western and Central Massachusetts transmission corridor. The response was stable for all faults tested with no nonconsequential source loss. Results are shown in the table below.

Table 34 - N-1 Stability Design Contingency Results

Contingency Name	Type	kV	Location/ Description	Clearing times (cycles)	Protection Groups	Light Load Results		Peak Load
						EW	WE	EW
V174W-NO	NC	115	[redacted]					
V174E-NO	NC	115						
E205E-PJ	NC	230						
E205W-BS	NC	230						
354-NFld	NC	345						
354-Ludlow	NC	345						
S197-BS	NC	115						

Contingency Name	Type	kV	Location/ Description	Clearing times (cycles)	Protection Groups	Light Load Results		Peak Load
						EW	WE	EW
E131-BS	NC	115	[redacted]					
Z126-WEB	NC	115	[redacted]					
E5-WARE	NC	69	[redacted]					
E5-F6E-DCT-Millbury	NC	69	[redacted]					
A1S-B2S-DCT-Gardner	NC	69	[redacted]					
A1N-B2N-DCT-Royalston	NC	69	[redacted]					
D4-Solar	NC	69	[redacted]					
J136N-BELFS	NC	115	[redacted]					

Contingency Name	Type	kV	Location/ Description	Clearing times (cycles)	Protection Groups	Light Load Results		Peak Load
						EW	WE	EW
O15N- PALM	NC	69	[redacted]					
A127-ERV	NC	115						
A127-ST	NC	115						
I135E-FP	NC	115						
I135E-WHIT	NC	115						
I135-CHINK	NC	115						
X176E-PALM	NC	115						
X176E-THORN	NC	115						

Contingency Name	Type	kV	Location/ Description	Clearing times (cycles)	Protection Groups	Light Load Results		Peak Load
						EW	WE	EW
X176-THORN	NC	115	[redacted]					
W175W-PALM	NC	115						
SP-HVDC Bipole	NC	450						
BS-1205E-BF-SLG	NC	230						
BS-1205W-BF-SLG	NC	230						
BS-T97-BF-SLG	NC	115						
BS-T31-BF-SLG	NC	115						

Contingency Name	Type	kV	Location/ Description	Clearing times (cycles)	Protection Groups	Light Load Results		Peak Load
						EW	WE	EW
AD-3T5T-BF-SLG	NC	115	[redacted]					

6.10 N-1-1 Stability Test Results

Several design contingencies were tested with an initial element out of service as shown in the table below. Any generation backdown that was required between contingencies were found not to exceed existing limits. The response was stable for all faults tested with no nonconsequential source loss. Results are shown in the table below.

Table 35 - N-1-1 Stability Design Contingency Results

Initial N-1	Post N-1	N-1-1 Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)	Protection Groups	Light Load Results		Peak Load Results
Line Out	System Adjustments							EW	WE	EW
301/302 345 kV [Ludlow-Millbury]	None	E-205E-PJ	NC	230	[redacted]					
		Z126-WEB	NC	115	[redacted]					
		S197-BS	NC	115	[redacted]					
		V174W-NO	NC	115	[redacted]					
		NFLD-2T-BF-SLG	NC	345	[redacted]					

Initial N-1	Post N-1	N-1-1 Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)	Protection Groups	Light Load Results		Peak Load Results
Line Out	System Adjustments							EW	WE	EW
					[redacted]					
		NFLD-9T-BF-SLG	NC	345						
		Ludlow-5T-BF-SLG	NC	345						
		CH-174W-BF-SLG	NC	115						
		381-NFLD	NC	345						
		FITZ-3791-BF-SLG	NC	345						
		SP-HVDC Bipole	NC	450						
		BS-T97-BF-SLG	NC	115						

Initial N-1	Post N-1	N-1-1 Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)	Protection Groups	Light Load Results		Peak Load Results
Line Out	System Adjustments							EW	WE	EW
					[redacted]					
Northfield 345-115 kV auto	none	A127-ST	NC	115	[redacted]					
Fitzwilliam 345-115 kV auto	none	I135-FP	NC	115	[redacted]					
S-197 115 kV line [Bear Swamp-Deerfield]	None	B2S-PJ-3PH	NC	69	[redacted]					

No criteria violations were found for any conditions tested, either for N-1 contingencies or N-1-1 contingencies.

7 SHORT CIRCUIT ANALYSIS

7.1 Short Circuit Models

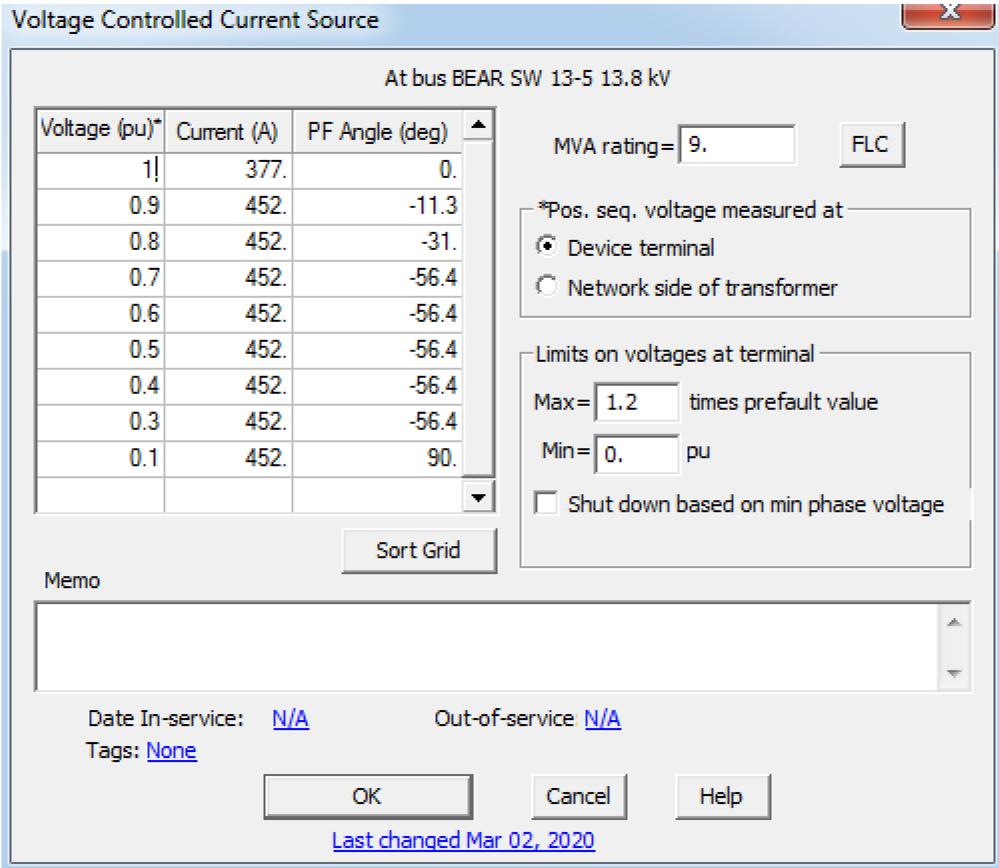
The short circuit study case was based on the ISO-NE's 2024 Master Short Circuit case (dated 1/1/2020) which represents the transmission and generation system configuration that would be in place by 2024. Short circuit analysis was conducted for the entire Group 1 + Group 2 DER in the Western MA Cluster (730 MW). The DER was modeled at each substation with a single equivalent generator, at the low side of each substation to which they will be connected. The MW size of the single equivalent generator, modeled at each specific substation, was equal the total amount of DER (greater than 1 MW) to be connected to that substation.

7.2 Methodology and Criteria

The modeling assumptions and short circuit performance criteria, including settings used in Aspen's breaker rating module, are per National Grid's TGP34 'Circuit Breaker Fault Current Assessment Guide' and its associated TGP34 Technical Guidelines.

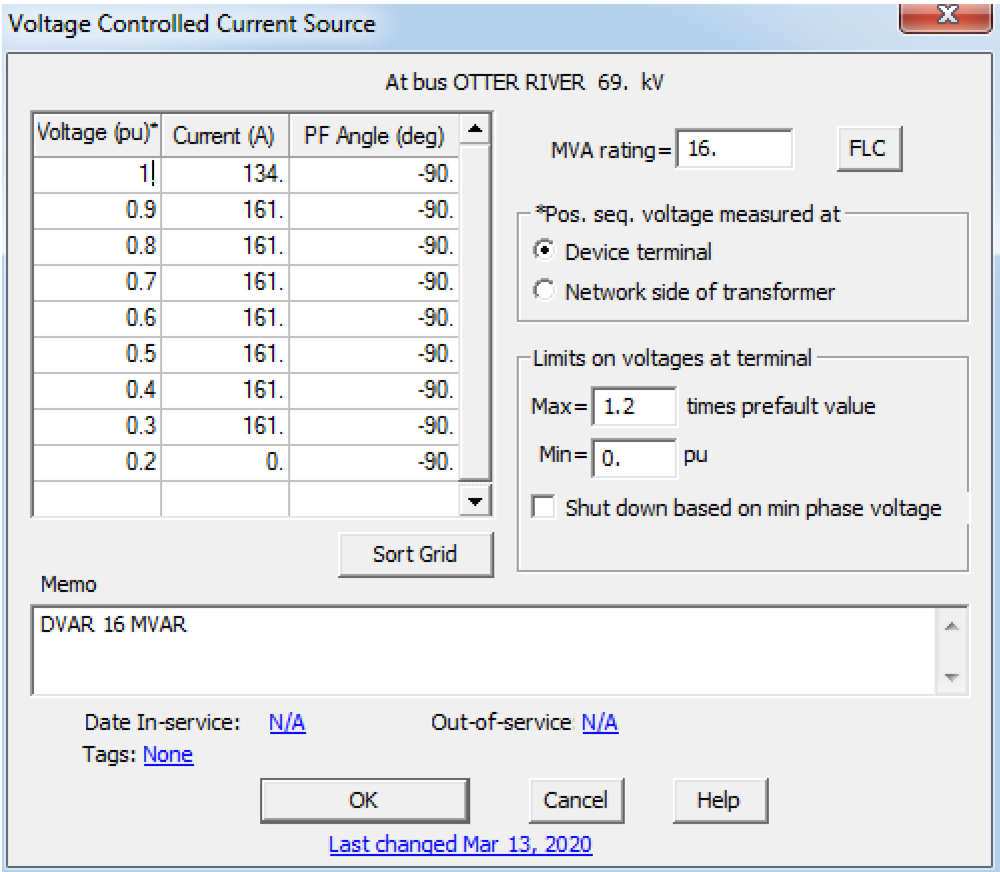
Voltage Controlled Current Source (VCCS) models were used for all PV inverters in Groups 1 and 2. The VCCS models were assumed to deliver up to 1.2 p.u. of its nameplate current during fault conditions. Distinct Power Factor (PF) angles were modeled for several different voltage levels for each inverter. The PF Angle (degrees) for each DER terminal voltage was calculated based on recommendations provided in the ASPEN "Technical Bulletin on Modeling Type-4 Wind Plants and Solar Plants". Figure 7-1 is an example of an ASPEN model that was used for a 9 MW aggregate unit.

Figure 16 - Sample VCCS model



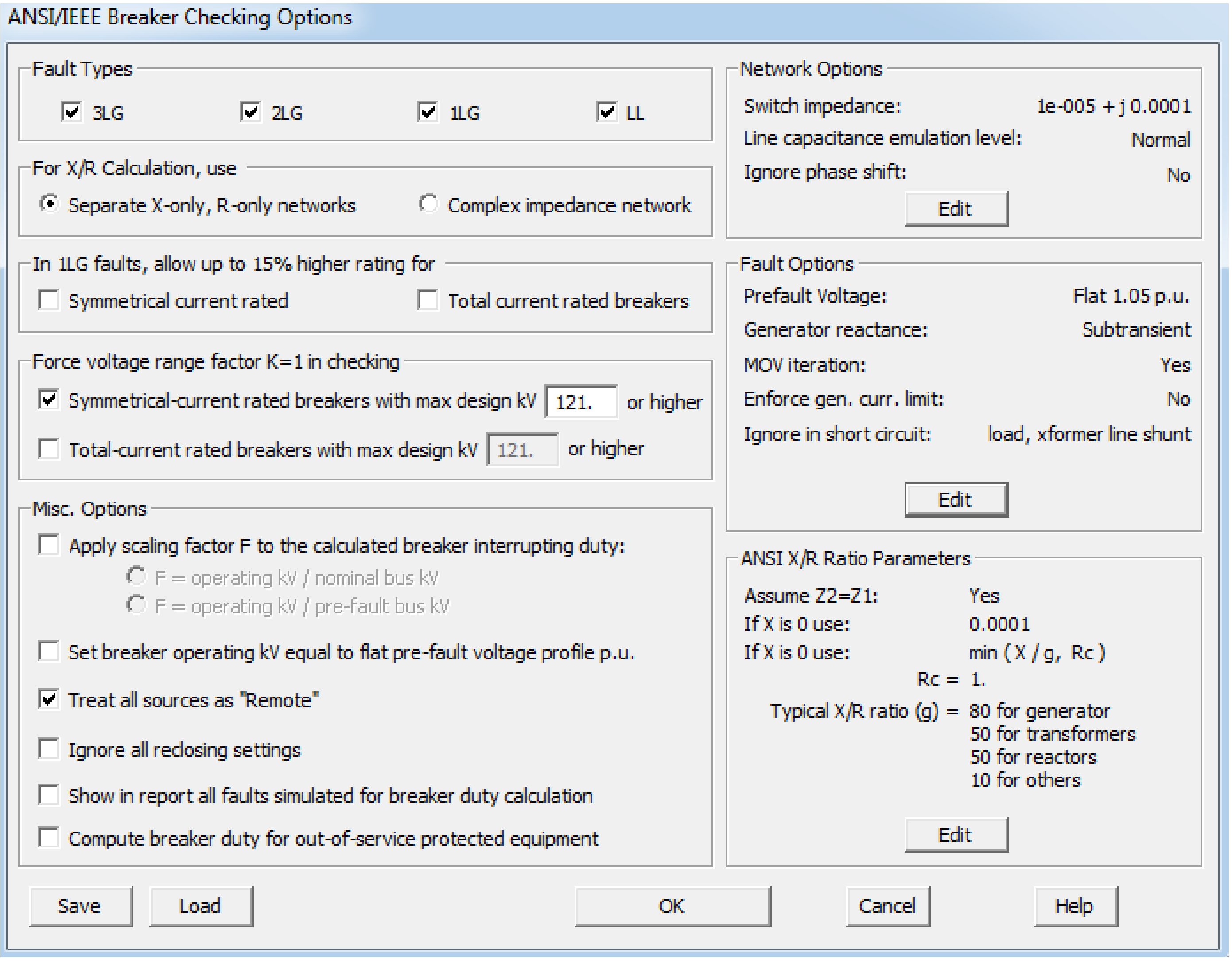
The VCCS model was also utilized to model the 2 x 16 MVAR DVAR at Otter River 69 kV switching station. The VCCS was assumed to deliver up to 1.2 p.u. of its nameplate current during fault conditions. The figure below shows the model parameters used (as recommended by American Superconductor).

Figure 17 - VCCS Model parameters for Otter River 16 MVAR DVAR



The figure below shows the ASPEN solution options assumed for the short circuit analysis. Note that current limits were not enforced for inverter-based generation modeled with current limited synchronous generators. This is a slightly conservative assumption, but not overly conservative since there is very little, if any inverter-based generators modeled with current limited synchronous generators in the study area.

Figure 18 - ASPEN Solution Options Assumed for short circuit analysis



7.3 Results

The following table shows the short circuit duty at each National Grid transmission substation (69 kV and above) in Western Massachusetts, following the additional of all 730 MW of DER associated with Groups 1 and 2. The table includes the maximum short circuit current in Percentage (Duty_P) and Momentary Breaker Duty in Percentage (M_Duty_P) generated by the ASPEN breaker rating module for all 69 kV and above circuit breakers in Western Massachusetts.

The results show that the short circuit currents are less than 95% of the interrupting capability for all transmission breakers in the study area. Therefore, the PV inverters in Groups 1 and 2 do not cause any breaker in the system to become overdutied.

Table 36 - ASPEN short circuit Results – Post Group 1 + 2 DER

BUS	DUTY_A (Maximum short ckt Amps)	BKR_CAPA (Amps)	DUTY_P (%)	M_DUTY_A (Amps)	M_BKR_CAPA (Amps)	M_DUTY_P (%)	3LG_AMPS	1LG_AMPS	2LG_AMPS	LL_AMPS
ADAMS 115.kV	13782.7	40000	34.5	19876.2	64000	31.1	13782.7	9359.5	12851.3	11895.8
ADAMS 69 69.kV	6849.2	40000	17.1	10523.2	64000	16.4	6849.2	4134.6	6152.7	5896.7
BEAR SW 115 115.kV	23889.8	50000	47.8	36167	80000	45.2	22533.2	21784.9	22498.3	18611.5
BEARSWMP 23 230.kV	14118.7	63000	22.4	20513	100800	20.4	13761.9	13980.9	14266.4	10969.4
CARPNTR 115 115.kV	30004.6	40000	75	46180.9	64000	72.2	28963.4	25213.3	28750.3	25076.6
CHESTNUT HIL 69.kV	3252	22000	14.8	3451.3	35200	9.8	3252	1913.4	2941.6	2788.2
Crystal Lake 69.kV	4928.8	31500	15.6	5404.6	50400	10.7	4928.8	2825.4	4483.2	4259
DEERFIEL4 69.kV	9837.1	27000	36.4	13437.4	43200	31.1	9837.1	9081.5	9720.8	8372.9
DEERFLD5 69.kV	7366.5	19000	38.8	10206.4	30400	33.6	7366.5	6605.1	7129.5	6325.4
E LNGMDW2 69 69.kV	3102.5	40000	7.8	3714.2	64000	5.8	3102.5	1530.9	2803.6	2709.6
FLAGG POND 115.kV	16637	20000	83.2	22748.6	32000	71.1	16637	12262	15162.9	14228.3
HARRIMAN 69.kV	9226.2	40000	23.1	13758.7	64000	21.5	9226.2	8925.5	9165.9	7863.4
HARRIMAN 115.kV	15643.2	40000	39.1	22701.5	64000	35.5	15643.2	11860.9	14468.7	13228.3
Harrington 69.kV	8283.4	40000	20.7	10327.3	64000	16.1	8283.4	5432.7	7488.8	6983.3
LITREST 115 115.kV	11577.9	40000	28.9	17393.5	64000	27.2	11577.9	7796.8	10638.2	9995.7
MEADOW_ST 5 69.kV	9446.4	31500	30	11823.9	50400	23.5	9446.4	5623.7	8504.2	8107.7
[redacted]										
MILLBURY5 B1 69.kV	19076.7	31500	60.6	29045.7	50400	57.6	19076.7	18842.9	19018.2	16418.4
MILLENM 115 115.kV	20219.6	40000	50.5	31592.2	64000	49.4	23992.9	22494.8	23746.8	20732
N OXFRD 115.kV	17103.8	40000	42.8	25520.7	64000	39.9	17103.8	10486.7	15816.1	14823.9
Lost Town 115.kV	11347.6	40000	28.4	15675.4	64000	24.5	11347.6	8080	10737.1	9953.4
OTTER RIVER 69.kV	5289	22000	24	5728.2	35200	16.3	5289	3040.2	4791.4	4631.3
PALMER 115 115.kV	15108.1	40000	37.8	22403	64000	35	15108.1	11221.9	13845.7	12963.3
PALMER 69 69.kV	14234.2	31500	45.2	21836.6	50400	43.3	14234.2	12803.4	13653.2	12278.2
PRATTS 115 115.kV	30182.9	40000	75.5	43416.8	64000	67.8	30182.9	23881.4	28389.7	25902.8
PRATTS 230 230.kV	7197.8	50000	14.4	11065.5	80000	13.8	9069.6	8075.5	8767.6	7774.7
PRATTS 2 69 69.kV	21296.1	40000	53.2	32466.6	64000	50.7	21044.8	20853.9	21296.1	18030.2

BUS	DUTY_A (Maximum short ckt Amps)	BKR_CAPA (Amps)	DUTY_P (%)	M_DUTY_A (Amps)	M_BKR_CAPA (Amps)	M_DUTY_P (%)	3LG_AMPS	1LG_AMPS	2LG_AMPS	LL_AMPS
SEARSBURG 69.kV	6205.6	40000	15.5	8771.3	64000	13.7	6205.6	4798.9	5797.9	5333.7
SHUTSBURY 69.kV	3867.9	31500	12.3	4672.8	50400	9.3	3867.9	2227.9	3421.9	3314.6
Stafford st 115.kV	20079.1	40000	50.2	27677.8	64000	43.2	20079.1	9638.2	18103.4	17350.6
THRNDIK 6X 115.kV	17746.4	40000	44.4	26891.5	64000	42	17746.4	9664.8	15733	15275.9
VERNON 1 69.kV	5566.8	22000	25.3	7407.6	35200	21	5021.7	5418	5566.8	4299.1
West Hampden 115.kV	14229.4	40000	35.6	20819.9	64000	32.5	14229.4	10607.3	13222.2	12149.2
West Hampden 69.kV	5294.1	40000	13.2	8214.6	64000	12.8	5008.3	5294.1	5251.8	4352.7
WARE 69 69.kV	9142.7	31500	29	11747.5	50400	23.3	9142.7	4864.2	8150.5	7912.6
WEB ST 115.kV	16850.3	40000	42.1	23974.8	64000	37.5	16880.3	8125.8	15201.2	14525.5
Whitmanville 115.kV	13537.3	40000	33.8	18382	64000	28.7	13537.3	9141.8	12292.2	11661.5

Where:

BUS	Breaker bus name and nominal kV
BREAKERS	Breaker name
RATINGTYPE	Breaker rating type: S for symmetrical current rated; T for total current rated
DUTY_P	Interrupting duty in percent
DUTY_A	Interrupting current in amps
BKR_CAPA	Calculated interrupting capacity in amps
M_DUTY_P	Momentary duty for total-current rated breakers and close-and-latch duty for symmetrical-current rated breakers in percent
M_DUTY_A	Momentary duty for total-current rated breakers and close-and-latch duty for symmetrical-current rated breakers in amps
M_BKR_CAPA	Calculated momentary capacity of total current rated breakers and close-and-latch capacity for symmetrical current rated breakers in amps
MAX_SC_CASE	Fault with maximum short circuit interrupting current
ISC	Breaker short circuit current in amps
ANSI_X/R	ANSI X/R ratio
FLAG	Rating flag, interrupting duty
FLAG_M	Rating flag, momentary (close-and-latch) duty
3LG_AMPS	Maximum 3LG fault current at breaker bus
3LG_X/R	ANSI X/R ratio in 3LG fault at breaker bus

2LG_AMPS	Maximum 2LG fault current at breaker bus
2LG_X/R	ANSI X/R ratio in 2LG fault at breaker bus
1LG_AMPS	Maximum 1LG fault current at breaker bus
1LG_X/R	ANSI X/R ratio in 1LG fault at breaker bus
LL_AMPS	Maximum LL fault current at breaker bus
LL_X/R	ANSI X/R ratio in LL fault at breaker bus

This appendix has been redacted for Critical Energy/Electric Infrastructure Information.

Appendix A - Steady State Base Case Summaries

This appendix has been redacted for Critical Energy/Electric Infrastructure Information.

Appendix B – Stability Case Summaries

Appendix C - Stability Models for DER Greater Than or Equal To 5MW

Figure: REGC Block Diagram

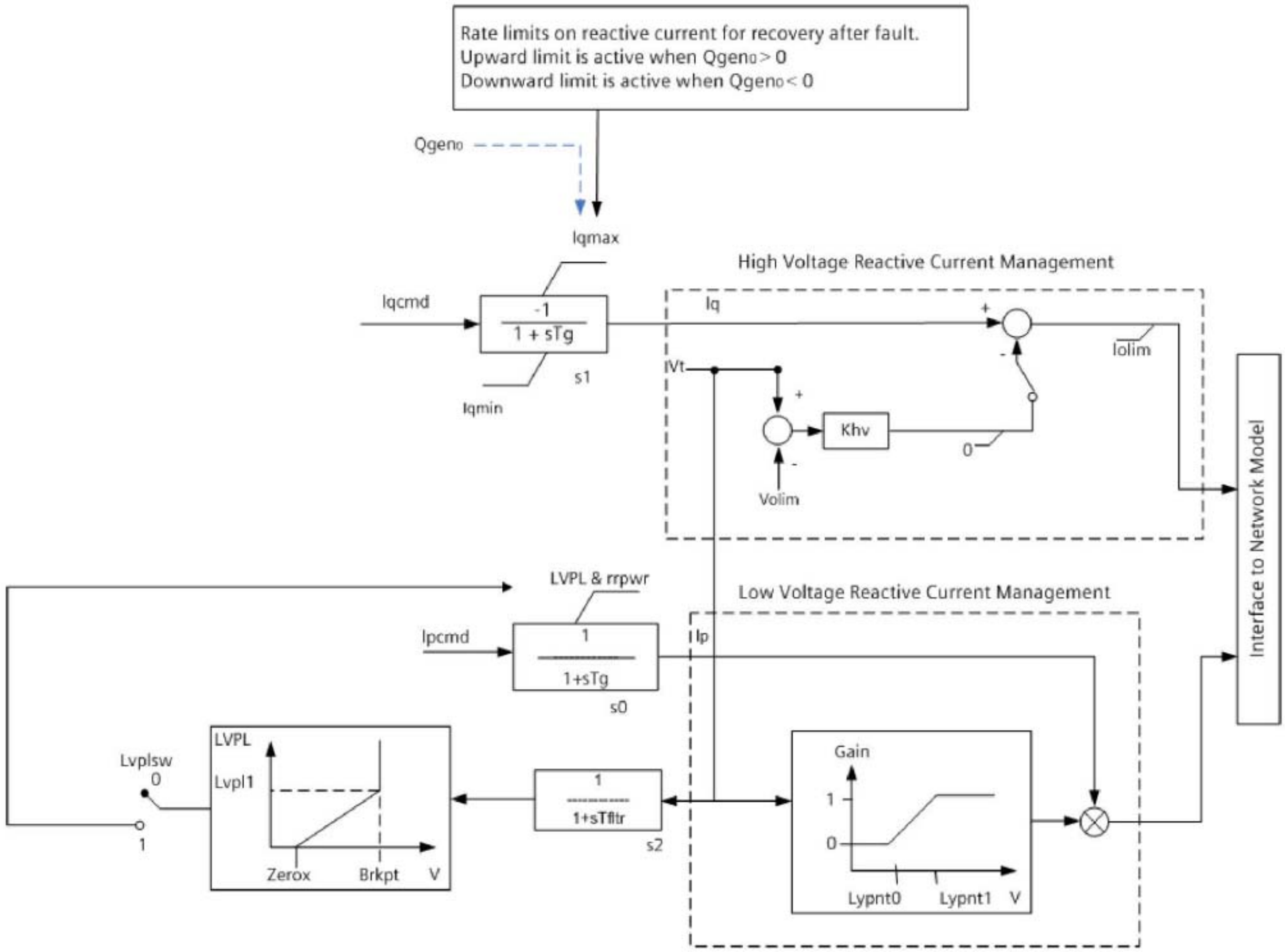


Figure: REECA Block Diagram

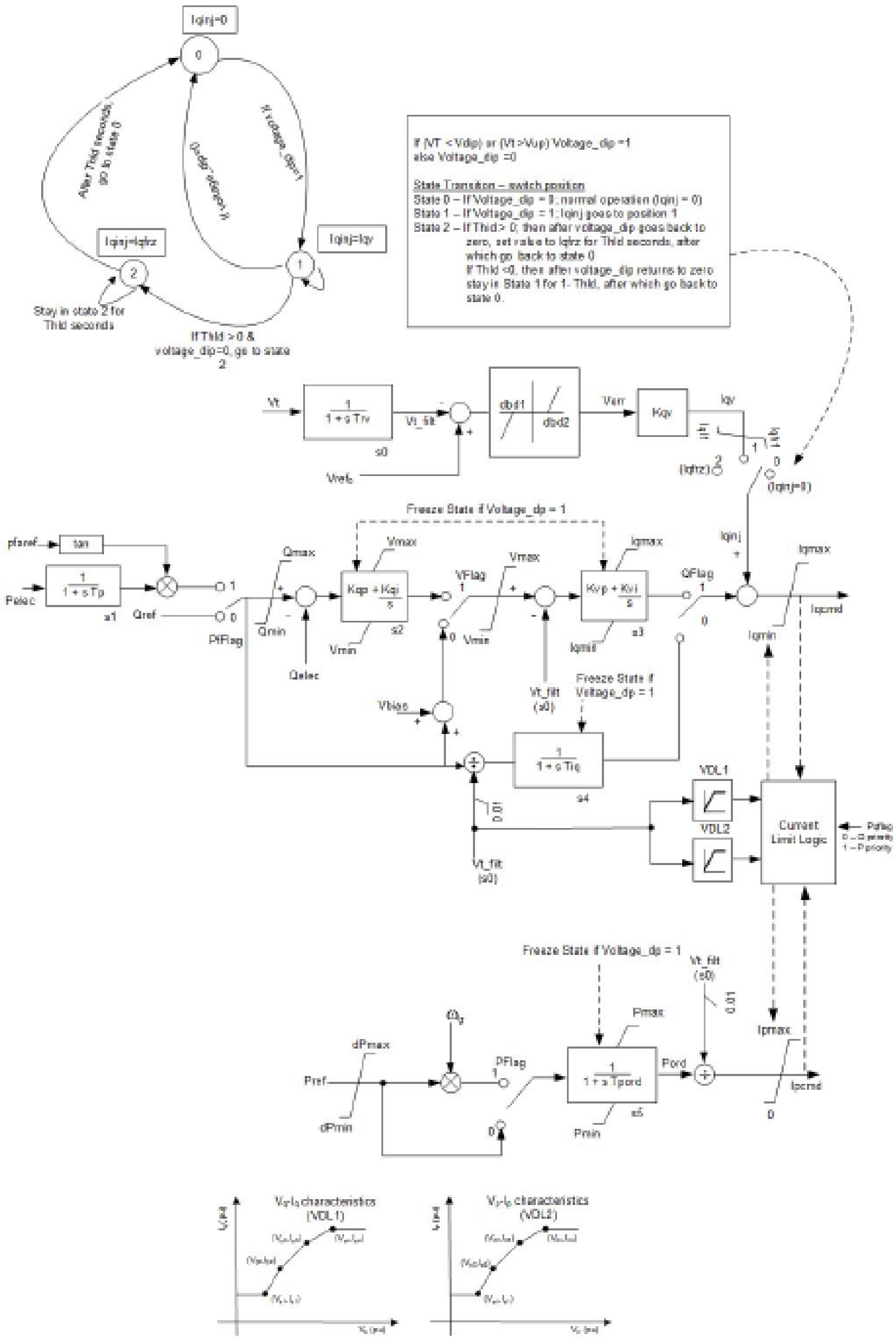
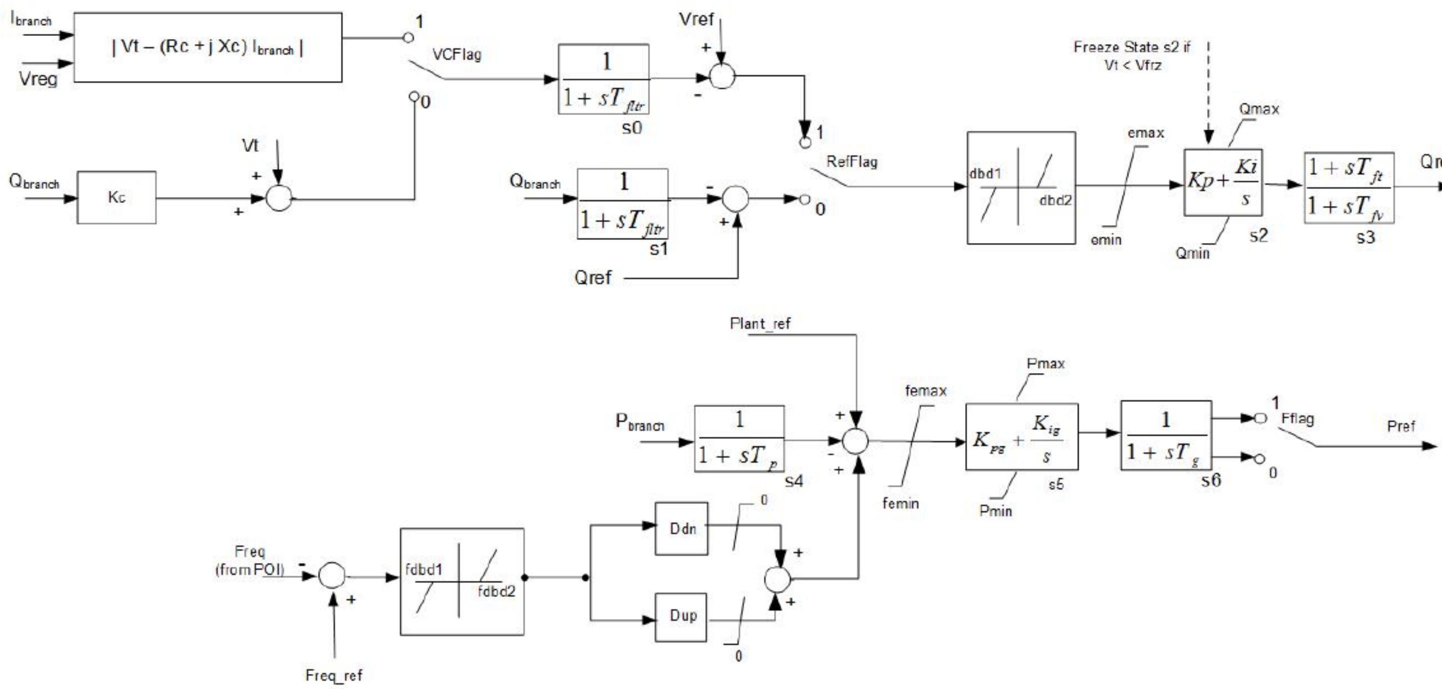


Figure: REPC Block Diagram



IDV File

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//5 CORNERS:
BAT_SPLT,113115,931152,'5 COR-GSU', 13.2
BAT_BRANCH_CHNG,113115,931152,'1',,,,,, 0.019277, 0.010182, 0.4E-04,,,,,,,,,,,,;
BAT_SPLT,931152,931151,'5 COR-INV', 0.6
BAT_BUS_CHNG_3,931151,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,931152,931151,'2',1,931152,600,0,0,0,33,0,931152,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,931151,931152,'2',,,,,,,,,,,,,2,, 0.009713, 0.0575, 5.7,,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,931151,931152,'1'
BAT_MBIDBRN,931151,931152,'2','1'
BAT_PLANT_DATA,931151,0, 1.0, 100.0
BAT_MACHINE_DATA_2,931151,'DG',1,600,0,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
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BAT_FDNS,1,0,0,1,1,0,0,0

//BELCHERTOWN:
BAT_SPLT,113065,930652,'BELCH-GSU', 13.2
BAT_BRANCH_CHNG,113065,930652,'1',,,,,, 0.019277, 0.010182, 0.4E-04,,,,,,,,,,,,;
BAT_SPLT,930652,930651,'BELCH-INV', 0.6
BAT_BUS_CHNG_3,930651,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,930652,930651,'2',1,930652,600,0,0,0,33,0,930652,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,930651,930652,'2',,,,,,,,,,,,,2,, 0.009713, 0.0575, 8.0,,,,,,,,,,,,,,,,,,,,," "," "
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BAT_MBIDBRN,930651,930652,'2','1'
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BAT_MACHINE_CHNG_2,930651,'DG',,,,,1, 8.0,,0.0,0.0, 8.0,0.0, 8.0,, 9999.0,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//CRYSTAL LAKE:
BAT_SPLT,113396,933962,'CRYST-GSU', 13.8
BAT_BRANCH_CHNG,113396,933962,'1',,,,,, 0.019277, 0.010182, 0.4E-04,,,,,,,,,,,,;
BAT_SPLT,933962,933961,'CRYST-INV', 0.6
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BAT_MACHINE_DATA_2,933961,'DG',1,600,0,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
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BAT_FDNS,1,0,0,1,1,0,0,0

//E WINCHENDON :
BAT_SPLT,113395,933952,'E WIN-GSU', 13.8
BAT_BRANCH_CHNG,113395,933952,'1',,,,,, 0.019277, 0.010182, 0.4E-04,,,,,,,,,,,,;
BAT_SPLT,933952,933951,'E WIN-INV', 0.6
BAT_BUS_CHNG_3,933951,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933952,933951,'2',1,933952,600,0,0,0,33,0,933952,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933951,933952,'2',,,,,,,,,,,,,2,, 0.009713, 0.0575, 10.0,,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933951,933952,'1'
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BAT_PLANT_DATA,933951,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933951,'DG',1,600,0,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933951,'DG',,,,,1, 10.0,,0.0,0.0, 10.0,0.0, 10.0,, 9999.0,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//LASHAWAY:
BAT_SPLT,113079,930792,'LASHA-GSU', 23.0
BAT_BRANCH_CHNG,113079,930792,'1',,,,,, 0.019277, 0.010182, 0.4E-04,,,,,,,,,,,,;
BAT_SPLT,930792,930791,'LASHA-INV', 0.6
BAT_BUS_CHNG_3,930791,2,,,,,,,,,,,;
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//LITTLE REST ROAD -1 :
BAT_SPLT,113076,930762,'LITL -GSU', 13.2
BAT_BRANCH_CHNG,113076,930762,'1',,,,,, 0.019277, 0.010182, 0.4E-04,,,,,,,,,,,,;
BAT_SPLT,930762,930761,'LITL -INV', 0.6
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BAT_MBIDBRN,930761,930762,'2','1'
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//LITTLE REST ROAD -2:
BAT_SPLT,113076,990762,'LITL2-GSU', 13.2
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BAT_SPLT,990762,990761,'LITL2-INV', 0.6
BAT_BUS_CHNG_3,990761,2,,,,,,,,,,,;
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BAT_MBIDBRN,990761,990762,'2','1'
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BAT_MACHINE_DATA_2,990761,'DG',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
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BAT_BRANCH_CHNG,993007,930072,'1',,,,,, 0.019277, 0.010182, 0.4E-04,,,,,,,,,,,,;
BAT_SPLT,930072,930071,'POWDE-INV', 0.6
BAT_BUS_CHNG_3,930071,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,930072,930071,'2',1,930072,600,0,0,0,33,0,930072,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0,
1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,930071,930072,'2',,,,,,,,,,,,,2,, 0.009713, 0.0575, 8.8,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,930071,930072,'1'
BAT_MBIDBRN,930071,930072,'2','1'
BAT_PLANT_DATA,930071,0, 1.0, 100.0
BAT_MACHINE_DATA_2,930071,'DG',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,930071,'DG',,,,,,1, 8.8,,0.0,0.0, 8.8,0.0, 8.8,, 9999.0,,,,,,,,,;
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//POWDER MILL - 2:
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BAT_BRANCH_CHNG,993007,990072,'1',,,,,, 0.019277, 0.010182, 0.4E-04,,,,,,,,,,,,;
BAT_SPLT,990072,990071,'POWD2-INV', 0.6
BAT_BUS_CHNG_3,990071,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,990072,990071,'2',1,990072,600,0,0,0,33,0,990072,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0,
1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,990071,990072,'2',,,,,,,,,,,,,2,, 0.009713, 0.0575, 22.0,,,,,,,,,,,,,,,,,,," "," "
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BAT_MBIDBRN,990071,990072,'2','1'
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BAT_MACHINE_DATA_2,990071,'DG',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,990071,'DG',,,,,,1, 22.0,,0.0,0.0, 22.0,0.0, 22.0,, 9999.0,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//SHUTESBURRY:
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BAT_BRANCH_CHNG,113093,930932,'1',,,,,, 0.019277, 0.010182, 0.4E-04,,,,,,,,,,,,;
BAT_SPLT,930932,930931,'SHUTE-INV', 0.6
BAT_BUS_CHNG_3,930931,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,930932,930931,'2',1,930932,600,0,0,0,33,0,930932,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0,
1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
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BAT_MBIDBRN,930931,930932,'2','1'
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BAT_MACHINE_DATA_2,930931,'DG',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,930931,'DG',,,,,,1, 10.0,,0.0,0.0, 10.0,0.0, 10.0,, 9999.0,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//SNOW STREET:
BAT_SPLT,113402,934022,'SNOW -GSU', 13.2
BAT_BRANCH_CHNG,113402,934022,'1',,,,,, 0.019277, 0.010182, 0.4E-04,,,,,,,,,,,,;
BAT_SPLT,934022,934021,'SNOW -INV', 0.6
BAT_BUS_CHNG_3,934021,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,934022,934021,'2',1,934022,600,0,0,0,33,0,934022,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0,
1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
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BAT_MBIDBRN,934021,934022,'2','1'
```

BAT_PLANT_DATA,934021,0, 1.0, 100.0
BAT_MACHINE_DATA_2,934021,'DG',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,934021,'DG',,,,,,1, 12.1,,0.0,0.0, 12.1,0.0, 12.1,, 9999.0,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//WENDELL DEPOT - 1:
BAT_SPLT,113085,930852,'WENDE-GSU', 13.8
BAT_BRANCH_CHNG,113085,930852,'1',,,,,,, 0.019277, 0.010182, 0.4E-04,,,,,,,,,,,,,;
BAT_SPLT,930852,930851,'WENDE-INV', 0.6
BAT_BUS_CHNG_3,930851,2,,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,930852,930851,'2',1,930852,600,0,0,0,33,0,930852,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0,
1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,930851,930852,'2',,,,,,,,,,,,,,2,, 0.009713, 0.0575, 10.0,,,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,930851,930852,'1'
BAT_MBIDBRN,930851,930852,'2','1'
BAT_PLANT_DATA,930851,0, 1.0, 100.0
BAT_MACHINE_DATA_2,930851,'DG',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,930851,'DG',,,,,,1, 10.0,,0.0,0.0, 10.0,0.0, 10.0,, 9999.0,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//WENDELL DEPOT - 2:
BAT_SPLT,113085,990852,'WEND2-GSU', 13.8
BAT_BRANCH_CHNG,113085,990852,'1',,,,,,, 0.019277, 0.010182, 0.4E-04,,,,,,,,,,,,,;
BAT_SPLT,990852,990851,'WEND2-INV', 0.6
BAT_BUS_CHNG_3,990851,2,,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,990852,990851,'2',1,990852,600,0,0,0,33,0,990852,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0,
1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,990851,990852,'2',,,,,,,,,,,,,,2,, 0.009713, 0.0575, 5.0,,,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,990851,990852,'1'
BAT_MBIDBRN,990851,990852,'2','1'
BAT_PLANT_DATA,990851,0, 1.0, 100.0
BAT_MACHINE_DATA_2,990851,'DG',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,990851,'DG',,,,,,1, 5.0,,0.0,0.0, 5.0,0.0, 5.0,, 9999.0,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

DYR File

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//BELCHERTOWN:
   930651 'USRMDL' DG  'REGCAU1'  101   1    1   14    3    4      0
       0.20000E-01   15.000      0.8000      0.79000       1.0000
        2.0000       0.8000      0.0000      -2.0000      0.20000E-01
        0.0000       15.000     -15.000       1.0000      /
   930651 'USRMDL' DG  'REECAU1'  102    0    6    45   6   9
        0       0       0       0       0       1
        0.5000         1.1000         0.20000E-01    -0.10000         0.10000
        2.0000         1.0000         -1.0000          0.0000          0.0000
        0.0000         0.0000         0.20000E-01      1.0000         -1.0000
        1.2000        -1.2000          1.0000          5.0000          1.0000
        5.0000         0.0000         0.20000E-01      1.0000         -1.0000
        1.0000        -1.0000          1.0000          0.25000E-01     0.1000
        0.0000         0.4990          0.0000          0.5000          1.0000
        1.1000         1.0000          0.1000          0.0000          0.4990
        0.0000         0.5000          1.0000          1.1000          1.0000      /
   // 930651 'USRMDL' DG  'REPCAU1'  107   0    7    27   7   9
          // 0       0      0    0       0       0       0
       // 0.20000E-01      1.0000          5.0000          0.0000          0.10000
        // 0.8000          0.0000          0.0000          0.0000          0.10000
      // -0.10000          0.0000          0.0000          1.0000         -1.0000
      // 0.1000E-01        2.5000        0.20000E-01      0.0000          0.00000
        // 10000.         -10000.         1.0000         -1.0000          0.10000
        // 20.000          20.000      /

/ LOW VOLTAGE PROTECTIONS
     930651001   'VTGDCAT'    930651    930651 'DG '  0.880000      10.000      2.0000      0.0000      /
     930651002   'VTGDCAT'    930651    930651 'DG '  0.500000      10.000      1.1000      0.0000      /
/ HIGH VOLTAGE PROTECTIONS
     930651003   'VTGDCAT'    930651   930651 'DG '   0.0000      1.1000      2.0000      0.0000      /
     930651004   'VTGDCAT'    930651   930651 'DG '   0.0000      1.2000      0.1600      0.0000      /
/ LOW FREQUENCY PROTECTIONS
     930651005   'FRQDCAT'    930651   930651 'DG '  58.5        100.0       300.00       0.0000      /
     930651006   'FRQDCAT'    930651   930651 'DG '  56.5        100.0       0.1600       0.0000      /
/ HIGH FREQUENCY PROTECTIONS
     930651007  'FRQDCAT'    930651   930651  'DG '  00.0        61.2       300.00       0.0000      /
     930651008  'FRQDCAT'    930651   930651  'DG '  00.0        62.0       0.1600       0.0000      /

//CRYSTAL LAKE:
/ SUNGROW Inverter Model - Crystal Lake
933961 'USRMDL' DG  'REGCAU1'  101   1    1   14    3    4     0
              0.020        10.0         0.90         0.50         1.0
              1.0          0.90         0.03         -1.0         0.001
              0.00         99.0         -99.0        1.00/
933961 'USRMDL' DG  'REECAU1'  102    0    6    45   6   9
              102      0      1      1      0            0
              0.50         1.2          0.001        -0.10        0.10         2.0          1.00         -1.0         1.00
              0.0          0.0          0.0          0.01         0.60         -0.60        1.10         0.9          1            5
              1            3.0          0.0          0.016668     999          -999         1            0            1.0
              0.10         0.0          0.0          0.49         0.0          0.5          1.0          1.2          1.0
              0.0          0.0          0.49         0.0          0.5          1.0          1.2          1.0/
// / Merit SI PPC
// 933961 'USRMDL' DG 'REPCAU1' 107 0 7 27 7 9
              // 102       103          102          '1'          0            0            0
              // 0.05      0.5          3            0            0.05         0.9
              // 0         0            0            0.05         -0.05        0
              // 0         0.6          -0.6         0.5          0.25         0.25
              // -0.0006   0.0006       999          -999         1            0
              // 0.7       20           20 /
933961001 'VTGTPAT' 933961 933961 DG -1 1.2 0.16 0.0 /
933961002 'VTGTPAT' 933961 933961 DG -1 1.1 2.0 0.0 /
933961003 'VTGTPAT' 933961 933961 DG 0.5 5 1.10 0.0 /
933961004 'VTGTPAT' 933961 933961 DG 0.88 5 2.0 0.0 /
933961005 'FRQTPAT' 933961 933961 DG 56.5 100 0.16 0.0 /
933961006 'FRQTPAT' 933961 933961 DG 58.5 100 300.0 0.0 /
933961007 'FRQTPAT' 933961 933961 DG -100 62.0 0.16 0.0 /
933961008 'FRQTPAT' 933961 933961 DG -100 61.2 300.0 0.0 /

//5 CORNERS:
/ SUNGROW Inverter Model - 5 corners
931151 'USRMDL' DG  'REGCAU1'  101   1    1   14    3    4     0
              0.020        10.0         0.90         0.50         1.0
              1.0          0.90         0.03         -1.0         0.001
              0.00         99.0         -99.0        1.00/
931151 'USRMDL' DG  'REECAU1'  102    0    6    45   6   9
              102      0      1      0      0            0
              0.50         1.20         0.001        -0.10        0.10         2.0          1.00         -1.0         1.00
              0.0          0.0          0.0          0.01         0.60         -0.60        1.10         0.9          1            5
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                1            3.0          0.0          0.016668   999          -999         1            0            1.0
                0.10         0            0            0.49       0            0.5          1.0          1.2          1.0
                0            0            0.49         0          0.5          1.0          1.2          1.0/
// / Merit SI PPC
// 931151 'USRMDL' DG 'REPCAU1' 107 0 7 27 7 9
                // 102       103          102          '1'        0            0            0
                // 0.05      0.5          3            0          0.05         0.9
                // 0         0            0            0.05       -0.05        0
                // 0         0.6          -0.6         0.5        0.25         0.25
                // -0.0006   0.0006       999          -999       1            0
                // 0.7       20           20 /
931151001 'VTGTPAT' 931151 931151 DG 0 1.2 0.16 0.0 /
931151002 'VTGTPAT' 931151 931151 DG 0 1.1 2.00 0.0 /
931151003 'VTGTPAT' 931151 931151 DG 0.5 999 1.10 0.0 /
931151004 'VTGTPAT' 931151 931151 DG 0.88 999 2.00 0.0 /
931151005 'FRQTPAT' 931151 931151 DG 56.5 999 0.16 0.0 /
931151006 'FRQTPAT' 931151 931151 DG 58.5 999 300.0 0.0 /
931151007 'FRQTPAT' 931151 931151 DG 0 62.0 0.16 0.0 /
931151008 'FRQTPAT' 931151 931151 DG 0 61.2 300.0 0.0 /

//LASHAWAY:
930791 'USRMDL' DG 'REGCAU1' 101 1 1 14 3 4
      0
      0.01    3.0  0.505  0.50  1.0   1.20   0.01
      0.011  -1.00  0.01    1.0  3.0  -3.0  1.000/
930791 'USRMDL' DG 'REECAU1' 102 0 6 45 6 9
      0 0 0 0 0 0
       0.5000  1.2000   0.0100   0.0000   0.0000  0.0000  1.0000  -1.0000
       0.5     0.0000   0.0000  0.0000    0.01   0.8000  -0.8000
       1.1000  0.9000   0.0100   0.1000   1.0000     0.1000  0.0000   0.01   1.0  -1.0
       1.0000  0.0000   1.0000   0.04     0.001    0.0   0.499   0.0   0.5   1.0   1.2000
       1.0  0.001  0.0   0.499   0.0   0.5   1.0   1.2000   1.0 /
// 930791 'USRMDL' DG 'REPCAU1' 107 0 7 27 7 9
    // 0 0 0 0 0 0 1
    // 0.01  0.6   3.0  0.0000   0.00     0.5  0.0000   0.0000   0.0000  1.0
   // -1.0  0.0000   0.0000   0.8  -0.8    2.0  7.0   0.01   -999.0000   999.0
   // 999.00 -9000.0   1.0000   0.0000   0.01   0.0000  0.0000/
930791001 'VTGTPAT' 930791 930791 DG -1.00 1.10  2.0 0.0 /
930791002 'VTGTPAT' 930791 930791 DG -1.00 1.20 0.16 0.0 /
930791003 'VTGTPAT' 930791 930791 DG 0.88 5 2.0 0.0 /
930791004 'VTGTPAT' 930791 930791 DG 0.50 5 1.10 0.0 /
930791005 'FRQTPAT' 930791 930791 DG 58.5 100 300.0 0.0 /
930791006 'FRQTPAT' 930791 930791 DG 56.5 100 0.16 0.0 /
930791007 'FRQTPAT' 930791 930791 DG -100 61.2 300.0 0.0 /
930791008 'FRQTPAT' 930791 930791 DG -100 62.0 0.16 0.0 /

//LITTLE REST ROAD -1 :
/ WECC MODELS
 930761 'USRMDL' DG  'REGCAU1'  101   1    1   14    3    4      0
        0.20000E-01   10.000      0.80000      0.79000       1.0000
         2.0000      0.80000       0.0000      -2.0000      0.20000E-01
         0.0000       2.0000      -2.0000       1.0000       /
 930761 'USRMDL' DG  'REECAU1'  102    0    6    45    6    9
         0      0      0      0      0      1
         0.5000        1.2000        0.20000E-01    -0.10000        0.10000
         2.0000        1.0000       -1.0000         0.0000          0.0000
                              0.0000         0.0000        0.20000E-01
         1.0000       -1.0000        1.2000        -1.2000          1.0000
         5.0000        1.0000        5.0000         0.0000          0.20000E-01
         1.0000       -1.0000         1.0000       -1.0000          1.0000
         0.25000E-01    0.0000         0.0000         0.4900          0.0000
         0.5000        1.0000         1.2000        1.0000          0.0000
                0.0000         0.4900         0.0000         0.5000          1.0000
                1.2000         1.0000   /
 // 930761 'USRMDL' DG  'REPCAU1'  107   0    7    27   7   9
          // 991101        991101       991100    '1 '       0       0       0
        // 0.20000E-01      1.0000          3.4000          0.0000          0.10000
         // 0.0000          0.0000          0.0000          0.0000          0.10000
       // -0.10000          0.0000          0.0000          1.0000         -1.0000
       // 0.1000E-01        2.5000        0.20000E-01       0.0000          0.00000
         // 10000.         -10000.          1.0000          0.0000          0.1000
         20.000          20.000      /
/ LOW VOLTAGE PROTECTIONS
      930761001   'VTGDCAT'      930761     930761  'DG'
        0.88000       999.000       2.0000       0.0000       /
      930761002   'VTGDCAT'      930761     930761  'DG'
        0.50000       999.000       1.1000       0.0000       /
      930761003   'VTGDCAT'      930761     930761  'DG'
        0.60000       10.000       6550.0       0.0000      /
/ HIGH VOLTAGE PROTECTIONS
      930761004   'VTGDCAT'      930761     930761  'DG'
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        0.0000       10.000       6550.0       0.0000      /
      930761005   'VTGDCAT'      930761     930761  'DG'
        0.0000       1.1000       2.0000       0.0000      /
      930761006   'VTGDCAT'      930761     930761  'DG'
        0.0000       1.2000      0.16000       0.0000      /
      930761007   'VTGDCAT'      930761     930761  'DG'
        0.0000       1.4000      0.10000E-02   0.0000      /
/ LOW FREQUENCY PROTECTIONS
      930761008   'FRQDCAT'      930761     930761  'DG'
        58.500       999.00       300.00       0.0000      /
      930761009   'FRQDCAT'      930761     930761  'DG'
        56.500       999.00      0.16000       0.0000      /
     930761010   'FRQDCAT'      930761     930761  'DG'
        57.000       100.00       6550.0       0.0000      /
     930761011   'FRQDCAT'      930761     930761  'DG'
        55.000       100.00       6550.0       0.0000      /
/ HIGH FREQUENCY PROTECTIONS
     9307610012   'FRQDCAT'      930761     930761  'DG'
        0.0000       61.200       300.00       0.0000      /
     930761013   'FRQDCAT'      930761     930761  'DG'
        0.0000       62.000      0.16000       0.0000      /
     930761014   'FRQDCAT'      930761     930761  'DG'
        0.0000       63.000       6550.0       0.0000      /
     930761015   'FRQDCAT'      930761     930761  'DG'
        0.0000       64.000       6550.0       0.0000      /

//LITTLE REST ROAD -2:
 990761 'USRMDL' DG  'REGCAU1'  101   1    1   14    3    4      0
       0.20000E-01   10.000      0.80000      0.79000       1.0000
        2.0000      0.80000       0.0000      -2.0000      0.20000E-01
        0.0000       2.0000      -2.0000       1.0000      /
 990761 'USRMDL' DG  'REECAU1'  102    0    6    45   6   9
           0       0       0       0       0       1
       0.50000         1.2000        0.20000E-01    -0.10000         0.10000
        2.0000         1.0000        -1.0000         0.0000          0.0000
        0.0000         0.0000        0.20000E-01      1.0000         -1.0000
        1.2000        -1.2000         1.0000         5.0000          1.0000
        5.0000         0.0000        0.20000E-01      1.0000         -1.0000
        1.0000        -1.0000         1.0000        0.25000E-01      0.0000
        0.0000        0.49000         0.0000        0.50000          1.0000
        1.2000         1.0000         0.0000         0.0000         0.49000
        0.0000        0.50000         1.0000         1.2000          1.0000      /
 // 990761 'USRMDL' DG  'REPCAU1'  107   0    7    27   7   9
       // 991101      991101      991100    '1'       0       0       0
       // 0.20000E-01      1.0000          3.4000          0.0000         0.10000
        // 0.0000          0.0000          0.0000          0.0000         0.10000
      // -0.10000          0.0000          0.0000          1.0000         -1.0000
       // 0.10000E-01      2.5000        0.20000E-01      0.0000          0.0000
        // 10000.         -10000.          1.0000          0.0000         0.10000
        // 20.000          20.000      /
      990761001   'VTGDCAT'    990761   990761  'DG'
       0.88000       999.00       2.0000       0.0000      /
      990761002   'VTGDCAT'    990761   990761  'DG'
       0.50000       999.00       1.1000       0.0000      /
      990761003   'VTGDCAT'    990761   990761  'DG'
       0.60000       10.000       6550.0       0.0000      /
      990761004   'VTGDCAT'    990761   990761  'DG'
        0.0000       10.000       6550.0       0.0000      /
      990761005   'VTGDCAT'    990761   990761  'DG'
        0.0000       1.1000       2.0000       0.0000      /
      990761006   'VTGDCAT'    990761   990761  'DG'
        0.0000       1.2000      0.16000       0.0000      /
      990761007   'VTGDCAT'    990761   990761  'DG'
        0.0000       1.4000      0.10000E-02   0.0000      /
      990761008   'FRQDCAT'    990761   990761  'DG'
        58.500       999.00       300.00       0.0000      /
      990761009   'FRQDCAT'    990761   990761  'DG'
        56.500       999.00      0.16000       0.0000      /
     990761010   'FRQDCAT'    990761   990761  'DG'
        57.000       100.00       6550.0       0.0000      /
     990761011   'FRQDCAT'    990761   990761  'DG'
        55.000       100.00       6550.0       0.0000      /
     990761012   'FRQDCAT'    990761   990761  'DG'
        0.0000       61.200       300.00       0.0000      /
     990761013   'FRQDCAT'    990761   990761  'DG'
        0.0000       62.000      0.16000       0.0000      /
     990761014   'FRQDCAT'    990761   990761  'DG'
        0.0000       63.000       6550.0       0.0000      /
     990761015   'FRQDCAT'    990761   990761  'DG'
        0.0000       64.000       6550.0       0.0000      /
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//POWDER MILL - 1:
/ SUNGROW Inverter Model - add powder mill SunRaise Development
930071 'USRMDL' DG  'REGCAU1'  101   1    1   14    3    4      0
                0.020          10.0           0.90           0.50           1.0
                1.0            0.90           0.03           -1.0           0.001
                0.00           99.0           -99.0          1.00/
930071 'USRMDL' DG  'REECAU1'  102    0    6    45   6   9
                102       0       1       1       0         0
                0.50           1.20           0.001          -0.10          0.10           2.0            1.00           -1.0           1.00
                0.0            0.0            0.0            0.01           0.60           -0.60          1.10           0.9            1              5
                1              3.0            0.0            0.016668       999            -999           1              0              1.0
                0.10           0              0              0.49           0              0.5            1.0            1.2            1.0
                0              0              0.49           0              0.5            1.0            1.2            1.0/
// / Merit SI PPC
// 930071 'USRMDL' DG 'REPCAU1' 107 0 7 27 7 9
                // 102         103            102            '1'            0              0              0
                // 0.05        0.5            3              0              0.05           0.9
                // 0           0              0              0.05           -0.05          0
                // 0           0.6            -0.6           0.5            0.25           0.25
                // -0.0006     0.0006         999            -999           1              0
                // 0.7         20             20 /
930071001 'VTGTPAT' 930071 930071 DG 0 1.2 0.16 0.0 /
9300710012 'VTGTPAT' 930071 930071 DG 0 1.1 2.00 0.0 /
9300710013 'VTGTPAT' 930071 930071 DG 0.5 999 1.10 0.0 /
9300710014 'VTGTPAT' 930071 930071 DG 0.88 999 2.00 0.0 /
9300710015 'FRQTPAT' 930071 930071 DG 56.5 999 0.16 0.0 /
9300710016 'FRQTPAT' 930071 930071 DG 58.5 999 300.0 0.0 /
9300710017 'FRQTPAT' 930071 930071 DG 0 62.0 0.16 0.0 /
9300710018 'FRQTPAT' 930071 930071 DG 0 61.2 300.0 0.0 /

//POWDER MILL - 2:
990071 'USRMDL' DG 'REGCAU1' 101 1 1 14 3 4
      0
      0.02 10.0 0.1 0.0 1.0 2.0 0.1 0.0 -1.0 0.015
      0.0 99.0 -99.0 0.0 /
990071 'USRMDL' DG 'REECAU1' 102 0 6 45 6 9
      0 1 0 0 0 0
      0.5 1.2 0.015 -0.1 0.1 2.0 1.0 -1.0 0.0 0.0 0.0 0.0 0.0
      1.0 -1.0 1.1 0.9 0.0 0.0001 0.0 0.0 0.0001 0.0 1.0
     -1.0 1.0 0.0 1.0 0.0 0.0 0.0 0.49 0.0 0.5 1.0 1.2 1.0 0.0
     0.0 0.49 0.0 0.5 1.0 1.2 1.0/
9900711 'VTGTPAT' 990071 990071 DG -1.00 1.10  2.0 0.0 /
9900712 'VTGTPAT' 990071 990071 DG -1.00 1.20 0.16 0.0 /
9900713 'VTGTPAT' 990071 990071 DG 0.88 5 2.0 0.0 /
9900714 'VTGTPAT' 990071 990071 DG 0.50 5 1.10 0.0 /
9900715 'FRQTPAT' 990071 990071 DG 58.5 100 300.0 0.0 /
9900716 'FRQTPAT' 990071 990071 DG 56.5 100 0.16 0.0 /
9900717 'FRQTPAT' 990071 990071 DG -100 61.2 300.0 0.0 /
9900718 'FRQTPAT' 990071 990071 DG -100 62.0 0.16 0.0 /

//SHUTESBURRY:
/ WECC MODELS
 930931 'USRMDL' DG  'REGCAU1'  101   1    1   14    3    4      0
        0.20000E-01   10.000      0.80000      0.79000       1.0000
         2.0000      0.80000       0.0000      -2.0000      0.20000E-01
         0.0000       2.0000      -2.0000       1.0000      /
 930931 'USRMDL' DG  'REECAU1'  102    0    6    45   6   9
         0       0       0       0       0       1
         0.5000         1.2000        0.20000E-01    -0.10000         0.10000
         2.0000         1.0000       -1.0000          0.0000          0.0000
                        0.0000          0.0000        0.20000E-01
         1.0000       -1.0000         1.2000         -1.2000          1.0000
         5.0000         1.0000        5.0000          0.0000          0.20000E-01
         1.0000       -1.0000         1.0000        -1.0000          1.0000
         0.25000E-01    0.0000         0.0000         0.4900          0.0000
         0.5000         1.0000         1.2000         1.0000          0.0000
                0.0000          0.4900         0.0000         0.5000          1.0000
                1.2000          1.0000   /
 // 930931 'USRMDL' DG  'REPCAU1'  107    0    7    27    7    9
          // 991101        991101       991100     '1 '        0       0       0
        // 0.20000E-01      1.0000          3.4000          0.0000          0.10000
         // 0.0000          0.0000          0.0000          0.0000          0.10000
       // -0.10000          0.0000          0.0000          1.0000          -1.0000
        // 0.1000E-01        2.5000        0.20000E-01       0.0000          0.00000
          // 10000.         -10000.          1.0000          0.0000          0.1000
          // 20.000          20.000      /
/ LOW VOLTAGE PROTECTIONS
      930931001    'VTGDCAT'      930931     930931  'DG'
        0.88000       999.000       2.0000       0.0000      /
      930931002    'VTGDCAT'      930931     930931  'DG'
        0.50000       999.000       1.1000       0.0000      /
```

```
      930931003   'VTGDCAT'      930931     930931  'DG'
        0.60000       10.000       6550.0       0.0000      /
/ HIGH VOLTAGE PROTECTIONS
      930931004   'VTGDCAT'      930931     930931  'DG'
         0.0000       10.000       6550.0       0.0000      /
      930931005   'VTGDCAT'      930931     930931  'DG'
         0.0000       1.1000       2.0000       0.0000      /
      930931006   'VTGDCAT'      930931     930931  'DG'
         0.0000       1.2000      0.16000       0.0000      /
      930931007   'VTGDCAT'      930931     930931  'DG'
         0.0000       1.4000      0.10000E-02   0.0000      /
/ LOW FREQUENCY PROTECTIONS
      930931008   'FRQDCAT'      930931     930931  'DG'
         58.500       999.00       300.00       0.0000      /
      930931009   'FRQDCAT'      930931     930931  'DG'
         56.500       999.00      0.16000       0.0000      /
     930931010   'FRQDCAT'      930931     930931  'DG'
         57.000       100.00       6550.0       0.0000      /
     930931011   'FRQDCAT'      930931     930931  'DG'
         55.000       100.00       6550.0       0.0000      /
/ HIGH FREQUENCY PROTECTIONS
     930931012   'FRQDCAT'      930931     930931  'DG'
         0.0000       61.200       300.00       0.0000      /
     930931013   'FRQDCAT'      930931     930931  'DG'
         0.0000       62.000      0.16000       0.0000      /
     930931014   'FRQDCAT'      930931     930931  'DG'
         0.0000       63.000       6550.0       0.0000      /
     930931015   'FRQDCAT'      930931     930931  'DG'
         0.0000       64.000       6550.0       0.0000      /

//SNOW STREET:
/Snow St. WECC Models

934021 'USRMDL' DG 'REGCAU1' 101 1 1 14 3 4
0
0.01 2.0  0.505  0.50  1.0
1.20  0.01  0.011  -1.00  0.01
1.0  2.0  -2.0  1.000/

934021 'USRMDL' DG 'REECAU1' 102 0 6 45 6 9
0 0 1 0 0 0
0.5000  1.2000   0.0100   0.0000   0.0000
0.0000  1.0000  -1.0000   0.5   0.0000
0.0000  0.0000   0.01   0.8000  -0.8000
1.1000  0.9000   0.0100   0.1000   1.0000
0.1000  0.0000   0.01   1.0  -1.0
1.0000  0.0000   1.0000   0.04
0.001  0.0   0.499   0.0   0.5   1.0   1.2000   1.0
0.001  0.0   0.499   0.0   0.5   1.0   1.2000   1.0
/

// 934021 'USRMDL' DG 'REPCAU1' 107 0 7 27 7 9
// 0 0 0 0 0 0 1
// 0.01  0.6   3.0  0.0000   0.00
// 0.5  0.0000   0.0000   0.0000  1.0
// -1.0  0.0000   0.0000   0.8  -0.8
// 2.0  7.0   0.01   -999.0000   999.0
// 999.00 -9000.0   1.0000   0.0000   0.01
// 0.0000  0.0000/


934021012 'VTGTPAT' 934021 934021 DG  0.00  1.2 0.16 0.0 /
934021013 'VTGTPAT' 934021 934021 DG  0.5  10 1.10 0.0 /
934021014 'VTGTPAT' 934021 934021 DG  0.88  1.1 2.00 0.0 /

934021015 'FRQTPAT' 934021 934021 DG  56.5  62 0.100 0.0 /
934021016 'FRQTPAT' 934021 934021 DG  58.5  61.2 300.0 0.0 /

//WENDELL DEPOT - 1:
   990851 'USRMDL' DG  'REGCAU1'  101   1    1   14    3    4      1
        0.20000E-01   999        0.50000      0.0000       0.0600
         1.2500      0.90000       0.4000      -0.0600      0.20000E-01
         0.0800       100.00      -100.00       1.0000       /
  990851 'USRMDL' DG  'REECAU1' 102   0   6   45   6   9
        0         1       0       0       0     0
         0.0500          1.200         0.10000E-01      0.0100          0.0100       0.0000
         1.0000         -1.0000          0.0000         0.0000        0.0000            0.0000
         0.10000E-01      1.0000        -1.0000          1.2000         0.50000          0.0000
         0.0000          0.0000          0.0000         0.0000        0.20000E-01     1.25000
       -1.25000         1.0000          0.0000          1.1000         0.10000E-01     0.0
       0.0     0.49    0.0    0.5    1.0    1.2     1.0    0.0
```

```
      0.0    0.49      0.0      0.5     1.0     1.2      1.0       /
990851001 'VTGTPAT' 990851 990851 DG -1.00 1.10  2.0 0.0 /
990851002 'VTGTPAT' 990851 990851 DG -1.00 1.20 0.16 0.0 /
990851003 'VTGTPAT' 990851 990851 DG 0.88 5 2.0 0.0 /
990851004 'VTGTPAT' 990851 990851 DG 0.50 5 1.10 0.0 /
990851005 'FRQTPAT' 990851 990851 DG 58.5 100 300.0 0.0 /
990851006 'FRQTPAT' 990851 990851 DG 56.5 100 0.16 0.0 /
990851007 'FRQTPAT' 990851 990851 DG -100 61.2 300.0 0.0 /
990851008 'FRQTPAT' 990851 990851 DG -100 62.0 0.16 0.0 /

//WENDELL DEPOT - 2:
/ SUNGROW Inverter Model - add Wendell Depot DG- O YA Solar
930851 'USRMDL' DG  'REGCAU1'  101   1    1   14    3    4      0
        0.020     10.0      0.90      0.50      1.0
        1.0       0.90      0.03      -1.0      0.001
        0.00      99.0      -99.0     1.00/
930851 'USRMDL' DG  'REECAU1'  102    0    6    45   6   9
        102    0    1    0    0       0
        0.50      1.2       0.001     -0.10     0.10      2.0       1.00      -1.0      1.00
        0.0       0.0       0.0       0.01      0.60      -0.60     1.10      0.9       1         5
        1         3.0       0.0       0.016668  999       -999      1         0         1.0
        0.10      0.0       0.0       0.49      0.0       0.5       1.0       1.2       1.0
        0.0       0.0       0.49      0.0       0.5       1.0       1.2       1.0/
// / Merit SI PPC
// 930851 'USRMDL' DG 'REPCAU1' 107 0 7 27 7 9
        // 102    103       102       '1'       0         0         0
        // 0.05   0.5       3         0         0.05      0.9
        // 0      0         0         0.05      -0.05     0
        // 0      0.6       -0.6      0.5       0.25      0.25
        // -0.0006  0.0006  999       -999      1         0
        // 0.7    20        20 /
930851001 'VTGTPAT' 930851 930851 DG -1 1.2 0.16 0.0 /
930851002 'VTGTPAT' 930851 930851 DG -1 1.1 2.0 0.0 /
930851003 'VTGTPAT' 930851 930851 DG 0.5 5 1.10 0.0 /
930851004 'VTGTPAT' 930851 930851 DG 0.88 5 2.0 0.0 /
930851005 'FRQTPAT' 930851 930851 DG 56.5 100 0.16 0.0 /
930851006 'FRQTPAT' 930851 930851 DG 58.5 100 300.0 0.0 /
930851007 'FRQTPAT' 930851 930851 DG -100 62.0 0.16 0.0 /
930851008 'FRQTPAT' 930851 930851 DG -100 61.2 300.0 0.0 /

//E WINCHENDON :
/ WECC MODELS - E.Winchendon solar
    933951 'USRMDL' DG  'REGCAU1'  101   1    1   14    3    4      0
       0.20000E-01   10.000      0.8000     0.79000      1.0000
        2.0000       0.8000      0.0000     -2.0000      0.20000E-01
        0.0000       2.000       -2.000      1.0000      /
    933951 'USRMDL' DG  'REECAU1'  102    0    6    45   6   9
        0      0      0      0      0      1
        0.5000         1.2000        0.20000E-01    -0.10000        0.10000
        2.0000         1.0000        -1.0000         0.0000         0.0000
        0.0000         0.0000        0.20000E-01     1.0000        -1.0000
        1.2000        -1.2000         1.0000         5.0000         1.0000
        5.0000         0.0000        0.20000E-01     1.0000        -1.0000
        1.0000        -1.0000         1.0000        0.25000E-01     0.10000
        0.0000         0.49900        0.0000         0.5000         1.0000
        1.1000         1.0000        0.10000         0.0000         0.4990
        0.0000         0.5000         1.0000         1.10000        1.0000      /
    // 933951 'USRMDL' DG  'REPCAU1'  107   0   7    27   7   9
          // 1101        1101      1100    '1 '       0       0       0
        // 0.20000E-01      1.0000        5.00000         0.0000         0.10000
         // 0.8000          0.0000         0.0000         0.0000         0.10000
       // -0.10000          0.0000         0.0000         1.0000        -1.0000
       // 0.1000E-01        2.5000        0.20000E-01      0.0000         0.00000
         // 10000.         -10000.         1.0000        -1.0000         0.1000
         // 20.000          20.000     /


/ LOW VOLTAGE PROTECTIONS
     933951001   'VTGDCAT'    933951    933951 'DG'  0.880000     10.000     2.0000     0.0000     /
     933951002   'VTGDCAT'    933951    933951 'DG'  0.500000     10.000     1.1000     0.0000     /
/ HIGH VOLTAGE PROTECTIONS
     933951003   'VTGDCAT'    933951    933951 'DG'   0.0000     1.1000     2.0000     0.0000     /
     933951004   'VTGDCAT'    933951    933951 'DG'   0.0000     1.2000     0.1600     0.0000     /
/ LOW FREQUENCY PROTECTIONS
     933951005   'FRQDCAT'    933951    933951 'DG'  58.5       100.0      300.00     0.0000     /
     933951006   'FRQDCAT'    933951    933951 'DG'  56.5       100.0      0.1600     0.0000     /
/ HIGH FREQUENCY PROTECTIONS
     933951007  'FRQDCAT'    933951    933951  'DG'  00.0       61.2       300.00     0.0000     /
     933951008  'FRQDCAT'    933951    933951  'DG'  00.0       62.0       0.1600     0.0000     /
```

Appendix D - Stability Model for Otter River DVAR

DYR File

```
/ / AMSC D-VAR PSSE CDVAR6 User Model - Rev 33, Sep 2018
'OTTER DVAR 1','USRFCT','CDVAR6U1',21,1,34,70,1,124,
0,113019,113019,113019,0,0,-1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
0,0.03,0.01,0.005,0.03,0.01,0.005,2,200,16,0,0.04,0.1,0.05,0.87,0.04,0.1,0.05,1.115,2,400,1.5,2,0.5,
0.2,1,0.01,4,0,0,0.004,0.25,1,0.1,
-1,0.2,-0.52,3,1,0.2,0.52,3,120,80,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.936,12.39/

'OTTER DVAR 2','USRFCT','CDVAR6U1',21,1,34,70,1,124,
0,113019,113019,113019,0,0,-1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,
0,0.03,0.01,0.005,0.03,0.01,0.005,2,200,16,0,0.04,0.1,0.05,0.87,0.04,0.1,0.05,1.115,2,400,1.5,2,0.5,
0.2,1,0.01,4,0,0,0.004,0.25,1,0.1,
-1,0.2,-0.52,3,1,0.2,0.52,3,120,80,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.936,12.39/
```

This appendix has been redacted for Critical Energy/Electric Infrastructure Information.

Appendix E - N-1 Thermal and Voltage Results

This appendix has been redacted for Critical Energy/Electric Infrastructure Information.

Appendix F – Stability Analysis Plots

Appendix F_WCMA DER Group 2_Stability Analysis Plots.zip

This appendix has been redacted for Critical Energy/Electric Infrastructure Information.

Appendix G - PSCAD Study Report

Western MA DER Group 2 PSCAD final report 4_29_2020.pdf

Transmission System Impact Study Results for Group 3 of Distributed Energy Resource (DER) Additions in Western Massachusetts

This document has been redacted for Critical Energy/Electric Infrastructure Information (CEII).

June 2022

Prepared by:
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nationalgrid

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1 EXECUTIVE SUMMARY

This document provides the transmission system impact study results for Group 3 of National Grid's Western MA DER interconnection cluster study. Group 3 consists of the third stage of proposed Distributed Energy Resources (DER) additions applying for interconnection into the National Grid distribution system in Western MA. Groups 1 and 2 (previously approved) consisted of 314 MW of DER in Western Massachusetts, after accounting for all project attrition. None of Group 1 and 2 DER can charge from the transmission grid. Group 3 consists of an additional 252 MW of DER in Western MA, of which 121 MW can charge from the transmission system.

The following table shows the Group 3 DER broken down by Generation type.

Table 1 - Group 3 DER by Generation Type

Generation Type	Group 3 Total PV + BESS Discharging Limit[1] (kW)	Group 3 Total BESS Charging Limit[2] (kW)
PV Only	9,998	N/A
BESS Only	164,750	113,550
PV+DC BESS*	51,681	6,150
PV+AC BESS**	25,448	1,000
Grand Total	**251,877**	**120,700**

*With DC coupled PV+BESS, the PV and BESS share the same inverter
** With AC coupled PV+BESS, the PV and BESS are each equipped with dedicated inverters

Results of the steady state analysis indicate the the following Transmission upgrades need to be made to accommodate the integration of the Group 3 DER,

- **A1/B2 line rebuild/reconductor:** The A1/B2 69 kV transmission lines were found to overload following the addition of Group 3 DER. These overloads will be eliminated following the rebuild of both lines that is already planned due to asset condition issues. The lines will be rebuilt using 795 ACSS conductor. The refurbishment is scheduled to be completed in 2027.

- **Royalston Breaker Additions**: Voltage problems were identified at several substations along the A1/B2 lines following the addition of Group 3 DER. 69 kV breaker additions at Royalston substation, already planned as part of the A1/B2 rebuild project, will resolve these high voltage problems.

[1] Discharging limit imposed by distribution system constraints
[2] Charging limit imposed by distribution system constraints

- **Vernon 69 kV substation rebuild**: A-1 and B-2 69 kV terminal equipment at Vernon substation were found to overload following the addition of Group 3 DER. There is presently an asset condition project planned to rebuild Vernon station (to be renamed "Huntington" substation) which will eliminate the overloads. The rebuild is scheduled to be completed in 2026.

- **E5/F6 line rebuild/reconductor:** The E-5/F-6 69 kV transmission lines were found to overload following the addition of Group 3 DER if [redacted] Solar (QP1031) is built These overloads will be eliminated following the rebuild of both E5/F6 lines, already scheduled to address asset condition issues on the lines. The lines will be rebuilt using 795 ACSS conductor. The rebuild project is scheduled to be completed in 2030. Note that if QP1031 is withdrawn, Group 3 DER alone does not cause the E5/F6 lines to become overloaded.

Transient stability, short circuit, and PSCAD analyses were also conducted during this study, and no issues were identified.

2 INTRODUCTION

This document provides the system impact study results for the interconnection of 252 MW of Distributed Energy Resources (DER), greater than 1 MW, into the Western Massachusetts distribution system, owned by National Grid, over the years 2022 to 2025. Below are some additional characteristics of the Group 3 DER:

- None of the additional DER will be directly connected to the transmission system.
- All the DER will be mixed with distribution load.
- None of the additional DER will control voltage.
- All DER was set to a power factor of unity in the study.
- All the DER will respond to frequency deviations.

2.1 Study Objective

The objective of this study is to identify the transmission upgrades, if any, required to integrate the proposed DER without resulting in any significant adverse impact on the reliability, stability, and operating characteristic of the New England bulk power transmission system and National Grid transmission system.

2.2 Project Description

252 MW of DER (>1 MW) have applied to interconnect to the National Grid distribution system in Western MA by 2025.

2.3 Study Area

The transmission system geographic map and one-line diagram of the study area are shown in the following figures, with the DER project locations identified.

Figure 1 - Proposed DER Locations - Geographic Map

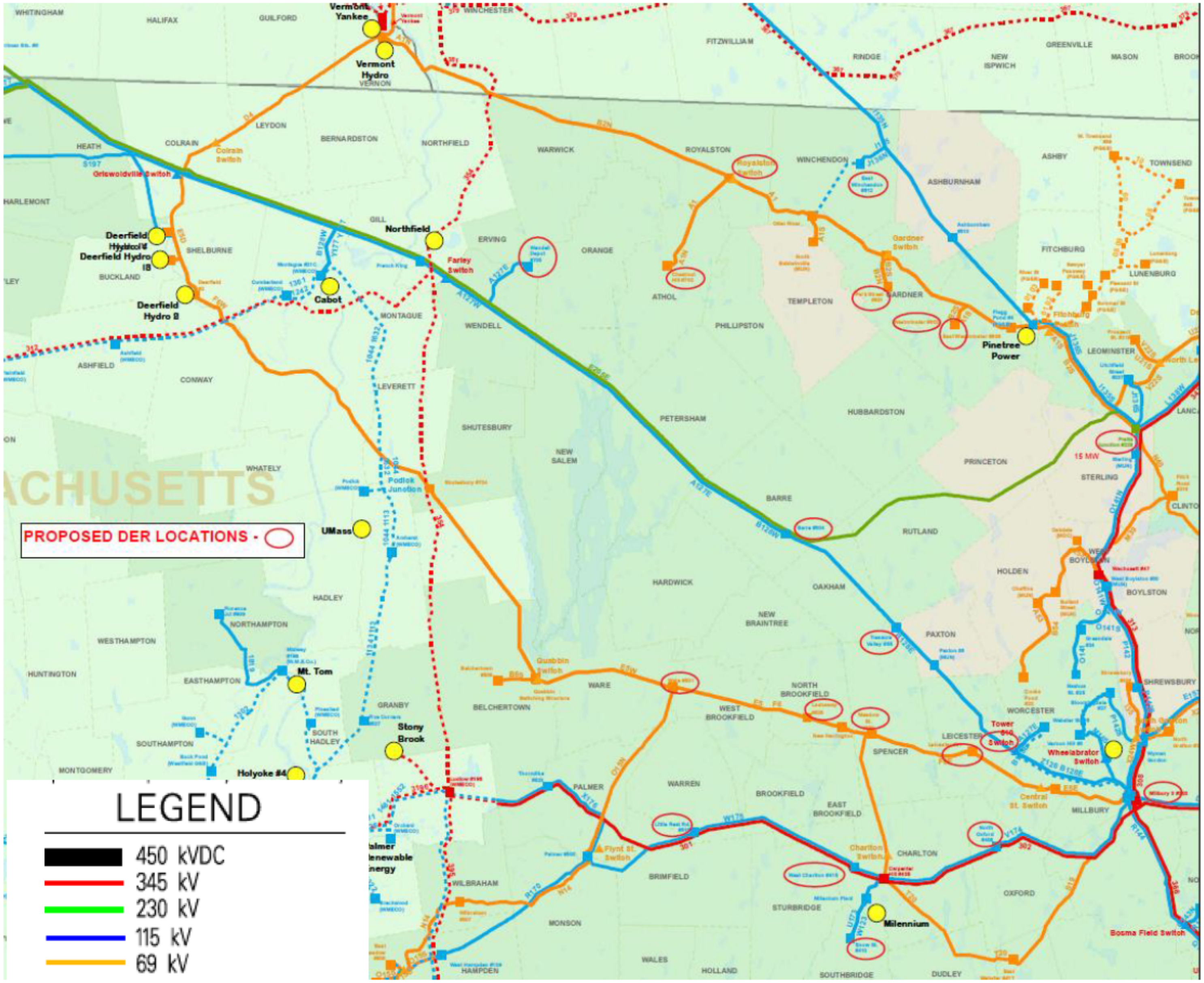


Figure 2 - Proposed DER locations for Group 3 - One Line Diagram

[redacted]

3 STUDY APPROACH

DER additions 1 MW and below, did not need to be added to the base cases for this study. The base cases utilized for this study already modeled DER 1 MW and below, via negative loads (with "PD" identifiers) that model the forecasted PV, 1 MW and below, out to year 2025. This DER, 1 MW and below, is distributed proportionally across the load busses in Western Massachusetts. Therefore, only DER additions that exceed 1 MW, were added to the cases utilized for this study. All 252 MW associated with Group 3 is greater than 1 MW.

3.1 Group 3 Totals by Substation

The Group 3 total amounts to 252 MW of new DER, and constitutes the third increment of National Grid DER studied in Western MA. The DER totals for Group 3 are shown in the following table for each substation.

Table 2 - Group 3 Total DER by Substation

Substation	Generation Type	Group 3 Total PV + BESS Discharging Limit[3] (kW)	Group 3 Total BESS Charging Limit[4] (kW)
BARRE SUBSTATION	Battery only	8,000	8,000
	DC coupled	4,400	3,150
Crystal Lake SUBSTATION	Battery only	8,000	5,200
E. WESTMINSTER SUBSTATION	DC coupled	4,990	3,000
E. WINCHENDON SUBSTATION	Battery only	14,900	8,800
	PV Only	4,999	N/A
LASHAWAY SUBSTATION	Battery only	15,000	12,000
LITTLE REST RD SUBSTATION	AC Coupled	3,000	0
	DC coupled	2,800	0
MEADOW STREET 552 SUBSTATION	DC coupled	8,800	0
	PV Only	4,999	N/A
MILLBURY SUBSTATION	AC Coupled	2,750	0
	Battery only	10,000	3,500
N. OXFORD SUBSTATION	Battery only	13,600	11,200
	DC coupled	4,400	0
PRATTS JUNC. SUBSTATION	Battery only	11,000	7,000
ROYALSTON SUBSTATION	AC Coupled	7,500	0
SNOW ST. SUBSTATION	AC Coupled	4,998	1,000
	Battery only	18,250	14,750
STAFFORD ST SUBSTATION-New	Battery only	10,000	10,000
	DC coupled	12,500	0
TREASURE VALLEY SUBSTATION	Battery only	10,000	5,000
W. CHARLTON SUBSTATION	Battery only	20,000	8,500
WARE SUBSTATION	DC coupled	11,000	0
WENDELL DEPOT SUBSTATION	AC Coupled	7,200	0
	Battery only	18,000	15,200
	DC coupled	2,791	0
LAUREL CIRCLE SUBSTATION	Battery only	8,000	4,400
Grand Total		**251,877**	**120,700**

[3] Discharging Limits imposed by distribution system constraints
[4] Charging Limits imposed by distribution system constraints

The total DER studied for the Group 3 Western MA Cluster study amounts to 252 MW. This DER is incremental to the DER in Groups 1 and 2 of the Western Massachusetts Cluster, which amounted to 314 MW, after accounting for all project attrition within the clusters. No DER in Groups 1 and 2 can charge from the transmission system. The totals for Groups 1 and 2 are shown in the following table for each substation.

Table 3 – Group 1 + 2 DER Totals by Substation, Post Attrition

Substation for Groups 1 + 2	**Total MW**
ADAMS SUBSTATION	11
ASHBURNHAM SUBSTATION	5
BARRE SUBSTATION	12.4
BEAR SWAMP UPPER YARD SUBSTATION	2.5
BELCHERTOWN SUBSTATION	8
CHESTNUT HILL 702 SUBSTATION	3.3
Crystal Lake SUBSTATION	24.7
E. WEBSTER SUBSTATION	5
E. WESTMINSTER SUBSTATION	8
E. WINCHENDON SUBSTATION	3.9
EAST LONGMEADOW SUBSTATION	9
FIVE CORNERS SUBSTATION	3
LASHAWAY SUBSTATION	13.7
LEICESTER SUBSTATION	2.6
LITCHFIELD ST SUBSTATION	10
LITTLE REST RD SUBSTATION	6
MEADOW STREET 552 SUBSTATION	13.4
MILLBURY SUBSTATION	14.4
N. OXFORD SUBSTATION	8.7
PALMER 503 SUBSTATION	18
PONDVILLE SUBSTATION	4.9
SHUTESBURY	20
SNOW ST. SUBSTATION	24.7
THORNDIKE SUBSTATION	12.5
TREASURE VALLEY SUBSTATION	2.2
W. CHARLTON SUBSTATION	17
WARE SUBSTATION	13.3
WENDELL DEPOT SUBSTATION	15
West Hampden 139 SUBSTATION	13.2
WESTMINSTER SUBSTATION	4.9
WILBRAHAM SUBSTATION	4
Total	**314**

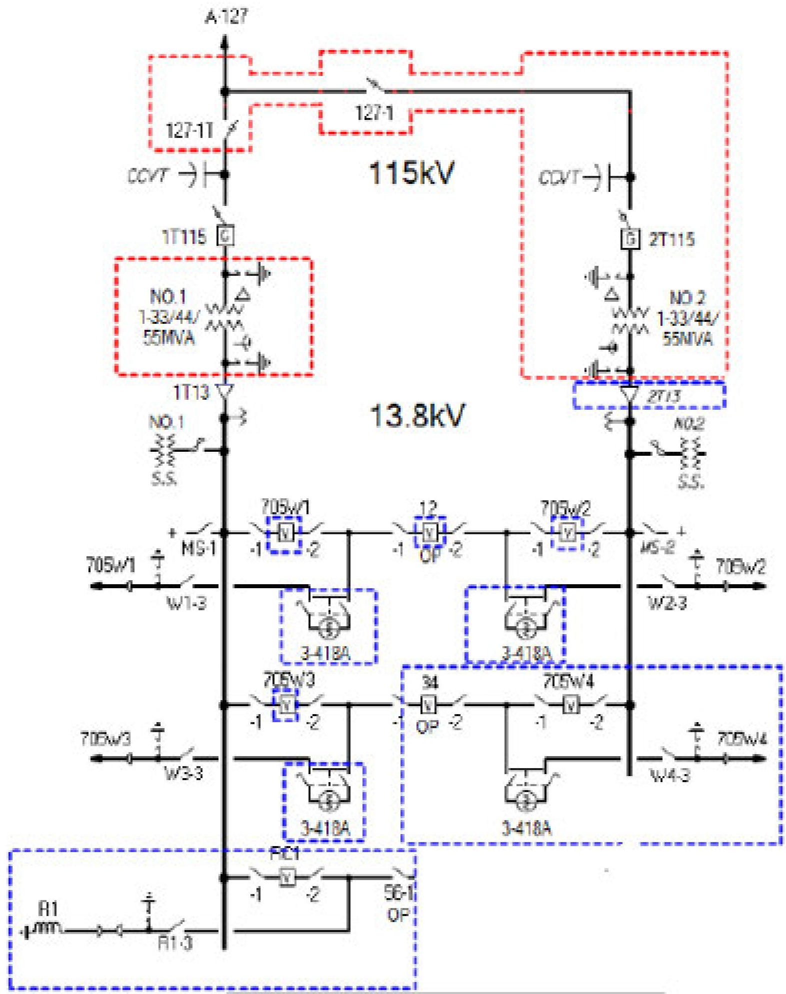
3.2 Distribution Substation Upgrades

Several distribution substation upgrades will need to be built in order to accommodate the interconnection of the Group 3 DER into the Western MA Distribution system:

Wendel Depot Substation

A second 115/13.8 kV transformer (55 MVA) will be installed, as well as the replacement of the existing 115/13.8 kV transformer with a 55 MVA unit.

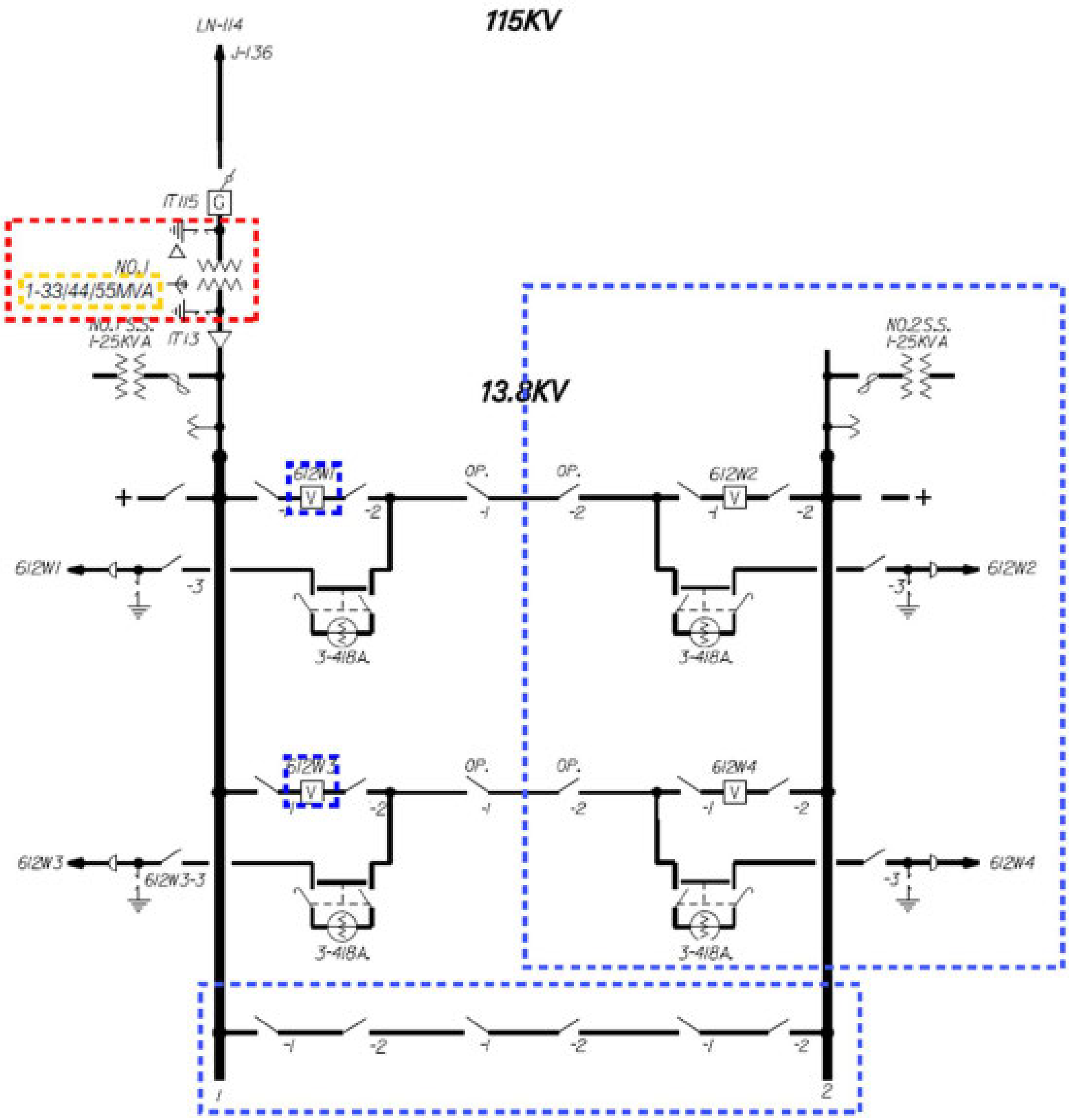
Figure 3 – Wendel Depot Substation Upgrades



E Winchendon Substation

Replace existing 115/13.8 kV transformer with a 55 MA unit.

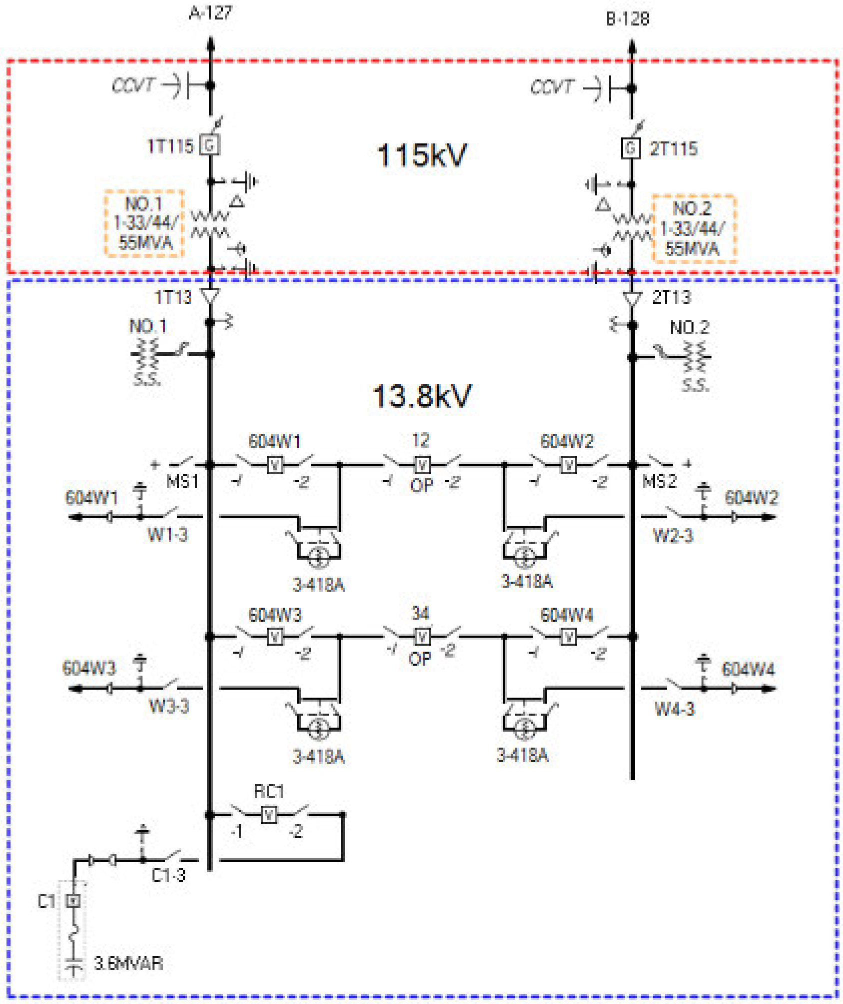
Figure 4 – E Winchendon Substation Upgrades



Barre Substation

Replace both existing 115/13.8 kV transformers with 55 MVA units.

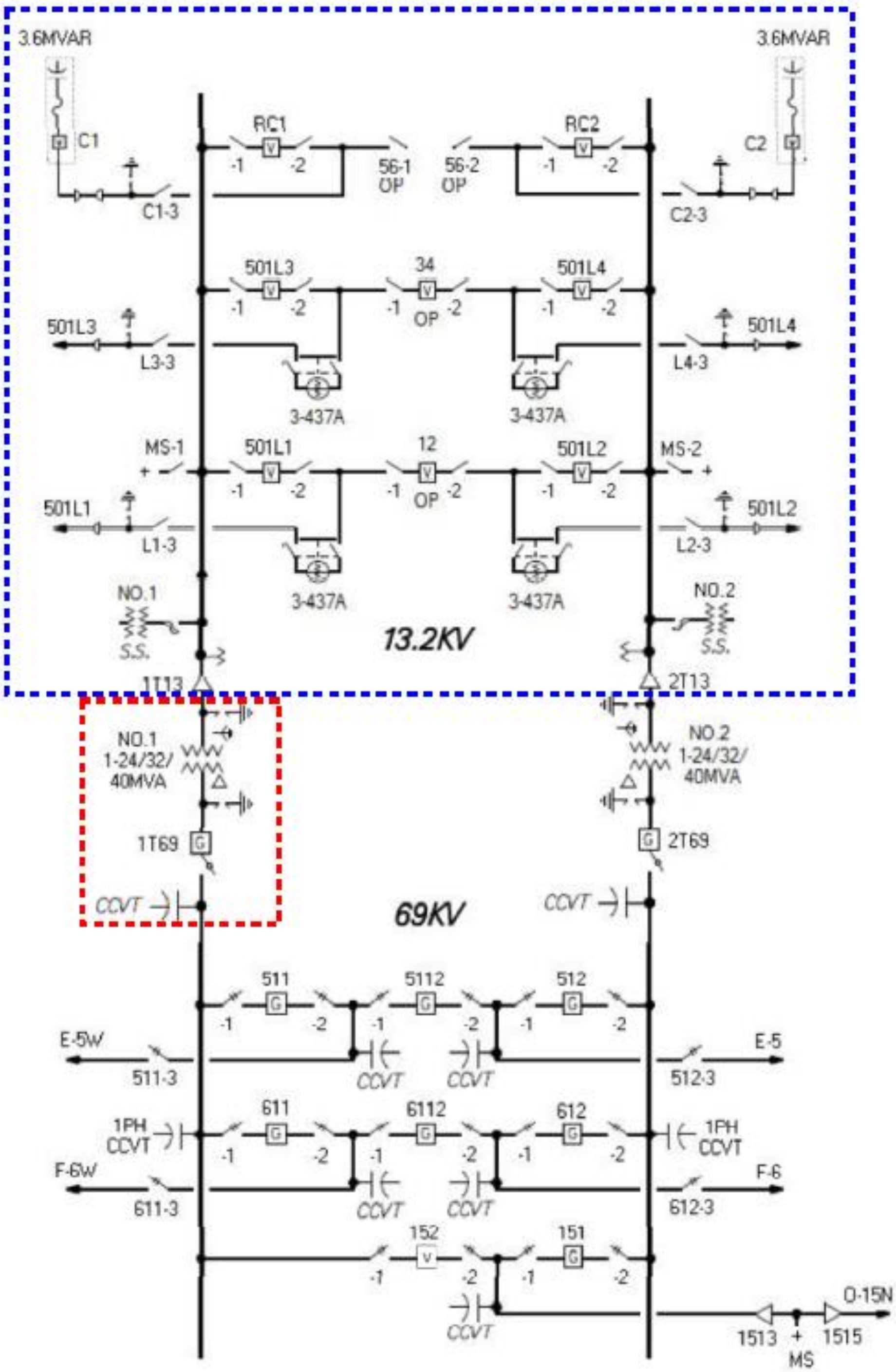
Figure 5 – Barre Substation Upgrades



Ware Substation

Replace existing 69/23 kV transformer with 69/13.8 kV 40 MVA transformer.

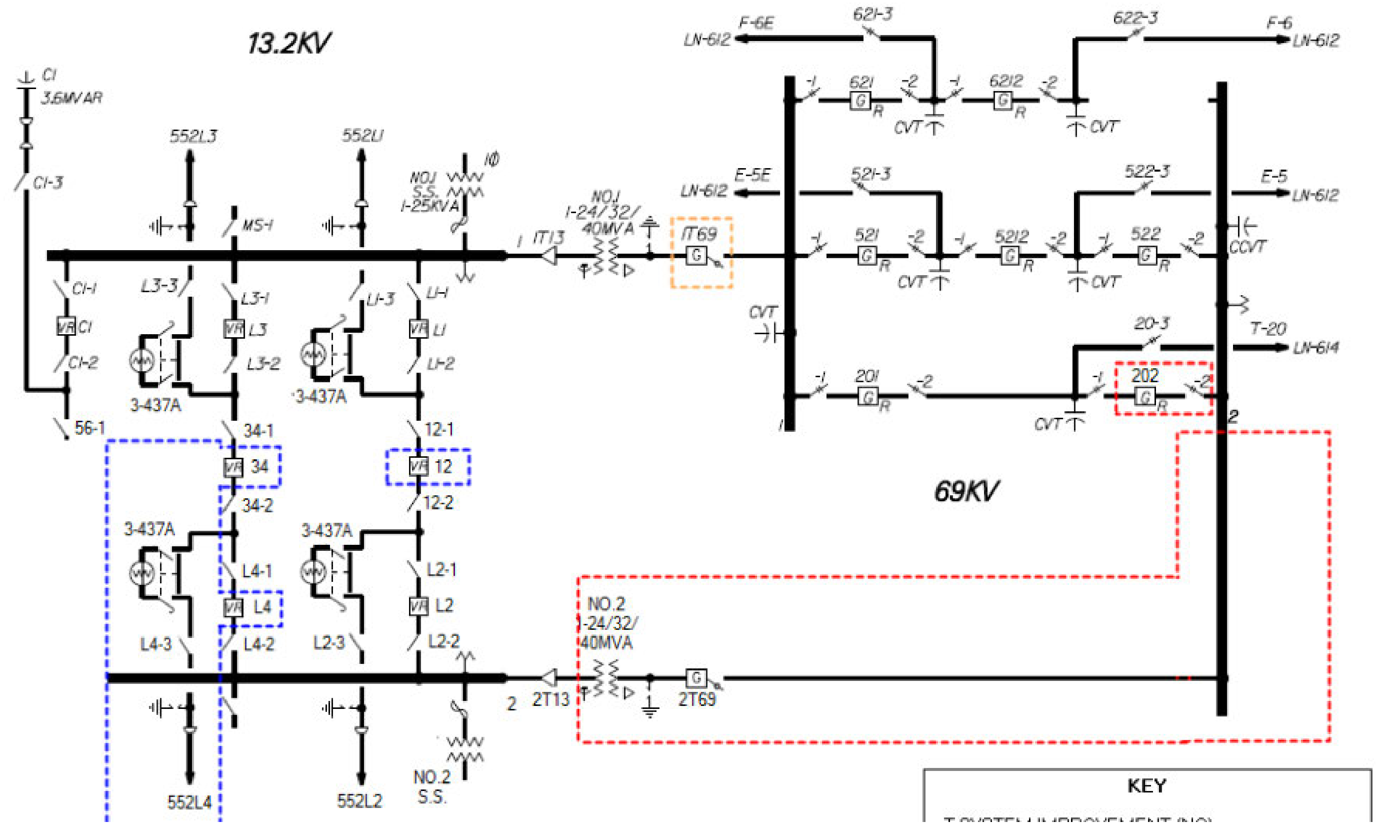
Figure 6 – Ware Substation Upgrades



Meadow St Substation

Install a second 69/13.2 kV transformer (40 MVA) and install 69 kV breaker.

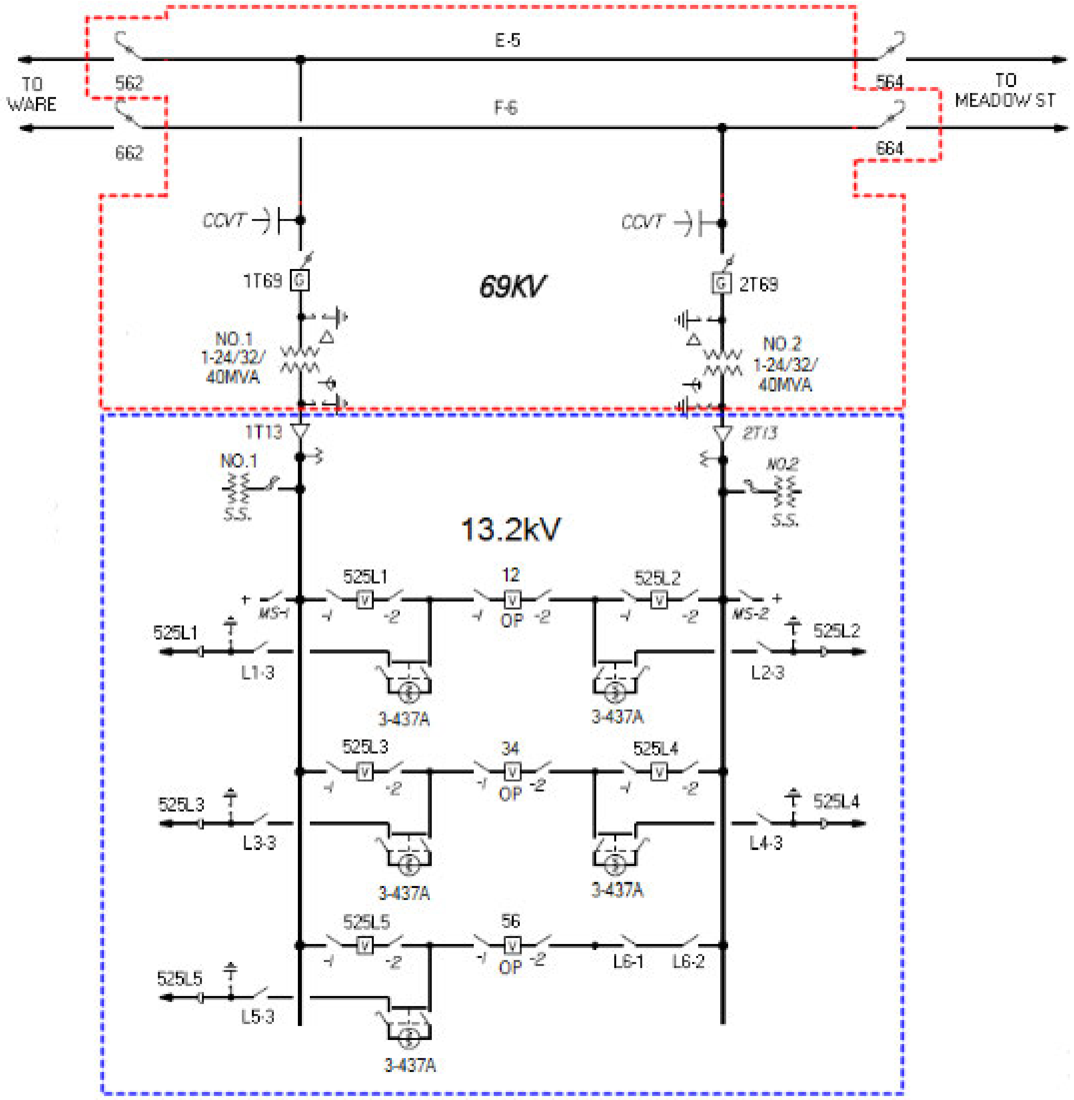
Figure 7 – Meadow St Substation Upgrades



Lashaway Substation

Replace the existing 69/13.2 kV transformer with a 40 MVA unit, and replace the existing 69/23kV transformer with a 69/13.2 kV transformer (40 MVA).

Figure 8 – Lashaway Substation Upgrades



Leicester 69/13.8kV substation - Retire

3.3 Study Assumptions

- DER was dispatched as follows in both the steady state base cases, as well as the stability base cases:
  - All the Group 1, 2, and 3 DER in this study, greater than 1 MW, were added to the cases, and dispatched at 100% nameplate, at all load levels. This DER is modeled with negative load[5] at each distribution bus for the substations listed in Table 3. No distribution feeder impedance is assumed.
  - For the purposes of describing the treatment of existing and forecasted PV in the study, PV is placed into three categories:
    - All existing Category 1 PV (existing or PPA approved PV facilities greater than or equal to 5 MW) in the 2025 base case representation provided by ISO-NE, was dispatched at 100 % output for all load levels.
    - All existing Category 2 PV (existing PV facilities greater than 1 MW and less than 5 MW) provided by ISO-NE with the 2025 base cases, is dispatched at 100 % output at the peak load level only. No Category 2 PV was modeled in the light load and intermediate load cases.
    - All existing Category 3 PV (Existing facilities less than or equal to 1 MW and all future forecasted solar PV for which locational information is not available) provided by ISO-NE with the 2025 base cases, is dispatched at 100 % output at the peak load level only. Note that the "future" solar PV greater than 1 MW and less than 5 MW is carved out of the Category 3 PV to avoid double counting of the new DER for which this study is being conducted. No Category 3 PV was modeled in the light load and intermediate load cases.

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- None of the DER additions were modeled in voltage control mode, since all of the new DER will be mixed with distribution load (i.e., no DER will be installed on dedicated feeders)
- All of the Group 3 DER will be operated in frequency response mode (per the new Source Requirements Document (SRD) developed for Group 3). None of the Group 1 and Group 2 DER will be operated in frequency response mode (per the previous SRD in place during the Group 1 and Group 2 studies). Therefore, the DER additions for each group were modeled accordingly in the stability study.
- No transmission ring busses are required for any DER additions that are mixed with distribution load, or will be mixed with distribution load in the future.
- Starting from the original base cases developed for this study, and prior to testing any contingencies, the Group 1, 2 and 3 DER was dispatched (at 100% output) against existing (and PPA approved) non-DER generation in Connecticut. This maintained the same transfer levels (pre vs post DER additions) of interfaces relevant to this study (i.e., E-W and NY-NE).

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[5] DER was modeled as generators in the load flow base cases utilized for the stability testing

- Treatment of transmission overloads above 100 kV in study:
    - For N-0 and N-1 conditions, transmission overloads above 100kV found after dispatching the DER against generation in Connecticut, the DER may be redispatched against existing local non-DER generation in western MA, directly connected to the 115 kV system or above, pre-contingency, to remove such overloads[6].
    - For N-1-1 conditions, it was assumed that existing generators, connected directly to the 115 kV system and above, could be redispatched, or tripped, between N-1 and N-1-1 contingencies, to eliminate a post N-1-1 thermal overloads above 100 kV.
    - No DER generation can be redispatched between contingencies to eliminate N-1-1 overloaded elements above 100 kV.

- Treatment of transmission overloads below 100 kV in study:
    - For N-0 and N-1 conditions, the new DER can't be dispatched against existing generation directly connected to the 69 kV system to eliminate N-0 or N-1 69 kV overloads.
    - For N-1-1 conditions, it was assumed that any existing generator directly connected to the 69 kV system in Western MA, and under the control National Grid's control center could be redispatched between N-1 and N-1-1 contingencies to prevent post N-1-1 contingency 69 kV overloads from occurring. Also, Bear Swamp generation/pump can be redispatched between N-1 and N-1-1 contingencies to prevent post N-1-1 contingency 69 kV overloads. These generators that were assumed to be redispatched between contingencies by National Grid operators to prevent post N-1-1 69 kV overloads are shown in the table below. Note that no future generator (e.g., King Brook Solar) was assumed to be able to ramp down between N-1 and N-1-1 contingencies, due to additional complexities introduced to the National Grid Control center.

[6] This is consistent with the Mininum Interconnection Standard (MIS) outlined by FERC Order 2003.

Table 4 - Generators Available for Redispatch to Prevent N-1-1 69 kV Overloads

PSSE Bus number	Generator Name
109296	Sears Wind_E
109297	Sears Wind_W
109403	Drfld East G
109404	Drfld West G
109503	Harriman G3
109504	Harriman G2
109505	Harriman G1
109517	Sears Hydro
109529	Vernon Hyd A
109530	Vernon Hyd B
109531	Vernon Hy T1
109532	Vernon Hy T2
113098	Deerfield 2g
113099	Deerfield 3g
113100	Deerfield G4
113101	Deerfield G5
113102	Fife Brook
113104	Sherman Hyd
113123	Hoosac Clr1
113125	Hoosac Clr2
113096	Bearswamp G1
913096	Bearswamp P1
113097	Bearswamp G2
913097	Bearswamp P2

  - No DER generation can be redispatched between contingencies to eliminate 69 kV N-1-1 overloaded elements.
  - It is assumed that N-1-1 contingencies involving 69 kV double circuit towers, or 69 kV breaker failures will not cause a significant adverse impact outside the local area (i.e., NPCC criteria violation), and therefore were not tested.

- Hydro Generation that is defined as "Daily Cycle Pondage" or "Weekly Cycle" in the CELT report can be ramped up to nameplate capability, according to the ISO-NE Planning Technical Guide, between N-1 and N-1-1 contingencies to prevent post N-1-1 contingency thermal overloads or voltage violations. However, this generation can't be assumed to ramp up between contingencies post Group 3, if ramping up solves N-1-1 voltage or thermal problems that did not exist prior to Group 3 going in-service (Per ISO-NE PP5-6 document, section 3.4: "No Increase in Conditional Dependence").

Table 5 - Hydro Generation Available to Ramp Up between Contingencies

RESOURCE NAME	GEN TYPE ID	PRIM FUEL TYPE	FUEL GEN TYPE DESC	STATE	RSP AREA	NAMEPLATE (MW)	WINTER SCC (MW) Jan 1, 2019	ACTUAL WINTER PEAK SCC (MW) Jan 21, 2019	EXPECTED SUMMER PEAK SCC (MW) JUL 1, 2019
BELLOWS FALLS	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	VT	VT	45.900	47.216	47.216	47.216
COBBLE MOUNTAIN	HW	WAT	HYDRO (WEEKLY CYCLE)	MA	WMA	23.100	27.431	27.431	31.989
DEERFIELD 5	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	MA	WMA	17.550	13.990	13.990	13.965
HARRIMAN	HW	WAT	HYDRO (WEEKLY CYCLE)	VT	WMA	33.600	38.471	38.471	40.798
JACKMAN	HW	WAT	HYDRO (WEEKLY CYCLE)	NH	NH	3.200	3.459	3.459	3.600
DEERFIELD 2 LWR DRFIELD	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	MA	WMA	9.600	18.667	18.667	18.580
SEARSBURG	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	VT	WMA	4.500	4.567	4 567	4.451
SHERMAN	HW	WAT	HYDRO (WEEKLY CYCLE)	MA	WMA	8.100	6.220	6 220	6.154
VERNON	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	VT	WMA	34.560	32.000	32.000	32.000
WILDER	HW	WAT	HYDRO (WEEKLY CYCLE)	VT	VT	35.640	40.674	40.674	40.920
CABOT TURNERS FALLS	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	MA	WMA	61.920	61.800	61.800	61.800
CABOT TURNERS FALLS	HDP	WAT	HYDRO (DAILY CYCLE - PONDAGE)	MA	WMA	6.400	6.400	6.400	6.400

- Pumped Storage Generation in the study area (Northfield and Bear Swamp) can be ramped up to 1/2 nameplate capability (two units at Northfield and 1 unit at Bear Swamp) between N-1 and N-1-1 contingencies to prevent post N-1-1 contingency thermal overloads or voltage violations. Note that this can only be assumed if the units are off or in generating mode in the base case (N-0). If units are in pumping mode in the base case, it cannot be assumed that units can be ramped up into generating mode between contingencies.

- "Smart Capacitor" Control Additions in Western Massachusetts, required for the addition of the Group 1 DER interconnections, were assumed in-service for the Group 3 analysis. These "smart capacitor" controls automatically switch off distribution feeder capacitors during light load and minimum load conditions. These "smart capacitor" automation schemes are itemized in the following table.

Table 6 - "Smart Capacitor" Control Additions in Western Massachusetts

Substation Bus	Feeder Capacitor MVAR
E Winchendon1 13.8	0.6
Crystal Lk1 13.8	2.7
Crystal Lk2 13.8	3.8
E Wstmstr T1 13.8	0.6
E Wstmstr T2 13.8	0.6
E Longmeadow 1 13.2	0.9
N Hampden T1 13.2	1.2
Palmer 13.2	1.5
Wilbraham 13.2	0.3
Lashaway 13.2	1.5
W Charlton 13.2	0.9
Litl Rest Rd 13.2	0.9
Thorndike 13.2	0.8
Treasure Vly 13.8	1.8
Chesnut Hl T1 13.8	1.5
Chesnut Hl T2 13.8	1.2
Total	**20.8**

Presently, in the existing system, the feeder capacitors listed in the preceding table are fixed capacitors; meaning that they are not switched automatically, and are in service all the time unless switched out manually in the field. After the automatic switching schemes are installed, these feeder capacitors will be switched out automatically if the feeder loading becomes less than 45% of peak feeder load. From a loadflow perspective, switching out these capacitors during light load and minimum load conditions is modeled by placing an equivalent amount of MVAR lagging load at each the substation busses listed in the table. These smart capacitor controls will be installed before Group 1 of the DER cluster goes into service. The new smart capacitors will have radios for status monitoring and control. The system operators will have the ability to put the capacitors in manual operation to either open or close as needed.

- H-134 115 kV project (RSP #951) (E Winchendon to Otter River) not in-service (PPA withdrawn)
- The Ware 69 kV breaker addition project, completing the O-15N 69 kV bay, as required for interconnection of Group 2 DER of the Western MA cluster, assumed in-service.
- New Stafford St 115/13.8 kV substation in Leicester MA, which will sectionalize the A-127, B-128 and Z-126 115 kV lines near the existing Tower 510 structure, assumed in-service.
- Reconductor of A-1/B-2 69 kV lines with 795 ACSS scheduled for 2027 in-service date. Since the Group 3 DER is scheduled to be in-service between 2022 and 2025, the reconductor of A-1/B-2 was not included in the base cases for this study.
- All the transmission and generation projects with approved PPA's were included in the base cases for this study. Additionally, the following relevant generators in the ISO-NE Interconnection Queue were modeled in each base case. Note that some of these projects that were withdrawn during the course of this study were placed out of service in the base cases.

- QP 660 (“Vernon Solar“ 20 MW PV unit connecting directly to D-4 69 kV line between Deerfield 4 and Vernon), withdrawn.

- QP-651 Alps Berkshire Phase Shifting Transformer Not In-Service (Withdrawn).

- QP697 (5.97 MW) and QP698 (8.04 MW), both connected at the E Winchendon 13.8 kV, in-service

- QP 797 [redacted] Solar – Meadow St) in-service

- QP 754 [redacted] Solar – connected to I-135N 115 kV line) Not In-Service (Withdrawn)

- QP 1105 ([redacted] Battery Storage Project – off A-127 115kV line) not-in-service (withdrawn from ISO-NE study queue)

- QP 1112 ([redacted] Storage Project – off B-128 115 kV line between Barre and French King substation) not-in-service (but tested as a sensitivity in study)

- QP 1031 ([redacted] Solar Project – off F-6W 69 kV line between Ware and Belchertown substations) not-in-service (but tested as a sensitivity in the study)

- Millbury 115 kV IEC61850 project – In-service. Project will replace the following [redacted] circuit breakers and associated Bushing Current Transformers (BCTs) with [redacted] circuit breakers:

  - B128, A127, Z126, M165, 27-302, 65-74, V174.
  - Replacing breakers 65-74 and V-174 will increase V-174 thermal rating [redacted]

4 STUDY CRITERIA

This analysis is conducted in accordance with the following criteria.

- NERC Transmission Planning Standards TPL-001-4, "*Transmission System Planning Performance Requirements"*,
- Northeast Power Coordinating Council (NPCC) Directory 1, "*Design and Operation of the Bulk Power System*".
- ISO New England Planning Procedure #3 (PP3) – "*Reliability Standards for the New England Area Bulk Power System*".
- ISO New England Planning Procedure #5 (PP5) – "Proposed Plan Application Procedure".
- National Grid Transmission Group Procedure (TGP) #28 – "*Transmission Planning Guide for the National Grid USA Service Company*".

5 STEADY STATE ANALYSIS

The following tables identify the steady state voltage criteria that were applied in the study:

Table 7 - Steady State Voltage Limits

Facility Owner	Voltage Level	Bus Voltage Limits (Per-Unit)	
		Pre-Contingency	Post-Contingency
National Grid	230 kV and above	0.98 to 1.05	0.95 to 1.05
	115 kV and below	0.95 to 1.05	0.90 to 1.05[7]
Eversource	115 kV and above	0.95 to 1.05	0.90 to 1.05 (before system adjustments) 0.95 to 1.05 (after system adjustments)
GMP	115 kV and below	0.95 to 1.05	0.90 to 1.10
VELCO	230 kV and above	0.98 to 1.05	0.95 to 1.05
	115 kV and below	0.95 to 1.05	0.95 to 1.05

Table 8 - Maximum Percent Voltage Variation at Delivery Points

CONDITION	345 & 230 kV (%)	115 kV[1] & Below (%)
Post Contingency & Automatic Actions	5.0	10.0
Switching of Reactive Sources or Motor Starts (All elements in service)	2.0 *	2.5 *
Switching of Reactive Sources or Motor Starts (One element out of service)	4.0 *	5.0 *

* These limits are maximums which do not include frequency of operation. Actual limits were considered on a case-by-case basis and will include consideration of frequency of operation and impact on customer service in the area.

Notes on two preceding Tables:

a. Voltages apply to facilities which are still in-service post-contingency.
b. Site specific operating restrictions may override these ranges.
c. These limits do not apply to automatic voltage regulation settings which may be more stringent.

[7] National Grid Buses that are part of the bulk power system, and other buses deemed critical by Network Operations, shall meet requirements for 345 kV and 230 kV buses

The following table identifies the thermal criteria that is applied in the study.

Table 9 - Thermal Criteria Applied in Study

SYSTEM CONDITION	TIME FRAME	MAXIMUM ALLOWABLE FACILITY LOADING
Pre-contingency (All lines in)	Continuous	Normal Rating
Post-contingency	Less than 15 minutes after contingency occurs	STE Rating
	More than 15 minutes after contingency occurs	LTE Rating

5.1 Steady State Solution Parameters

The steady state analysis is performed with pre-contingency solution parameters that allowed adjustment of load tap-changing transformers (LTCs), static VAR devices (SVDs including automatically switched capacitors. Post-contingency solution parameters were locked, and the area interchange control is disabled. The following table shows the pre- and post-contingency solution parameters that were used in this study.

Table 10 - Steady State Study Solution Parameters

Case	Area Interchange	Transformer LTCs	Phase Angle Regulators	Switched Shunts
Base	Disabled	Stepping	Locked	Regulating
Post Contingency	Disabled	Locked	Locked	Locked

5.2 Steady State Base Case Development

In order to investigate the impact of the proposed projects to the New England transmission system, a total of seven base cases were developed representing various load levels and interface transfer levels.

Study Year Tested
Since Group 3 of the DER will be installed by 2025, the year 2025 ISO-NE base cases, released in September 2020, were used for the steady state assessment.

Load Levels Tested
Four load levels were tested for steady state analysis. These cases are based on the loads contained in the CELT 2020 forecast.

1. Summer Peak Load
2. Shoulder Peak Load
3. Light Load
4. Minimum Load (8000 MW)

Interface Transfer Levels Tested

For each of the three load levels – Summer Peak Load, Shoulder Peak Load and Light Load, two base cases were developed for steady state testing:

1. High East to West Stress (3500 MW), with High NE-NY transfers (1200 MW), High Sandy Pond HVDC Import

2. High West to East Stress (3000 MW), with High NY-NE transfers (1600 MW), Low Sandy Pond HVDC Import

For Minimum Load level, one base case is developed for steady state testing.

The following table summarizes the interface levels and generation dispatches for the steady state base cases prior to the dispatch of Group 1,2 and 3 DER in the cases. More detailed case summaries are included in Appendix A.

To test the impact of the DER, both Group 1, 2 and 3 DER were added to each case and dispatched against Millstone 2 in Connecticut.

Table 11 - Steady State Base Case Summaries (before dispatching Group 1, 2, and 3 DER)

Base Case Load Flows (MW)							
Name	25pk-ew-100%-PV*	25pk-we-100%-PV*	25sh-ew+pump	25sh-we	25ll-ew+pump	25ll-we	Min-load
Year/Load Level	2025 Summer peak		2025 Shoulder peak		2025 Light Load		2025 Min Load
Bias	East-West	West-East	East-West	West-East	East-West	West-East	
Total Load	25697		18066		12518		8901
Scaling Load	31252		16673		11412		7858
Non-Scaling Load	556		556		556		556
DR passive	0		0		0		0
DR active	0		0		0		0
EE	-4756		0		0		0
Cat 2 and 3 PV	-2089		0		0		0
NON CELT MFG LOAD	301		301		301		301
New England Transmission Interface Transfers (MW)							
Sandy Pd HVDC Import	2000	1000	2000	1000	2000	1000	0
E-W	3512	-2996	3506	-3036	3543	-3002	65
NY-NE	-1231	1600	-1220	1599	-1204	1602	-34
North-South	4395	2212	3100	2841	3078	1584	2467
CT Export	-1190	-571	-64	-163	-763	336	165
Area Generation (MW)							
Northfield (MA) – 1180 MW (Max)	0	1180	-1100	1180.0	-1100	0	0
Bear Swamp 666 MW (Max)	0	666	-666	666	-666	0	0
Altresco (MA) – 164 MW (Max)	0	164	73	164	164	164	0
Cabot Hydro (MA) – 65 MW (Max)	11 (minimum)	65	11 (minimum)	65	11 (minimum)	65	11 (minimum)
Harriman Hydro (VT) – 41 MW (Max)	5 (minimum)	41	5 (minimum)	41	5 (minimum)	41	5 (minimum)
Vernon Hydro (VT) – 32 MW (Max)	5 (minimum)	32	5 (minimum)	32	5 (minimum)	32	5 (minimum)
Deerfield Hydro 2+3 +4 (20 MW Max)	5 (minimum)	20	5 (minimum)	20	5 (minimum)	20	5 (minimum)
Harrington St Solar (10 MW Max)	10	10	0	10	10	10	10
Warren Solar (Little Rest Rd) (14 MW Max)	14	14	0	14	14	14	14
Treasure Valley Solar (16 Max)	16	16	0	16	16	16	16
Millennium	0	360	361	0	361	360	0
Stony Brook	0	483	0	483	483	483	0
Bellows Falls	49	49	0	49	0	0	0
QP697&QP698 (14MW PV at E. Winchendon)	14	14	0	14	14	14	14

*Per the direction provided by ISO-NE, all existing PV in western MA (zone 41), modeled in peak load base case was scaled up from 26% output to 100% output. This PV was modeled as negative load (with "PD" and "PV" load identifiers) in the peak load cases. Note that the negative load with "PD" identifiers includes all existing PV less than 1 MW, as well as all future forecasted PV greater than 1 MW but less than 5 MW which does not have location based data associated with it. To avoid double counting of the "PD" load that includes the future forecasted PV between 1 and 5 MW, this portion of the "PD" was stripped out of the peak load base cases. The percent of "PD" load that includes the future forecasted PV for the Western MA zone 41 is 41.9%, per ISO-NE.

Sensitivity bases cases were also developed at peak load, with all DER in the study area at 26% output (of nameplate). The following tables summarize the interface levels and generation dispatches for the steady state base cases. Again, to test the impact of the DER, Group 1, 2 and 3 DER were added to each case and dispatched against Millstone 2 in Connecticut.

Table 12 - Steady State Base Case Summaries: Sensitivity to DER = 26% Output

(Prior to dispatching Group 1, 2, and 3 DER)

Base Case Load Flows (MW)		
Name	25pk-ew-26%	25pk-we-26%
Year/Load Level	2025 Summer peak	
Bias	East-West	West-East
Total Load	26338	26282
Total Losses	966	683
Total Generation	27670	24419
Scaling Load	31227	
Non-Scaling Load	556	
DR passive	0	
DR active	0	
EE	-4756	
Station Service	678	621
NON CELT LOAD	301	
New England Transmission Interface Transfers (MW)		
Sandy Pd HVDC Import	2000	1000
E-W	3521	-2987
NY-NE	-1188	1641
North-South	4506	2321
CT Export	-742	-97
Area Generation (MW)		
Northfield (MA) – 1180 MW (Max)	0	1180
Bear Swamp 666 MW (Max)	0	666
Altresco (MA) – 164 MW (Max)	0	164
Cabot Hydro (MA) – 65 MW (Max)	11* (minimum)	65
Harriman Hydro (VT) – 41 MW (Max)	5* (minimum)	41
Vernon Hydro (VT) – 32 MW (Max)	5* (minimum)	32
Deerfield Hydro 2+3 +4 (20 MW Max)	5* (minimum)	20
Harrington St Solar (10 MW Max)	10	10
Warren Solar (Little Rest Rd) (14 MW Max)	14	14
Treasure Valley Solar (16 Max)	16	16
Millenium	0	360
Stony Brook	0	483
Bellows Fall	49	49
QP697&QP698 (14MW PV at E. Winchendon)	14	14

5.3 Study Matrix for Steady State Analysis

To test the impact of the DER, Group 1,2 and 3 DER were added to each case, according to the following table, and dispatched against Millstone 2 in Connecticut. Dispatching the DER against Millstone 2 will maintain the same East-West, and NY-NE transfer levels, compared to the pre-DER base cases.

Table 13 – Proposed Study Matrix for Steady State Analysis

		Group 3 DER		Group 1 and 2 DER	Pre-Group 1 and 2 DER	FERC BESS projects under Study	
Load Level	**Bias**	**BESS output**	**PV output**	**PV output**	**PV output**		**Comments**
Peak Summer load	E-W	100% discharging	100%	100%	100%	Sensitivity analysis was conducted for [redacted] (QP1031) and [redacted] (QP1112)	
	W-E						
	E-W	100% Charging	26%	26%	26%		
	W-E						
Shoulder Peak Load	E-W +pump	100% Charging	0% (peak load night/morning - before 8am)	0% (peak load night - before 8am)	0% (peak load night - before 8am)		This case represents a peak load night. BESS could be charging (7am) before Bear Swamp Pumps shut off. PV assumed to 0 MW in case.
	W-E	100% discharging	100% (no pump case (day)	100% for PV 5 MW and above. 100% for PV under 5 MW	0%		
Light Load	E-W +pump	100% discharging	100%	100% for PV 5 MW and above. 100% for PV under 5 MW	0%		
	W-E						
					0%		
Min Load	none	100% discharging	100%	100% for PV 5 MW and above. 100% for PV under 5 MW	0%		

5.4 Steady State Contingency Analysis

N-1 and N-1-1 contingency conditions were tested in steady state analysis on the load flow base cases with and without the new DER added to the cases.

5.4.1 N-1 Contingency List

The N-1 Contingency list is shown in the table below.

Table 14 - N-1 Steady State Contingency List

CONTINGENCY NAME	kV	DESCRIPTION
HVDC Facilities		
Sandy Pond HVDC Phase II	-	Sandy Pond HVDC Converter – 2000 MW Maximum
345 kV Transmission Lines		
301/302	345	Millbury – Carpenter Hill – Ludlow
308	345	Wachusett – Millbury
312	345	Berkshire – Northfield (Post Alps-Berkshire ETU)
393	345	Alps – Berkshire (Post Alps-Berkshire ETU)
313	345	Wachusett – Millbury
314	345	Sandy Pond – Wachusett
326	345	Scobie – Sandy Pond
320	345	Lake Rd – Card St
343	345	Sandy Pond – Wachusett
354	345	Northfield – Ludlow
367	345	Amherst – Fitzwilliam
3195	345	Amherst – Eagle
380	345	Eagle – Scobie Pd
368	345	Manchester – Card St
379	345	Vernon – Fitzwilliam
381	345	Vernon – Northfield
398	345	Long Mt – Pleasant Valley (NY)
3340	345	Vernon – Vermont Yankee
3381	345	Vernon – Vermont Yankee
3271	345	Lake Rd – Card St
330	345	Lake Rd – Card St
3348	345	Lake Rd – Killingly
341	345	Lake Rd – W Farnum
368	345	Card St - Manchester
345 kV Transformers		
Wachusett T5	345/115	Wachusett Transformer #5
Wachusett T6	345/115	Wachusett Transformer #6
Wachusett T7	345/115	Wachusett Transformer #7
Fitzwilliam T1	345/115	Fitzwilliam Transformer #1
Ludlow T2	345/115	Ludlow Transformer #2
Ludlow T3	345/115	Ludlow Transformer #3
Northfield T1	345/115	Northfield Transformer #1 (post Pittsfield-Greenfield upgrades)
Berkshire T1	345/115	Berkshire Transformer #1
Carpenter Hill T1	345/115	Carpenter Hill Transformer #1
Agawam T1	345/115	Agawam T1
Agawam T2	345/115	Agawam T2
345 kV Line End Open Contingencies		
301 Millbury	345	Millbury – Carpenter Hill
302 Ludlow	345	Ludlow – Carpenter Hill
312 Northfield	345	Northfield – Berkshire
345 kV Breaker Open Contingencies		
393 Alps	345	Berkshire - Alps
345 kV Breaker Failures		
Fitzwilliam 3791 BF	345	379 + Fitz T1
Fitzwilliam 671 BF	345	367 + Fitz T1

CONTINGENCY NAME	kV	DESCRIPTION
Wachusett 7T BF	345	308 + Wachusett T7
Wachusett 6T BF	345	313 + Wachusett T6
Wachusett43-6T BF	345	343 + Wachusett T6
Wachusett 14-7T BF	345	314 + Wachusett T7
Ludlow 1T BF	345	334 + Ludlow T2
Ludlow 2T BF	345	334 + Ludlow T3
Ludlow 3T BF	345	Ludlow T3
Ludlow 4T BF	345	354 + Ludlow T2
Ludlow 5T BF3t19	345	3196 + 354
Ludlow 6T BF	345	3196
Ludlow 7T BF	345	301/302 + Ludlow T2+ Carpenter Hill Auto
Ludlow 8T BF	345	3419 + 301/302 + Ludlow T2+ Carpenter Hill Auto
Ludlow 9T BF	345	3419
Millbury 308+302 BF	345	301/302 + 308
Northfield 2T BF	345	312 + Northfield G1 + G2 (post Pittsfield-Greenfield upgrades)
Northfield 5T BF	345	354 + Northfield G3 + G4 (post Pittsfield-Greenfield upgrades)
Vernon 3TB4-B1 BF	345	381 + Vernon Reactor
Vernon 3TB3-B1 BF	345	379 + 3381
Vernon 3TB1-B1 BF	345	3320 + 3340
Vernon 3TB2-B1 BF	345	340 + Vernon T1
Vermont Yankee 1T	345	Vermont Yankee GSU
Vermont Yankee 381	345	3381 + Vermont Yankee Auto
Vermont Yankee 81-1T	345	3381 + Vermont Yankee GSU
Vermont Yankee 79-40	345	3340 + Vermont Yankee Auto
345 kV Double Ckt Towers		
-	-	-
230 kV Transmission Lines		
E-205E	230	Bear Swamp – Pratts Jct.
E-205W	230	Bear Swamp – Eastover Rd (NY)
38	230	Rotterdam (NY) – Eastover Rd (NY)
230 kV Double Ckt Towers		
-	-	-
230/115 kV Transformers		
Bear Swamp T4	230/115	Bear Swamp Transformer #4
Bear Swamp T5	230/115	Bear Swamp Transformer #5
PrattsJct T8 + T8A	230/115	PrattsJct Transformer #8 + 8A
Eastover Rd T1	230/115	Eastover Rd Transformer #1
Eastover Rd T2	230/115	Eastover Rd Transformer #2
230 kV Breaker Failures		
Bear Swamp 2205E BF	230	Bear Swamp G2 + T4 (230-115 kV) + E-205E
Bear Swamp 2205W BF	230	Bear Swamp G2 + T4 (230-115 kV) + E-205W
Bear Swamp 1205E BF	230	Bear Swamp G1 + T5 (230-115 kV) + E-205E + 115 kV Cap
Bear Swamp 1205W BF	230	Bear Swamp G1 + T5 (230-115 kV) + E-205W + 115 kV Cap
Eastover Rd RE205 BF	230	E-205W + Eastover Rd T1
Eastover Rd RE215 BF	230	E-205W + Eastover Rd T2
Eastover Rd R38 BF	230	38 + Eastover Rd T1
Eastover Rd R48 BF	230	38 + Eastover Rd T2
115 kV Transmission Lines		
1242	115	Montague – Berkshire
1361	115	Montague – Cumberland (post Pittsfield-Greenfield upgrades)
1231	115	Berkshire – Cumberland
1551	115	Doreen – Berkshire
1662	115	Doreen – Berkshire
PV20	115	Plattsburg – South Hero
K6	115	Bennington – Hoosick (NY)
K7	115	Whitehall – Bliss Ville
A-127E	115	Millbury- Webster St – Erving (post Erving substation)
A-127W	115	Erving – Harriman (post Erving substation)
B-128	115	Harriman – Millbury
E-131	115	Bear Swamp – Harriman – Adams
F-132	115	Adams – Doreen
I-135	115	Fitzwilliam – Flagg Pd
I-135S	115	Flagg Pd – PrattsJct
J-136S	115	Flagg Pd – Litchfield Tap – PrattsJct
J-136N	115	Bellows Falls – Flagg Pd

CONTINGENCY NAME	kV	DESCRIPTION
O-141	115	Greendale – Nashua St
O-141N	115	PrattsJct – Wachussett
O-141S	115	Nashua St – Millbury
O-141W	115	Wachusett– Greendale
P-142	115	W Boylston – Rolfe Ave
P-142N	115	PrattsJct – Wachusett
P-142S	115	Rolfe Ave – Millbury
P142W	115	Wachusett – W Boylston
Q-117	115	Adams – Bennington
R-170	115	Palmer – W Hampden
1205	115	W Hampden - Ludlow
1976	115	W Hampden - Scitico
S-197	115	Bear Swamp – Deerfield
V-174W	115	Carpenter Hill – N Oxford
V-174	115	N Oxford – Millbury
W-175	115	Carpenter Hill – Palmer
X-176	115	Palmer – Ludlow
Y-177	115	Harriman – Montague (NU)
Z-126	115	Millbury – Tower 510 – Webster St
115 kV Double Ckt Towers		
1161+1211 DCT	115	1161 + 1211 + 1662
1231+1242 DCT	115	1231 + 1242
1551+1662 DCT	115	1551 + 1662 + 1211
1715+1816 DCT	115	1715 + 1816 + Altresco Gen
A127E+B128 DCT	115	A-127E + B-128 (Millbury – Erving) (post Erving substation)
A127W+B128 DCT	115	A-127W + B-128 (Erving – Harriman) (post Erving substation)
141W+142 DCT	115	O-141W + P-142
O141S+P142 DCT	115	O-141S + P-142
O141N+P142N DCT	115	O-141N + P-142N
O141S+142S DCT	115	O-141S + P-142S
O141W+P142W DCT	115	O-141W + P-142W
I135S+J136S DCT	115	I-135S + J-136S
I135N+J136N DCT		I-135N + J-136N
I135+J136N DCT		I-135 + J-136N
115/69 kV Transformers		
Millbury T1	115/69	Millbury Transformer #1 (56 MVA)
Millbury T2	115/69	Millbury Transformer #2 (56 MVA)
Millbury T3	115/69	Millbury Transformer #3 (45 MVA) + 63 Mvar Cap Bank
Pratts Jct T5 +T6 + T7	115/69	PrattsJct Transformer bank #1
PrattsJct T3+T4	115/69	PrattsJct Transformer bank #2
Deerfield 4 T3 + T4	115/69	Deerfield4 transformer #3 + T4
Adams Autotransformer	115/69	Adams Autotransformer
Bennington T69	115/69	Bennington VT 115-69 kV transformer
Harriman Autotransformer	115/69	Harriman Autotransformer
Palmer Transformer bank #1	115/69	Palmer T3 + T5
Palmer Transformer bank #1	115/69	Palmer T4 + T6
W Hampden T1	115-69	West Hampden T1
115 kV Breaker Failures		
Adams 731 BF	115	E-131 + Q-117 (Post Adams Upgrade)
Adams 217 BF	115	F-132 + Q-117 (Post Adams Upgrade)
Adams T3T BF	115	F-132 + Adams Auto (Post Adams Upgrade)
Adams T5T BF	115	E-131 + Adams Auto (Post Adams Upgrade)
Bear Swamp 131 BF	115	E-131 + Bear Swamp T4 + Bear Swamp GSU #1
Bear Swamp 197 BF	115	S-197 + Bear Swamp T4 + Bear Swamp GSU #1
Bear Swamp T31 BF	115	E-131 + Bear Swamp Fut Xfmr + Bear Swamp 115 kV Cap + Bear Swamp GSU #2 (Post Bear Swamp Upgrade)
Bear Swamp T97 BF	115	S-197 + Bear Swamp Fut Xfmr + Bear Swamp 115 kV Cap + Bear Swamp GSU #2 (Post Bear Swamp Upgrade)
Bennington K4 BF	115	Q-117 + Bennington 115 kV Cap #1
Bennington KT1 BF	115	Bennington Auto + Bennington 115 kV Cap #2
Berkshire 12T BF	115	1551 + Berkshire T2
Berkshire 13T BF	115	1551 + 1231
Berkshire 16T BF	115	1662 +1242
Doreen 6T BF	115	1161 + 1662
Doreen 7T BF	115	1211 + 1662
Doreen 8T BF	115	1211 + 1551
Doreen 9T BF	115	1551 + 1816

CONTINGENCY NAME	kV	DESCRIPTION
Doreen 12T BF	115	1715 + F-132
Erving A BF	115	A-127W + A-127E open ended + Northfield T1
Erving B BF	115	A-127E + A-127W open ended + Northfield T1
Erving C BF	115	A-127E + A-127W + Northfield T1
Harriman A127 BF	115	A-127W + B-128 open ended
Harriman B128 BF	115	A-127W open ended + B-128
Harriman E131 BF	115	E-131 + Y177 open ended + Harriman G1 + G2 +G3
Harriman Y177 BF	115	E-131 open ended + Y177 + Harriman G1 + G2 +G3
Harriman TIE BF	115	A-127W open ended + B-128 open ended + E-131 open ended + Y177 open ended + Harriman G1 + G2 +G3
Montague 1T BF	115	1632 + Cabot Gen
Montague 3T BF	115	1044 + Y-177 open ended
Montague 7T BF	115	1361 + A-127W open ended
Montague 8T BF	115	1361 + 1242
Montague 10T BF	115	1242 + Cabot Gen
PrattsJct O141 BF	115	Pratts T3 + T4 115-69 kV autos + O-141N + Pratts 63 MVAR capacitor
PrattsJct 801 BF	115	Pratts T3 + T4 115-69 kV autos + E-205E + Pratts 63 MVAR capacitor
PrattsJct I135 BF	115	Pratts T3 + T4 115-69 kV autos + I-135S + Pratts 63 MVAR capacitor
PrattsJct 1110 BF	115	Pratts T3 + T4 115-69 kV autos + Pratts 63 MVAR capacitor
PrattsJct P142 BF	115	Pratts T3 + T4 115-69 kV autos + P-142N + Pratts 63 MVAR capacitor
PrattsJct 802 BF	115	Pratts T5 + T6 + T7 115-69 kV autos + E-205E + J-136 (PJ – Litch Tap)
PrattsJct L138 BF	115	Pratts T5 + T6 + T7 115-69 kV autos + L-138 + J-136 (PJ – Litch Tap)
PrattsJct K137 BF	115	Pratts T5 + T6 + T7 115-69 kV autos + K-137 + J-136 (PJ – Litch Tap)
PrattsJct J136 BF	115	Pratts T5 + T6 + T7 115-69 kV autos + J-136S
PrattsJct 2110 BF	115	Pratts T5 + T6 + T7 115-69 kV autos + J-136 (PJ – Litch Tap)
PrattsJct 38-42 BF	115	L-138W + P-142N
PrattsJct 37-41 BF	115	K-137W + O-141N
115 kV Capacitor Banks		
Bear Swamp Cap #1	115	Bear Swamp 63 Mvar Cap Bank
Bear Swamp Cap #2	115	Bear Swamp 63 Mvar Cap Bank
115 kV Line-End Open Contingencies		
1242 Mont-open	115	Montague – Berkshire
1242 Berk-open	115	Montague – Berkshire
1231 Berk-open	115	Berkshire – Cumberland
1231 Cumb-open	115	Berkshire – Cumberland
A-127 Millb-open	115	A-127 (Millbury – Tower 510)
B-128 Millb-open	115	B-128 (Millbury – Tower 510)
I135 Flagg-open	115	I-135 (Flagg Pd – Chinook)
I-135 Fitz-open	115	I-135 (Fitzwilliam – Chinook)
J136S Flagg-open	115	J-136S (Flagg Pd – Litchfield St Tap)
O141N Wach-open	115	O-141N (Wachusett – Sterling)
O141N Pratts-open	115	O-141N (PrattsJct – Sterling)
P142N Wach-open	115	P-142N (Wachusett – Sterling)
P142N Pratts-open	115	P-142N (Pratts Jct – Sterling)
P142S Milb-open	115	P-142S (Millbury – Wyman Gordon)
P142S Bloom-open	115	P-142S (Rolfe Ave. – Bloomingdale Tap)
P142S Rolfe-open	115	P-142S (Rolfe Ave – Bloomingdale Tap)
E131 Bear-open	115	E-131 (Bear Swamp – Bear Swamp Jct)
E131 Adams-open	115	E-131 (Adams – Bear Swamp Jct)
F132 Doreen-open	115	F-132 (Doreen – Partridere)
W-175 Carp-open	115	W-175 (Carpenter Hill – W Charlton)
W-175 Palm-open	115	W-175 (Palmer – Little Rest Rd)
X-176 Palm-open	115	X-176 (Palmer – Thorndike)
X-176 Ludlow-open	115	X-176 (Ludlow – Thorndike)
115 kV Breaker Open Contingencies		
A127W Harriman	115	Harriman - Cabot Jct
J136S Pratts	115	Pratts Jct – Litchfield tap
I135N-Bellows	115	Bellows Falls – Fitzwilliam Tap
J136N-Bellows	115	Bellows Falls – E Winchendon
E131-harriman	115	Harriman – Bear Swamp Jct
B128-harriman	115	Harriman – Cabot Jct
Y177-harriman	115	Harriman – Sherman
Harriman T3 115 kV	115	Harriman T3 115 kV winding - Midpoint
115 kV Bus Faults		

CONTINGENCY NAME	kV	DESCRIPTION
Harriman Bus #1	115	A-127 open ended + B128 open ended + GSU # 1 + #2 (Post-Harriman Tie breaker)
Harriman Bus #2	115	E-131 open ended + Y-177 open ended + T3 open ended (Post-Harriman Tie breaker)
Pratts Bus #1	115	
Pratts Bus #2	115	
69 kV Transmission Lines		
A-1	69	Otter River – Chestnut Hill
A-1N	69	Chestnut Hill – Vernon
A-1S	69	PrattsJct – Otter River
B-2N	69	Park St – Vernon
B-2S	69	PrattsJct – Park St (Gardner)
D-4N	69	Vernon – QP660
D-4S	69	QP660- Deerfield 4
E-5	69	Meadow St. – Ware
E-5D	69	Shutesbury – Deerfield 4
E-5E	69	Millbury – Meadow St
E-5W	69	Ware – Shutesbury
F-6	69	Meadow St. – Ware
F-6E	69	Millbury – Meadow St
F-6W	69	Ware – Deerfield 4
J-10	69	Adams – Deerfield 5
M-39	69	Fitch Rd – Wachusett
N-40	69	Fitch Rd – PrattsJct
N-14	69	Palmer – E Longmeadow
O-15N	69	Palmer – Ware
O-15S	69	W Hamden - E Longmeadow
Y-25N-1	69	Searsburg – Searsburg Wind
Y-25N-2	69	Bennington – Deerfield Wind
Y-25S	69	Deerfield 5 – Harriman – Searsburg
69 kV Breaker Failures		
Pratts A1S BF	69	A-1S + U-21S + N-40 + open end 69 kV side of Pratts 115/69 kV transformer bank #1
Pratts B2S BF	69	B-2S + V-22S + open 69 kV side of Pratts 115/69 kV transformer bank #2
Pratts 160 BF	69	Pratts 115/69 kV transformer bank #2 + Open end A-1S + N-40 + U-21S
Pratts 260 BF	69	Pratts 115/69 kV transformer bank #2 + Open end B-2S + V-22S
Pratts Tie BF	69	PrattsJct 69 kV busses #1 and #2 (open all lines and transformers at PrattsJct 69 kV)
Pratts U21 BF	69	U-21S + N-40 + open end 69 kV side of Pratts 115/69 kV transformer bank #1 + open end A-1S
Pratts V22 BF	69	V-22S + open end B-2S + open 69 kV side of Pratts 115/69 kV transformer bank #2
Deerfield #4 540	69	E-5D + Deerfield 69 kV bus (open end all other facilities out of Deerfield 69 kV)
Deerfield #4 640	69	F-6W + Deerfield 69 kV bus (open end all other facilities out of Deerfield 69 kV)
Crystal Lake B2S BF	69	B-2S + Crystal Lake T1 (69/13kV)
Crystal Lake B2N BF	69	B-2N + Crystal Lake T2 (69/13kV)
Searsburg Y25 BF	69	Y-25N-1 + Y25S
Deerfield Wind Y25-1 BF	69	Searsburg Wind + Y-25N-1 + Y-25N-2 open ended
Deerfield Wind Y25-2 BF	69	Searsburg Wind + Y-25N-2 + Y-25N-1 open ended
Deerfield Wind Y25-Tie BF	69	Searsburg Wind + Y-25N-1 + Y-25N-2
Adams 360 BF	69	Adams 115/69kV Autotransformer + J-10
Chestnut Hill 230 BF	69	A-1N + A-1 open ended + T2
Chestnut Hill 130 BF	69	A-1 + A-1N open ended + T1
Otter River A1 BF	69	A-1 + A-1S open ended
Otter River A1S BF	69	A-1S + A-1 open ended
Harriman 3810 BF	69	Y-25S + Harriman G3 + Harriman 115/69kV Autotransformer
Vernon A1 BF	69	A-1N + GSU #1
Vernon B2 BF	69	B-2N + D-4 open ended + GSU #2
Vernon D4 BF	69	B-2N + D-4 open ended + GSU #2
Vernon Tie BF	69	All lines (A-1N, B-2N, D-4) open ended + GSU #1 & #2
Bennington Y25 BF	69	Y-25N-2 + Benn 115/69kV Autotransformer + Benn Cap #2
69 kV Line-End Open Contingencies		
E-5E Mill-open	69	Millbury – Pondville
E-5 Meadow-open	69	Meadow St – Harrington St
E-5W Ware-open	69	Ware - Shutesbury
F-6E Mill-open	69	Millbury - Pondville
F-6 Meadow-open	69	Meadow St. – Lashaway
F-6W Ware-open	69	Ware – Belchertown

CONTINGENCY NAME	kV	DESCRIPTION
69 kV Breaker Open Contingencies		
A-1 Otter River	69	Royalston – Otter River
A-1S Otter River	69	Otter River – E Westminster
A1 Chestnut Hill	69	Chestnut Hill – Royalston
A1S Pratts Jct	69	Pratts Jct – E Westminster
B2S Pratts Jct	69	Pratts Jct – E Westminster
B-2S Crystal Lake	69	Crystal Lake - Westminster
B-2N Crystal Lake	69	Crystal Lake – Otter River
E5D Deerfield 4	69	Deerfield 4 – Deerfield 3
F6 Meadow St	69	Meadow St - Lashaway
F6 Shutesbury	69	Shutesbury – Deerfield 2
F6W Deerfield 4	69	Deerfield 4 – Deerfield 3
Harriman T3 69 kV	69	Harriman T3 69 kV winding - Midpoint
Y25 Searsburg	69	Searsburg North bus - Searsburg South bus
Y25 Deerfield 5	69	Deerfield 5 – Hoosic Wind Tap
69 kV Bus Faults		
Pratts Bus #1	69	
Pratts Bus #2	69	
Vernon #1	69	A-1 open ended at Vernon + GSU #1
Vernon #2	69	B-2 and D-4 open ended at Vernon + GSU #2
Deerfield #4	69	All lines open ended at Deerfield 4 (E-5, F-6, D-4)
69 kV Double Ckt Towers		
A1S+B2S	69	
A1S+B2N	69	
A1+B2N	69	
A1N+B2N	69	
E5E+F6E DCT	69	
E5+F6 DCT	69	
E5W+F6W DCT	69	
E5D+F6W DCT	69	
Generators/GSU		
Harriman Hydro (VT)	115/6.9	GSU 1
Harriman Hydro (VT)	115/6.9	GSU 2
Harriman Hydro (VT)	115/6.9	GSU 3
Cabot Hydro (MA)	115/13.8	Cabot GSU
Northfield (MA)	345/13.8	GSU #1 Unit 1 + Unit 2
Northfield (MA)	345/13.8	GSU #2 Unit 3 + Unit 4
Altresco (MA)	115/13.8	Unit 1 + Unit 2
Altresco (MA)	115/13.8	Unit 3 + Unit 4
Vernon Hydro #1 (VT)	69/13.8	GSU #1
Vernon Hydro #2 (VT)	69/13.8	GSU #2
Seabrook	345	
Bear Swamp G1/P1	230 kV	Bear Swamp Generator/Pump #1
Bear Swamp G2/P2	230 kV	Bear Swamp Generator/Pump #2
Millenium GT + ST	115 kV	Millennium Gas Turbine + Steam Turbine Unit

5.4.2 N-1-1 Contingency List

The following table lists the contingencies that was tested as the first line out in N-1-1 contingency analysis. In each line-out case, all contingencies described in previous section is tested as the second contingency.

Table 15 - N-1-1 Contingency List

Initial facility out (N-1), one at a time	Second Contingency (N-1-1)
Each transmission circuit (69 kV and above) tested in N-1 analysis Each transmission transformer (115/69 kV and above) tested in N-1 analysis Each Generator (connected to 69 kV and above) tested in N-1 Analysis Loss of Seabrook G1 Loss of Sandy Pond HVDC Pole 1 Loss of Sandy Pond HVDC Pole 2 Shunt Device	All contingencies listed in Table 14 except: Non BPS* Double Circuit Towers Non BPS* Breaker Failures Non BPS* Bus sections Line-End-Open Contingencies

*** Non** BPS **equipment is defined as any line or device that is not terminated at a BPS station**

Steady State Results

5.4.3 N-0 Thermal and Voltage Results

N-0 Thermal Results

Simulation results indicate that addition of the Group 3 DER, incemental to the Groups 1+2 DER, results in several transmission facility overloads during all-lines-in conditions as shown in table below.

Table 16 - N-0 Thermal Overloads

Worst case Loading at or above 100% of LTE Rating				Base case
Overloaded Facility	KV	Summer Normal Rating (MVA)	Loading (% LTE)	
B-2 [Pratts Jct – E Westminster] (2/0 Cu O/H line)	69	43	110	25pk-we-pv=100% + BESS discharge
			107	25sh-we_ PV=100% + BESS discharge
			107	25ll-we_ PV=100% + BESS discharge
			102.4	25sh-ew+pump PV=0% BESS Charging
B-2 [E Westminster - Westminster] (2/0 Cu O/H line)	69	43	107	25pk-we-pv=100% + BESS discharge
			104	25sh-we_ PV=100% + BESS discharge
B-2 [Westminster – Crystal Lake] (2/0 Cu O/H line)	69	43	109	25sh-we_ PV=100% + BESS discharge

N-0 Voltage Results

No N-0 voltage violations were found for any of the conditions tested.

N-1 Thermal and Voltage Results

N-1 Thermal Results

Simulation results indicate that addition of the Group 3 DER, incremental to the Groups 1+2 DER, results in several transmission facility overloads following N-1 contingencies as shown in table below.

Table 17 - N-1 Thermal Overloads

Worst case Loading at or above 100% of LTE Rating				Base case	CONTINGENCY (Loss of)
Overloaded Facility	KV	LTE Rating (MVA)	Loading (% LTE)		
B-2 [Pratts Jct – E Westminster] (2/0 Cu O/H line)	69	53	107 - 109	25pk-we-pv=100% + BESS discharge 25sh-we_ PV=100% + BESS discharge 25ll-we_ PV=100% + BESS discharge 25sh-ew+pump PV=0% BESS Charging	A-1S 69 kV line (Pratts – Otter River)
			104	25sh-we_ PV=100% + BESS discharge	A-1N 69 kV line (Vernon-Chestnut Hill)
			103	25pk-we-pv=100% + BESS discharge	A-1 69 kV line (Chestnut Hill – Otter River)
			103 - 109	25pk-we-pv=100% + BESS discharge 25sh-we_ PV=100% + BESS discharge 25sh-ew+pump PV=0% BESS Charging	E-205E 230 kV line (Bear Swamp – Pratts)
B-2 [E Westminster - Westminster] (2/0 Cu O/H line)	69	53	103	25sh-we_ PV=100% + BESS discharge	A-1N 69 kV line (Vernon-Chestnut Hill)
			104	25sh-we_ PV=100% + BESS discharge	Breaker Open A-1 Pratts
			108	25sh-we_ PV=100% + BESS discharge	E-205E 230 kV line (Bear Swamp – Pratts)
B-2 [Westminster – Crystal Lake] (2/0 Cu O/H line)	69	53	109	25sh-we_ PV=100% + BESS discharge	A-1S 69 kV line (Pratts – Otter River)
			104	25sh-we_ PV=100% + BESS discharge	A-1N 69 kV line (Vernon-Chestnut Hill)
			103	25sh-we_ PV=100% + BESS discharge	A-1 69 kV line (Chestnut Hill – Otter River)
			110	25sh-we_ PV=100% + BESS discharge	E-205E 230 kV line (Bear Swamp – Pratts)
A-1 [Otter River - Royalston] (2/0 Cu O/H line)	69	43	103	25sh-we_ PV=100% + BESS discharge	B-1S 69 kV line (Pratts – Crystal Lake)
			105	25sh-we_ PV=100% + BESS discharge	BF Pratts 260

If QP1031 [redacted] goes forward, the addition of Group 3 DER results in the following additional N-1 overloads.

Table 18 – Additional N-1 Thermal Overloads

(w/ [redacted] (QP1031) and [redacted] (QP1112) In-service)

Worst case Loading at or above 100% of LTE Rating				Base case	CONTINGENCY (Loss of)
Overloaded Facility*	KV	LTE Rating (MVA)	Loading (% LTE)		
E-5 [Meadow St- Leicester] (477 ACSR)	69	98	110	25pk-we-pv=100% + BESS discharge	F-6E 69 kV line (Millbury- Meadow St)
F-6 [Meadow St- Leicester] (477 ACSR)	69	98	110	25pk-we-pv=100% + BESS discharge	E-5E 69 kV line (Millbury- Meadow St)
E-5 [Leicester - Pondville] (477 ACSR)	69	98	110	25pk-we-pv=100% + BESS discharge	F-6 E 69 kV line (Millbury- Meadow St)
F-6 [Leicester - Pondville] (477 ACSR)	69	98	110	25pk-we-pv=100% + BESS discharge	E-5E 69 kV line (Millbury- Meadow St)
E-5 [Meadow St – Harrington St] (477 ACSR)	69	98	103	25pk-we-pv=100% + BESS discharge	F-6 69 kV line (Ware - Meadow St)

*All additional Overload facilities are due to the inclusion of QP1031 [redacted] only, not QP1112 [redacted].

N-1 Voltage Results

Simulation results indicate that the addition of the Group 3 DER (With or without QP1031 or QP 1112), results in several high and low voltage violations along the A1/B2 69 kV transmission circuits for several N-1 contingencies. These overloads are shown in the following table.

Table 19 - N-1 Voltage Violations

BUSSES W/ VOLTAGE VIOLATIONS		Voltage	BASE CASE	CONTINGENCY
Bus	**KV**	**Pu**		**(Loss of)**
E Westminster (A1)	69	1.07	25min pv=100% + BESS discharge	A1S Beaker Open at Pratts 69 kV
		0.88	25sh-ew+pump PV=0% BESS Charging	
E Westminster (B2)	69	1.06	25min pv=100% + BESS discharge	B2S Beaker Open at Pratts 69 kV
Westminster (B2)	69	1.06	25sh-we pv=100% + BESS discharge	B2S Beaker Open at Pratts 69 kV
Vernon (A1/B2)	69	1.056	25min pv=100% + BESS discharge	D-4 69 kV line [Vernon – Deerfield 4]
Otter River (A1)	69	1.06	25min pv=100% + BESS discharge	A1S Beaker Open at Pratts 69 kV
		0.88	25sh-ew+pump PV=0% BESS Charging	Pratts 69 kV tie breaker failure
Royalston (A1)	69	1.059	25min pv=100% + BESS discharge	A1S Beaker Open at Pratts 69 kV
		0.890	25sh-ew+pump PV=0% BESS Charging	Pratts 69 kV tie breaker failure
Chestnut Hill (A1)	69	1.053	25min pv=100% + BESS discharge	A1S Beaker Open at Pratts 69 kV
		0.89	25sh-ew+pump PV=0% BESS Charging	Pratts 69 kV tie breaker failure
Crystal Lake (B2)	69	1.07	25sh-we pv=100% + BESS discharge	B2S 69 kV line (Pratts – Crystal Lk)
		1.054	25sh-we pv=100% + BESS discharge	B2N 69 kV line (Vernon – Crystal Lk)

Appendix D provides the full N-0 and N-1 thermal and steady state voltage results.

5.4.4 N-1-1 Steady State Results

N-1-1 Thermal Results:

One additional thermal overload on the A-1 circuit (over and above that found for N-1 contingencies) was identified for N-1-1 contingencies. This occurs with or without [redacted] (QP1031) or [redacted] (QP1112) In-service.

Table 20 – N-1-1 Thermal Overloads (Incremental to N-1 Overloads)

Worst case Loading at or above 100% of LTE Rating				Base case	1st CONTINGENCY (Loss of)	2nd CONTINGENCY (Loss of)
Overloaded Facility	KV	LTE Rating (MVA)	Loading (% LTE)			
A-1S [Pratts Jct – E Westminster] (2/0 Cu O/H line)	69	53	103	25sh-ew+pump PV=0% BESS Charging	D-4 69 kV line [Vernon – Deerfield 4]	B2S 69 kV Breaker Open at Pratts Jct

Two additional thermal overloads (over and above that found for N-1 contingencies) were identified on the E-5/F-6 circuits with [redacted] (QP1031) in place.

Table 21 – Additional N-1-1 Thermal Overloads

(w/ [redacted] (QP1031) In-service)

Worst case Loading at or above 100% of LTE Rating				Base case	1st CONTINGENCY (Loss of)	2nd CONTINGENCY (Loss of)
Overloaded Facility*	KV	LTE Rating (MVA)	Loading (% LTE)			
E-5E [Millbury- Pondville] (477 ACSR)	69	98	105% 106%	25ll-we-pv=100% + BESS discharge 25pk-we-pv=100% + BESS discharge	O-15N 69 kV Line (Palmer – Ware)	F-6E 69 kV line (Millbury- Meadow St)
F-6E [Millbury- Pondville] (477 ACSR)	69	98	105% 106%	25ll-we-pv=100% + BESS discharge 25pk-we-pv=100% + BESS discharge	O-15N 69 kV Line (Palmer – Ware)	E-5E 69 kV line (Millbury- Meadow St)

*All additional Overload facilities are due to the inclusion of QP1031 [redacted] only, not QP1112 [redacted].

N-1-1 Voltage Results:

No additional voltage problems (over and above those found for N-1 contingencies) were identified for N-1-1 contingencies. This is true with or without [redacted] (QP1031) or [redacted] (QP1112) In-service.

Transmission Upgrades Required for Group 3 DER

- **A1/B2 line rebuild/reconductor:** The thermal overloads identified on the A1/B2 69 kV transmission lines will be eliminated by an asset condition project already scheduled for the A1/B2 lines which involves the complete rebuild of the lines using 795 ACSS conductor (ISD 2027)

- **Royalston Breaker Additions**: 69 kV breaker additions at Royalston substation are needed to eliminate voltage violations along the A1/B2 lines caused by the Group 3 DER after the A1/B2 rebuild is complete. These breaker additions are already required as part of the asset condition project to rebuild of the A1/B2 lines. Note that with the Royalston breakers in place, along with the rebuilt A1/B2 lines, the Chestnut Hill 69 kV substation will be supplied via two radial taps from A1 and B2 (unlike the existing supply to Chestnut Hill substation, which involves a loop through of the A-1 line). This new arrangement is shown in the following one-line diagram. The Chestnut Hill substation is also scheduled to be rebuilt in 2026 due to asset condition issues.

- **Vernon 69 kV substation rebuild**: 69 kV equipment at Vernon substation must be upgraded to eliminate overloads on the A-1N and B-2N 69 kV circuits. These overloads occur when both DER Group 3 is connected, and the A1/B2 are reconductored (decreases impedance). There is an asset condition project already planned to rebuild Vernon station (which will be named “Huntington” substation) in 2026, which will eliminate the overloads.

- **E5/F6 line rebuild/reconductor:** The thermal overloads on the E5/F6 69 kV transmission lines caused by the combination of [redacted] (QP1031) and Group 3 DER will be eliminated by the rebuild of both E5/F6 lines and reconductor with 795 ACSS conductor. The rebuild of both E5/F6 lines is already planned due to asset condition issues, and will be completed by year 2030. Note that if QP1031 is withdrawn, Group 3 DER does not cause the E5/F6 lines to become overloaded.

Figure 9 – Asset Condition Projects Planned for A1/B2 69 kV Corridor

[redacted]

5.5 Group 3 DER that Can't Connect until Transmission Upgrades are Built

The following Group 3 DER can't interconnect until the A-1/B-2 69 kV transmission lines are rebuilt, the Royalston Breakers installed, and the Vernon substation is rebuilt:

PPA ID	ISO QP Number	NGrid Case Number	Developer/Project Name	Substation
NEP-22-G03-036	1174	290747	[redacted]	Crystal Lake
NEP-22-G03-037	1175	301762		East Westminster
NEP-22-G03-041	1183	318176		Royalston

If [redacted] (QP1031) goes in-service, the following Group 3 DER can't interconnect until the E5/F6 69 kV line rebuild is completed:

PPA ID	ISO QP Number	NGrid Case Number	Developer/Project Name	Substation
NEP-22-G03-028	1177	281385	[redacted]	Lashaway
NEP-22-G03-029	1177	283873		Lashaway
NEP-22-G03-032	1179	178171		Meadow Street
NEP-22-G03-031	1179	178483		Meadow Street
NEP-22-G03-030	1179	193213		Meadow Street
NEP-22-G03-022	1188	178170		Ware
NEP-22-G03-023	1188	191401		Ware
NEP-22-G03-024	1188	191403		Ware
NEP-22-G03-025	1188	191405		Ware

6 TRANSIENT STABILITY ANALYSIS

Stability testing was performed with all Group 1, 2 and 3 DER in-service, along with the transmission upgrades required for the interconnection of Group 3 DER, described in the previous sections. The stability testing was performed according to all applicable reliability standards. The purpose of the testing is to verify that the addition of the Group 3 DER and associated transmission upgrades do not cause significant adverse impact on the stability of the New England transmission system.

PSS/E Rev 34 was used to conduct the stability simulations.

6.1 Stability Performance Criteria

Normal Contingency (NC) Criteria

- Both system wide stability and individual unit stability must be maintained for all normal design contingencies. Individual generating units ≥ 5 MW or any set of units totaling more than 20 MW shall not lose synchronism or trip off due to voltage, frequency or other protection, except for the units that are tripped for fault clearing.
- A 53% reduction in the magnitude of system oscillations must be observed over four periods of the oscillation.

Bulk Power System (BPS) Testing

BPS testing is performed to determine the impact of the Project on facilities classified as part of the Bulk Power System (BPS), in accordance with revision 2 of the NPCC Document A-10, dated March 27, 2020, "Classification of Bulk Power System Elements". The criteria for BPS testing are as follows.

Acceptable BPS Reponses

- A 53% reduction in the magnitude of system oscillations observed over four periods.
- Loss of source up to 1200 MW

Unacceptable BPS Reponses

- Transiently unstable, with wide spread system collapse.
- Transiently stable, with undamped or sustained power system oscillations.
- Loss of source greater than 1200 MW.

NEPOOL Voltage SAG Guidelines

For Normal Contingenciess, the minimum post-fault positive sequence voltage sag must remain above 70% of nominal voltage and must not exceed 250 milliseconds below 80% of nominal voltage within 10 seconds following a fault. These limits are supported by the typical sag tolerances shown in IEEE Standard 1346-1998.

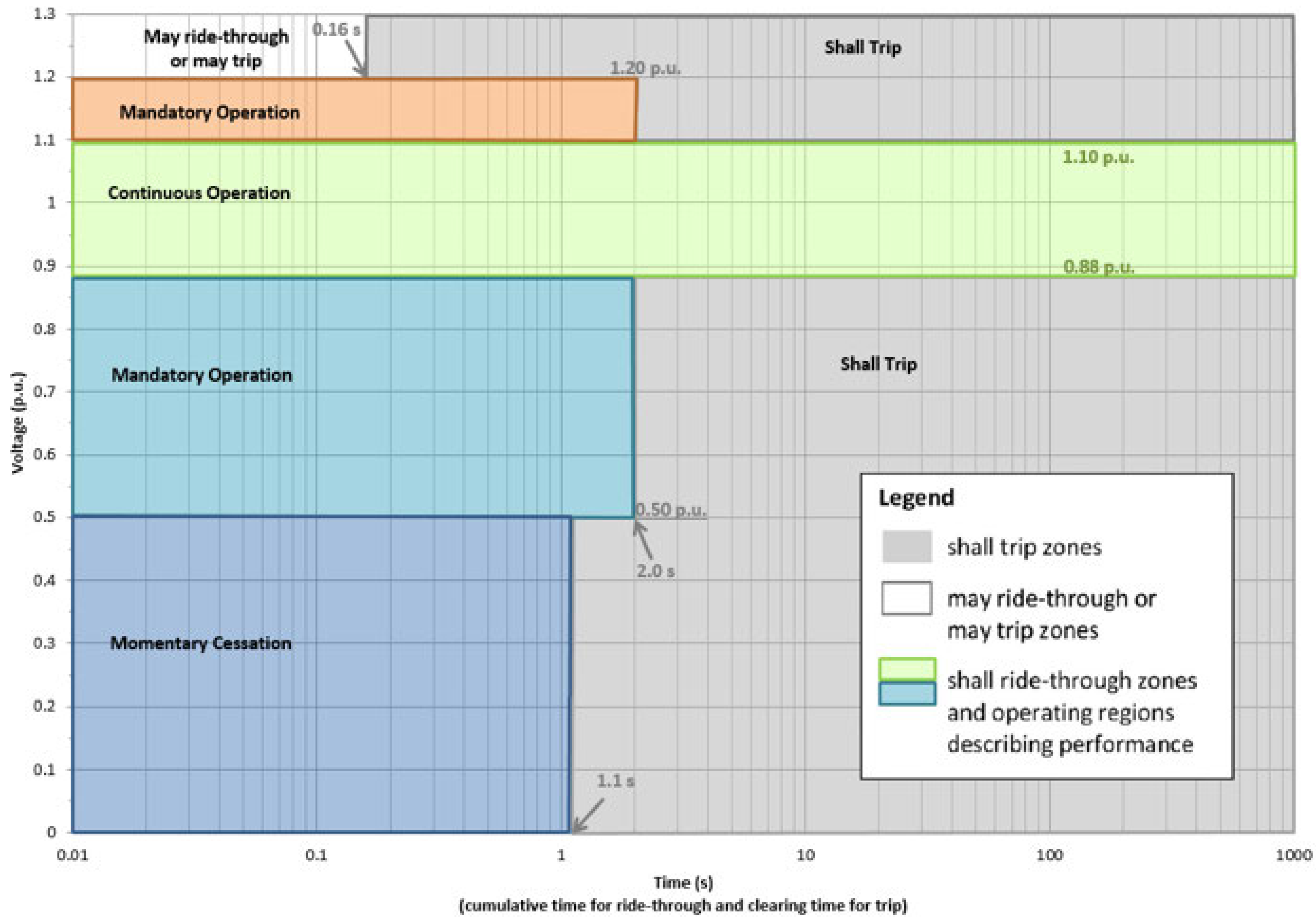
6.2 Voltage and Frequency Ride-Through Capability of DER

Groups 1, 2 and 3 DER do not have the same ride-through requirements. Groups 1 and 2 had an earlier version "Source Requirements Document" (SRD) applied to their interconnection requirements compared to the SRD applied to Group 3.

6.2.1 Voltage Ride-Through Capability for Groups 1 and 2 DER

The Voltage Ride-Through capability of Groups 1 and 2 DER were modeled according to the SRD that was applied to their interconnection, which is shown below.

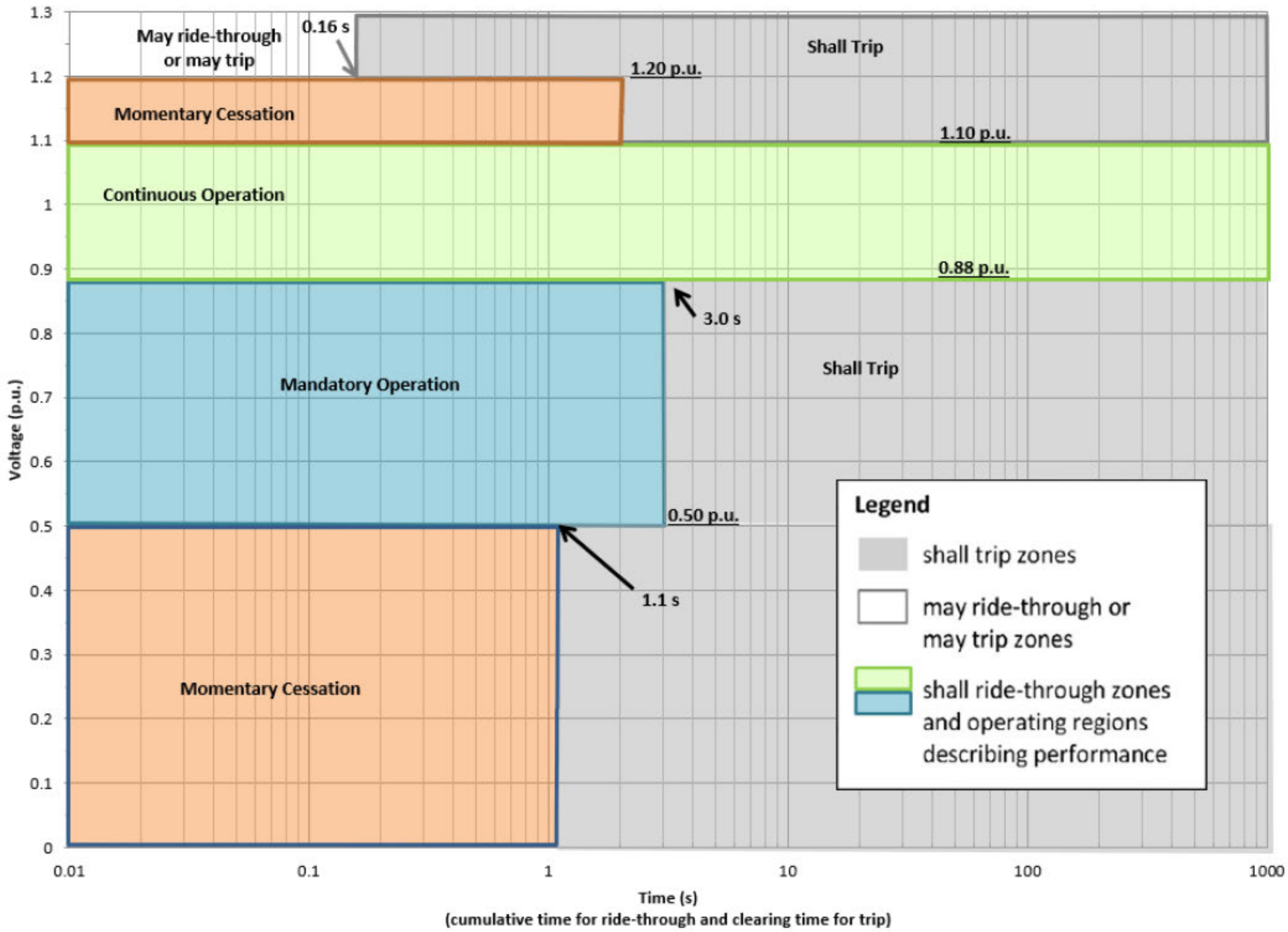
Figure 10 - Groups 1 and 2 Voltage Ride-Through Capability Curve



6.2.2 Voltage Ride-Through Capability for Group 3 DER

The Voltage Ride-Through capability of Group 3 DER is shown below. Note that the SRD was revised for Group 3 of the Western MA Cluster DER. Note that the only change pertaining to voltage ride-through in the revised SRD is that it extends the "Mandatory Operation" region from 2.0 seconds to 3.0 seconds. All Group 3 DER were modeled according to this voltage ride through curve.

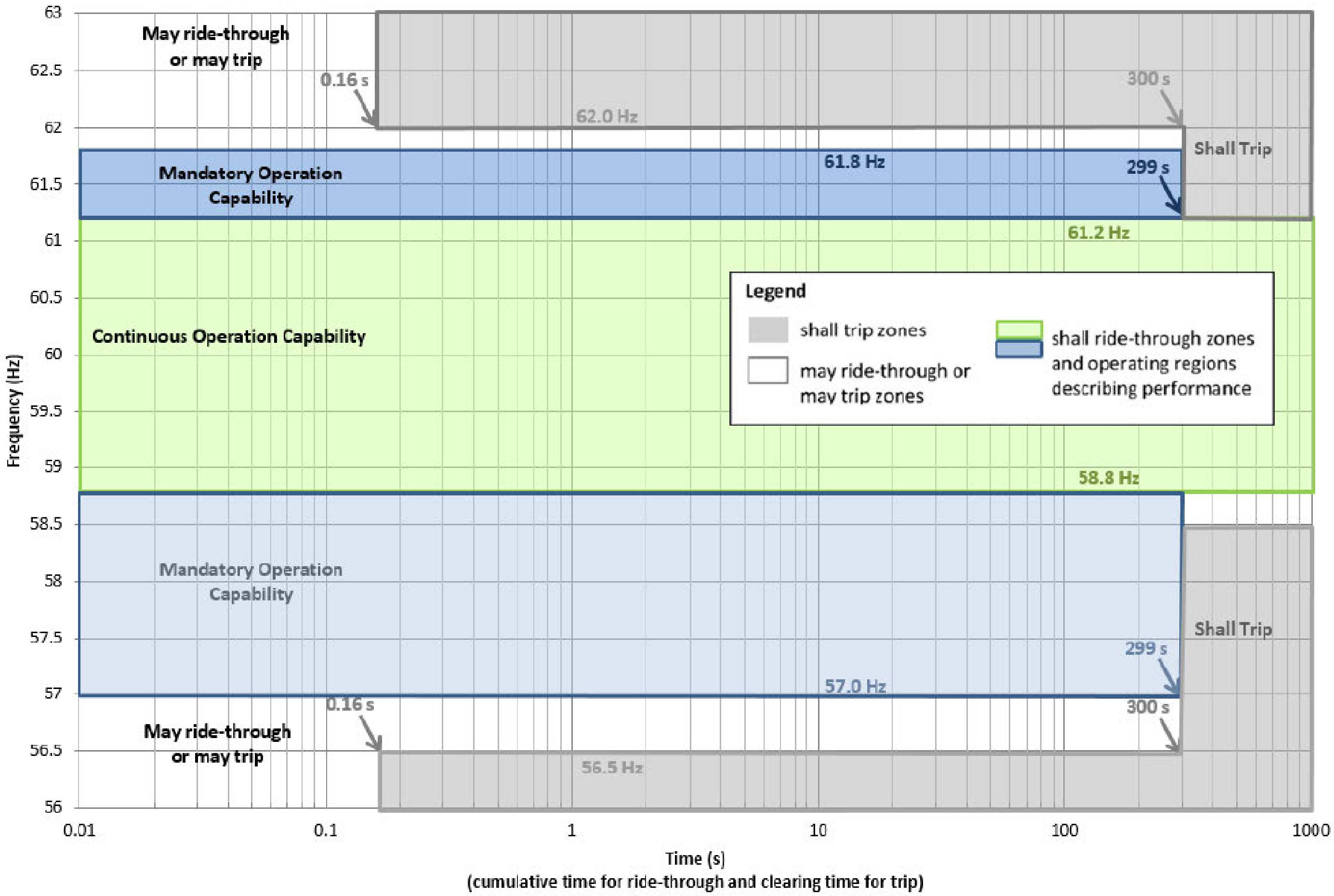
Figure 11 - Group 3 Voltage Ride-Through Capability Curve



6.2.3 Frequency Ride-Through Capability for Group 1, 2 and 3 DER

The Frequency Ride-Through requirement in the revised SRD for Group 3 is the same as in the SRD applied to Group 1 and 2. This frequency ride-through requirement curve is shown below. It was applied to all DER in Group 1, 2, and 3.

Figure 12 – Groups 1, 2, and 3 Frequency Ride-Through Curve



6.3 Frequency Response Requirement for Group 3 DER

The revised SRD for Group 3 requires that this DER respond to frequency deviations via a droop characteristic. No such requirement applies to Groups 1 and 2. Group 3 DER therefore was modeled with frequency response enabled in the stability simulations. Below are the Frequency-Droop control settings specified in the revised SRD for Group 3 DER.

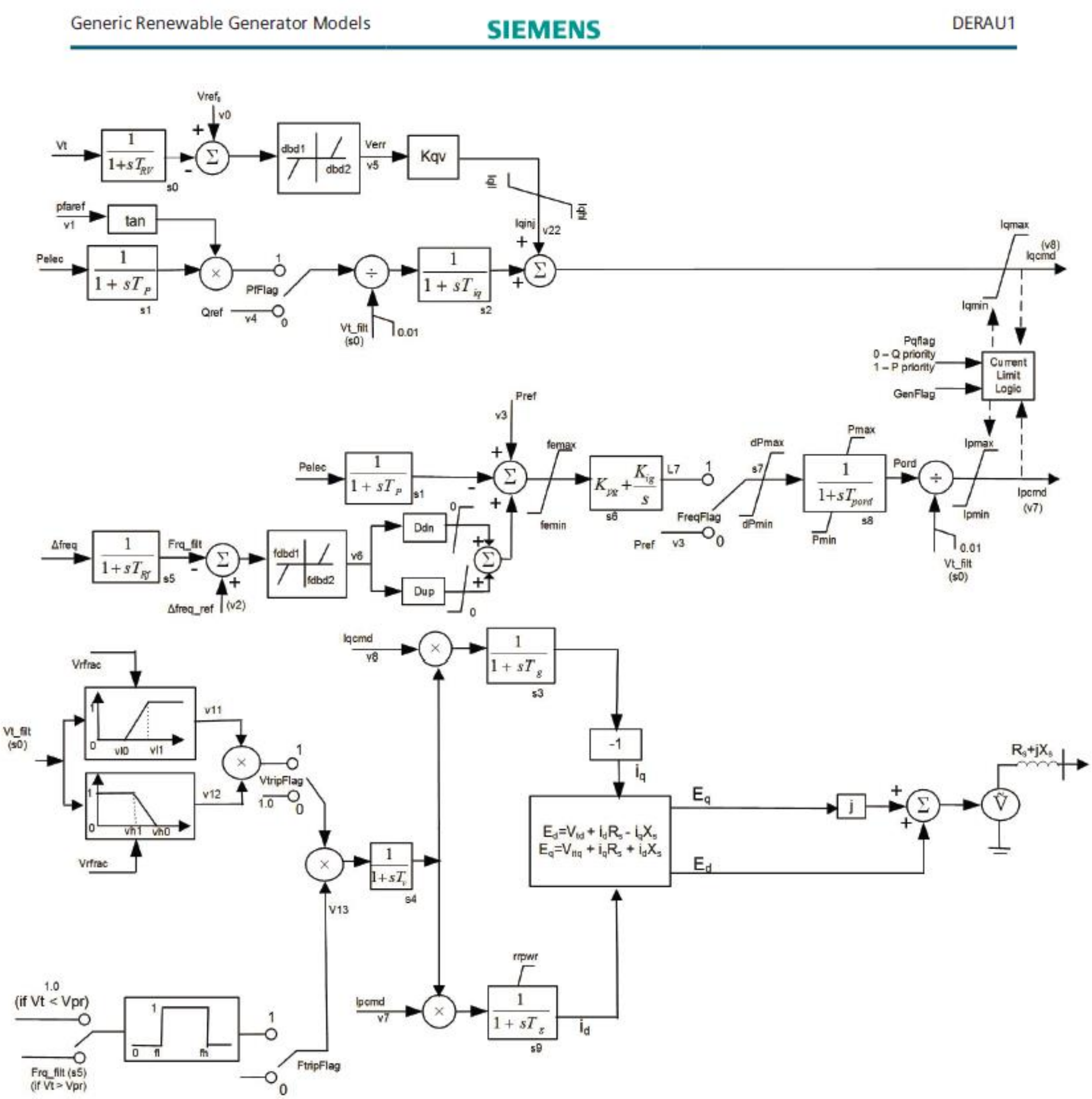
Frequency-Droop Control Settings required for Group 3 DER

Parameter	Inverter
dbOF, dbUF (Hz)	0.036
kOF, kUF (Droop)	0.05
T-response (small-signal) (s)	5

6.4 Stability Models for Group 1, 2, and 3 DER Between 1MW and 5MW

For Group 1, 2 and 3 DER greater than 1 MW, and less than 5 MW, this generation was modeled with the DER_A model. The block diagram of the DER_A model is shown in the following figure.

Figure 13 - DER_A Model Block Diagram



The input data that was used for the DER_A model is shown below. The parameters related to inverter dynamics characteristics are selected based on the latest guideline document from NERC.[8] The parameters related to voltage and frequency trip settings are selected such that the inverter complies with the voltage and frequency ride-through requirement of National Grid SRD.

Table 22 - DER_A Model Parameters Assumed for Study

Parameters	Value		Notes
	Group 1 and 2 DER	Group 3 DER	
trv	0.02	0.02	Voltage Transducer Time constant (default)
trfs	0.02	0.02	Frequency measurement transducer time constant (not in NERC guidance document, but assumed 0.02, same as Voltage Transducer Time constant)
dbd1	-99	-99	No voltage control will be modeled (default)
dbd2	99	99	No voltage control will be modeled (default)
kqv	0	0	No voltage control will be modeled (default)
vref0	0	0	No voltage control will be modeled (default)
tp	0.02	0.02	Power Transducer Time constant (default)
tiq	0.02	0.02	Q control Transducer Time constant (default)
ddn	0	20	reciprocal of droop for over-frequency conditions
dup	0	0 or 20	reciprocal of droop for under-frequency conditions (0 for solar and wind units. 20 for storage device)
fdbd1	-99	-0.0006	deadband (default)
fdbd2	99	0.0006	deadband (default)
femax	0	99	Freq error up limit (default)
femin	0	-99	Freq error low limit (default)
pmax	1	1	1 for wind, solar and battery units
pmin	0 or -1	0 or -1	0 for wind, solar units. -1 for battery units
dpmax	99	99	Power reference max ramp rate (default)
dpmin	-99	-99	Power reference min ramp rate (default)
tpord	0.02	5	Power Filter Open loop time constant (default)
kpg	0	0.1	Not mappable to interconnection standards (0, for no frequency control)
kig	0	10	Not mappable to interconnection standards (0, for no frequency control)
imax	1.2	1.2	Maximum converter current (typical inverter max output)
vl0	0.50	0.50	Voltage at head of feeder at which DER at head of feeder starts tripping.
vl1	0.55	0.55	Voltage at head of feeder at which DER at tail of feeder trips. Assume 5% voltage drop across Feeder. Amount of DER dropped will follow a linearly increasing amount until vl0, when all will be dropped
vh0	1.15	1.15	Voltage at head of feeder at which DER at tail of feeder trips. Assume 5% voltage drop across feeder
vh1	1.1	1.1	Voltage at head of feeder at which DER at head of feeder starts tripping. Amount of DER dropped will follow a linearly increasing amount until vh0, when all will be dropped

[8] https://www.nerc.com/comm/PC_Reliability_Guidelines_DL/Reliability_Guideline_DER_A_Parameterization.pdf

Parameters	Value		Notes
	Group 1 and 2 DER	Group 3 DER	
tvl0	1.1	1.1	low voltage cut-out timer corresponding to voltage vl0
tvl1	1.1	1.1	low voltage cut-out timer corresponding to voltage vl1
tvh0	2.0	2.0	High voltage cut-out timer corresponding to voltage vh0
tvh1	2.0	2.0	High voltage cut-out timer corresponding to voltage vh1
vrfrac	1	1	Per unit of DER that comes back after tripping (1 = 100% of DER comes back online if terminal voltage recovers above vlo (0.5 pu) within 1.1 seconds; 0 = 100% of DER is tripped permanently if terminal voltage does not recover above vlo (0.5 pu) within 1.1 seconds). The same logic holds true for voltages that exceed vh1.
fltrp	57.0	57.0	Frequency trip settings per National Grid SRD
fhtrp	62.0	62.0	
tfl	0.16	0.16	
tfh	0.16	0.16	
tg	0.02	0.02	† current control time constant (inner control loops) (default)
rrpwr	2.0	2.0	Ramp rate for real power increase following a fault (pu/S) as per 1547-2018 to achieve 80% recovery in 0.4 sec
tv	0.02	0.02	time constant on the output of the multiplier (time delay for partial tripping) (default value)
vpr	0.7	0.7	Low voltage inhibit on frequency tripping (due to spurious spikes that occur in positive sequence stability models) **- NOTE: all frequency tripping during simulations should be double checked for tripping due to spurious frequency spikes**
iqh1	0	0	No voltage control
iql1	0	0	No voltage control
pfflag	1	1	Constant power factor (based on initial value from steady state model)
frqflag	0	1	Freq control (1 to enable, 0 to disable)
pqflag	1	1	Active current (P) priority (during large disturbances)
Genflag	1 or 0	1 or 0	1 for Generator (0 is for storage device)
vtripflag	1	1	Enables voltage trip logic
ftripflag	1	1	Enables frequency trip logic

Note that all Group 3 DER will respond to frequency deviations, while all Group 1 and 2 DER will not, due to differences in the SRD between the groups.

All DER greater than 1 MW, but less than 5 MW, is modeled aggregately as a single equivalent generator, at the distribution bus of each substation to which it is connected. The MW size of the single equivalent generator, at a specific substation, is equal to the total amount of DER (greater than 1 MW but less than 5 MW) to be connected to that substation. No distribution feeder impedance is modeled between the equivalent generator and the distribution bus to which it is connected.

6.5 Stability Models of Group 1 and 2 DER Equal to 5MW and Greater

The Group 1 and 2 DER, equal to, or greater than 5 MW, were modeled with the same PSS/E library models as used for the Group 2 study.

These generators were modeled as individual generators combined with their equivalent collection system and GSU at the low side of the substation to which they will be connected through.

These generators were modeled with a standard PSS/E library model set consisting of the following modules:

REGCA – Renewable Energy Generator/Converter Model
REECA – Renewable Energy Electrical Model
REPCA – Plant Controller model

The following projects below exceeded 5 MW for Group 2.

Table 23 - Group 2 DER Greater than 5MW

Substation	Size (MW)
Shutesbury	10.0

The following projects below exceeded 5 MW for Group 1.

Table 24 - Group 1 DER Greater than 5MW

Substation	Size (MW)
Belchertown	8
Lashaway	6
Snow Street	12
Wendell Depot	5

6.6 Stability Models for Group 3 DER Equal to 5MW and Greater

The Group 3 DER, equal to, or greater than 5 MW, were modeled with the following library models for inverter based resources available in PSS/E Rev34.

1.) Renewable Energy Generator/Converter Model: REGC_B
2.) Renewable Energy Electrical Model: REEC_D
3.) Plant Controller model: REPCA

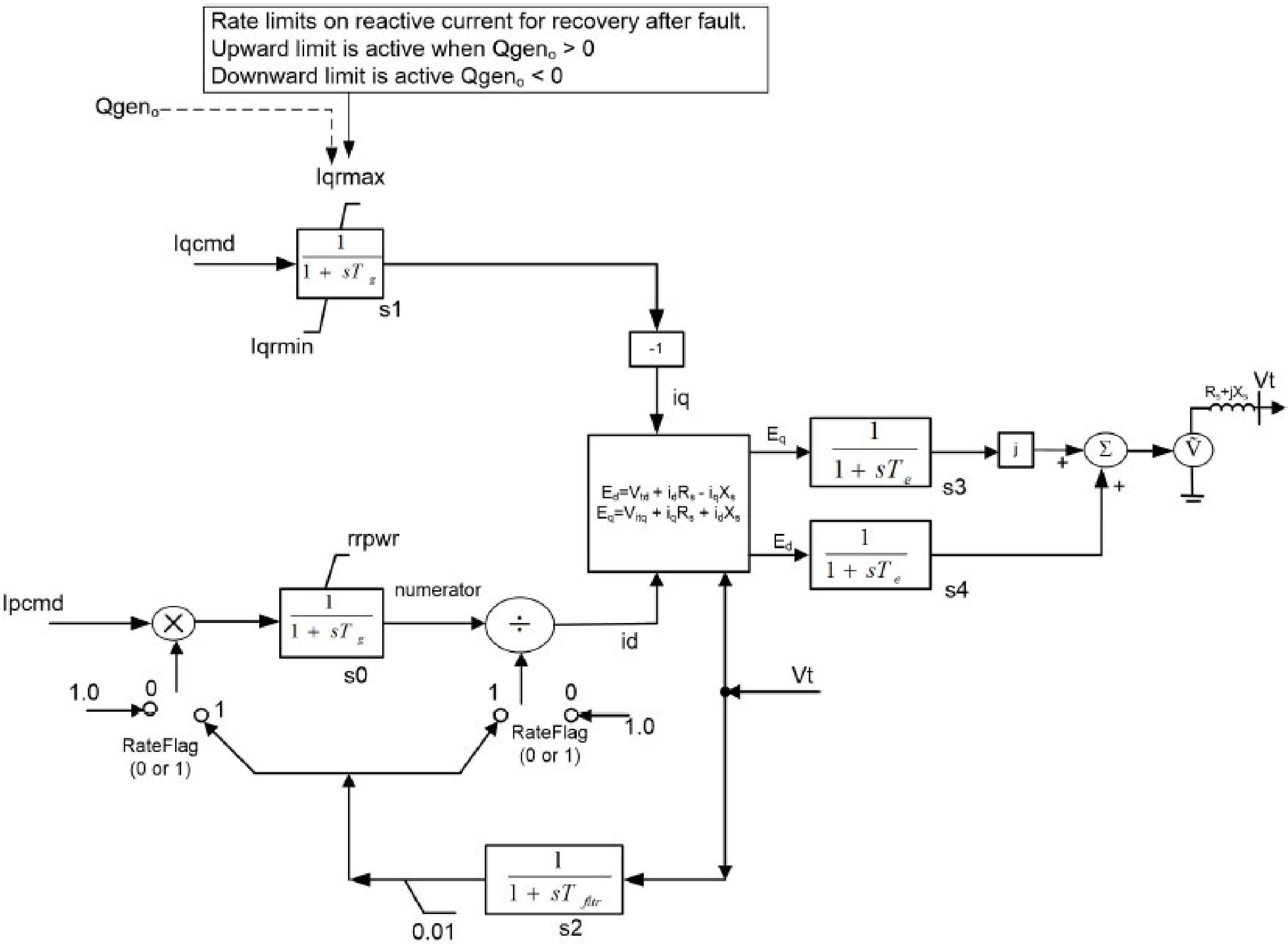
The following projects below exceeded 5 MW for Group 3.

Table 25 - Group 3 DER Greater than 5MW

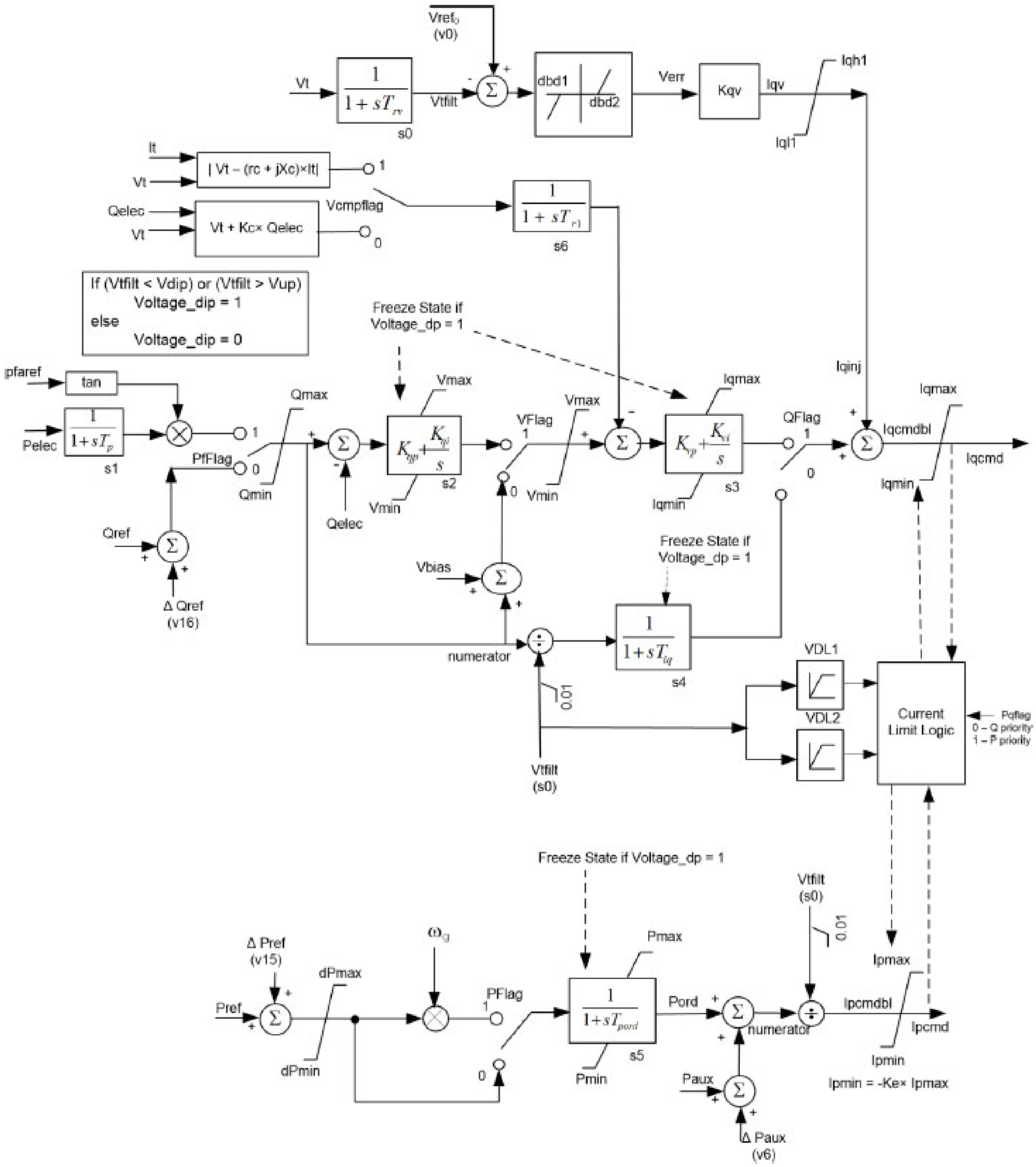
PPA ID	Substation	Type	Size (MW)	
			Discharging Limit	Charging Limit
NEP-22-G03-034	Barre	BESS only	8	8
NEP-22-G03-036	Crystal Lake	BESS only	8	5.2
NEP-22-G03-038	East Winchendon	BESS only	9.4	4.6
NEP-22-G03-039	East Winchendon	BESS only	5.5	4.2
NEP-22-G03-029	Lashaway	BESS only	10	7
NEP-22-G03-008	Laurel Circle	BESS only	8	4.4
NEP-22-G03-009	Millbury	BESS only	10	3.5
NEP-22-G03-011	North Oxford	BESS only	8	6.4
NEP-22-G03-013	North Oxford	BESS only	5.6	4.8
NEP-22-G03-006	Pratts Junction	BESS only	6	4.5
NEP-22-G03-041	Royalston	AC Coupled	5	0
NEP-22-G03-015	Snow St	BESS only	5	2.5
NEP-22-G03-016	Snow St	BESS only	5	2.5
NEP-22-G03-017	Snow St	BESS only	5.5	6.5
NEP-22-G03-001	Stafford St	DC Coupled	5	5
NEP-22-G03-033	Treasure Valley	BESS only	10	5
NEP-22-G03-020	West Charlton	BESS only	5	4.5
NEP-22-G03-021	West Charlton	BESS only	10	4
NEP-22-G03-044	Wendell Depot	BESS only	8	7.2
NEP-22-G03-043	Wendell Depot	BESS only	10	8

The block diagrams for these models are shown in the following figures.

REGC_B Block Diagram [Source: PSS/E]

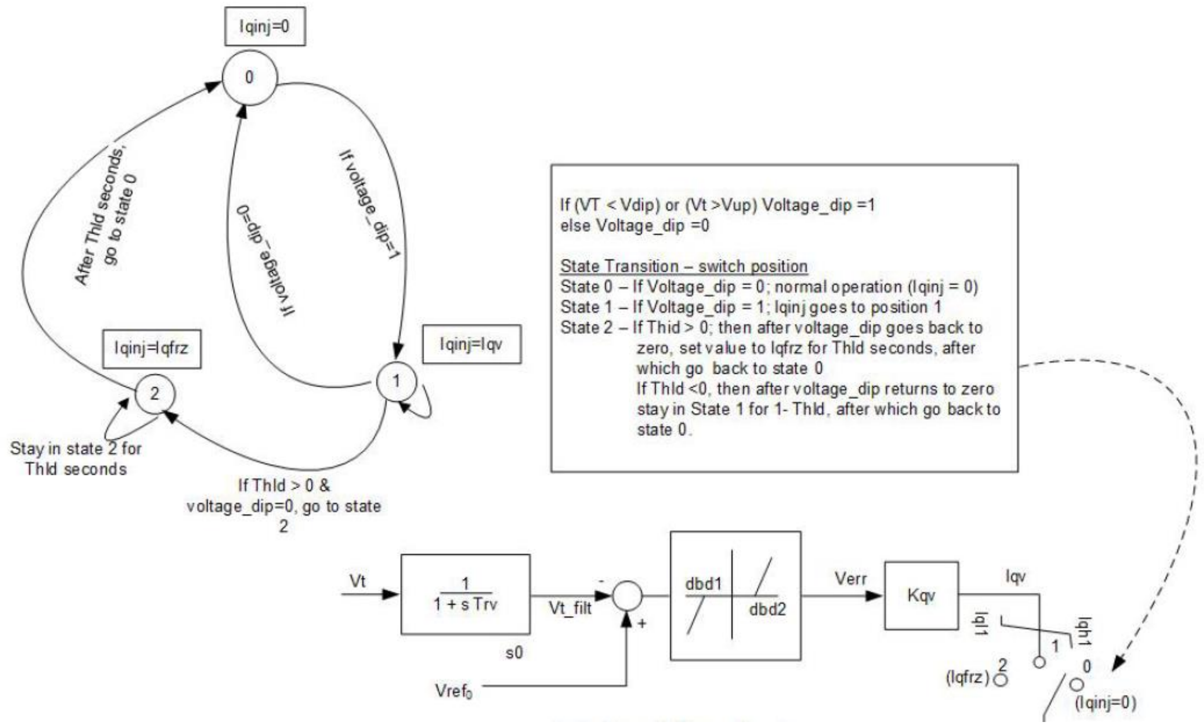


REEC_D Block Diagram [Source: PSS/E]

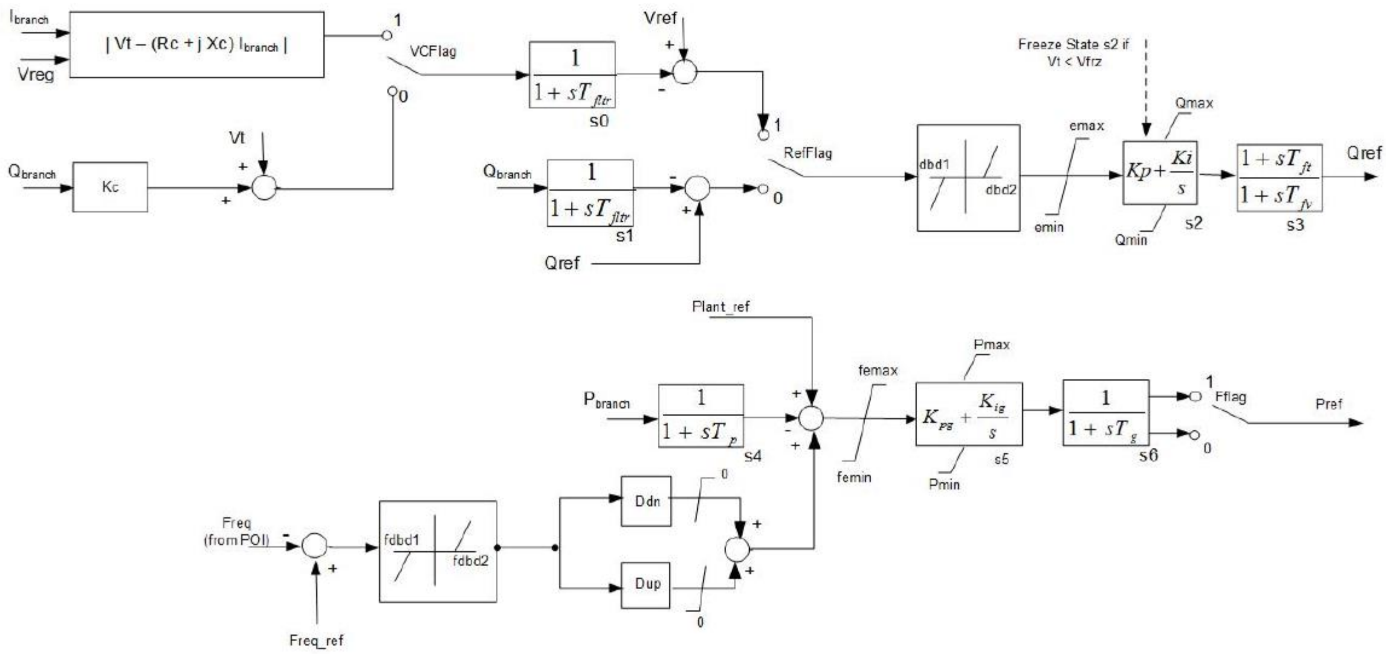


REEC_D Block Diagram – Continued:

REEC_D Block Diagram continued:
State Transition Diagram for dynamic voltage support during high or low voltage conditions



REPC_A Block Diagram [Source: PSS/E]



6.7 Stability Analysis Case Development

In order to investigate the impact of the proposed Group 3 DER on the New England transmission system, two base cases representing the 2026 summer peak load levels and two base cases representing the 2026 light load levels, were developed for this study.

Four base cases derived from the 2026 light load levels were also developed to determine if any existing substations, that are not part of the NPCC Bulk Power System (BPS) become part of the BPS as a result of the addition of Group 3 DER.

Year 2026 ISO-NE dynamics cases (PSS/E Rev 34), released in April 2021, were used for this transient stability assessment.

6.8 Stability Case Summaries

The following table summarizes the interface levels and generation dispatches for the stability base cases that includes Group 1,2 and 3 DER.

Table 26 - Stability Case Summaries for Design Contingency Testing

Interface Name	Interface Flows (MW)			
	Peak Load Case		Light Load Cases	
	23pk-ew	23pk-we	23ll-ew	23ll-we
NB-NE	808	1017	1013	1013
ORR_SOUTH	1375	1189	1326	1326
SURW_SOUTH	1359	1183	1611	1667
ME-NH	1996	1203	1978	2035
EAST-WEST	3104	-3072	3917	-2527
NE-NY	1290	-1467	1223	-1303
NNE-SCOB+394	3658	2961	3021	1697
NORTH-SOUTH	3724	2826	4060	1682
SEMA/RI – NE	2746	-2559	1121	-1255
HIGHGATE_IMP	224	224	224	224
SNDYPD_IMP	2000	2000	2000	0
CT IMPORT	3412	309	563	-144
Cross sound cable Export to NY	101	101	101	101
Bear Swamp	666	666	-666	0
Northfield	1180	1180	-1000	0
Altresco	197	197	197	197
Millennium	412	412	OOS	285

Table 27 - Stability Light Load Case Summaries for BPS Simulations

Interface Name	Interface Flows (MW)			
	WMAVT	BOS	ME_C	SEMA
NB-NE	1013	1013	1013	1013
SURW_SOUTH	1663	896	1252	897
ME-NH	1437	1255	1609	1256
EAST-WEST	-1578	3790	3867	4179
NE-NY	1054	1210	1279	1429
NNE-SCOB+394	3176	2678	3089	2447
NORTH-SOUTH	2980	2559	3237	2066
SEMA/RI - NE	-1816	2367	1743	3174
HIGHGATE_IMP	224	224	224	224
SNDYPD_IMP	0	2000	2000	2000
CT IMPORT	401	1100	1100	1148
Cross sound cable Export to NY	101	101	101	101
Bear Swamp	666	-666	-666	-666
Northfield	1180	-1100	-1100	-1100
Alresco	197	197	197	197
Millenium	412	0	0	0

6.9 Stability Study Matrix

To test the impact of the DER, Group 1,2 and 3 DER were added to each case, according to the following table, and dispatched against generation in Connecticut. Dispatching the DER against Connecticut will maintain the same East-West, and NY-NE transfer levels, compared to the pre-DER base cases.

Table 28 – Study Matrix for Stability Analysis

Load Level	Bias	Group 3 DER		Group 1 and 2 DER	Pre Group 1 and 2 DER	FERC BESS projects under Study	Comments
		BESS output	PV output	PV output	PV output		
Summer Peak load	E-W	100% Charging	26%	26%	only ≥5MW projects in WMA already modeled in the basecases were turned on	[redacted] (QP1031) and [redacted] (QP1112) were modeled in the study	All 1-5MW projects were modeled using DER_A model using parameters based on the latest guideline document from NERC. All ≥ 5 MW projects were modeled using standard renewable energy models parametrized by individual project developers
	W-E	100% discharging	100%	100%			
Light Load	E-W	100% charging	26%	26%			
	W-E	100% discharging	100%	100%			
BPS	WMAVT	100% discharging	100%	100%			
	BOS						
	ME-C						
	SEMA						

6.10 BPS Contingencies

The following simulations were conducted to determine if any existing substations become classified as Bulk Power System (BPS) substations as a result of the addition of Group 3 DER. Further, whether any of the new stations, required to accommodate the interconnection of the Group 3 DER, need to meet BPS design requirements.

Table 29 - Bulk Power System (BPS) Contingencies

Contingency Name	Type	kV	Location	Clearing Times (cycles)	Protection Groups	Light Load Results			
						BOS	ME_C	SEMA	WMAVT
BS-230-BPS	BPS	230	Bear Swamp	[redacted]					
BS-115-BPS	BPS	115	Bear Swamp						
PJ-115-BPS	BPS	115	Pratts Jct						

Contingency Name	Type	kV	Location	Clearing Times (cycles)	Protection Groups	Light Load Results			
						BOS	ME_C	SEMA	WMAVT
PJ-230-BPS	BPS	230	Pratts Jct	[redacted]					
Palmer-115-BPS	BPS	115	Palmer						
Carp-115-BPS	BPS	115	Carpenter Hill						
Flagg-115-BPS	BPS	115	Flagg Pd						
Stafford-115-BPS	BPS	115	Stafford St (new)						

6.11 N-1 Stability Contingencies

Several Breaker Failure (BF) contingencies were tested. These Breaker Failures were first tested with a 3-phase initiating fault, which is categorized as an Extreme Contingency. If this test failed the performance requirements outlined in ISO-NE PP-3, a corresponding design contingency is tested (Breaker failure with single line to ground imitating fault); otherwise, no corresponding design contingency is tested.

Table 30 - N-1 Breaker Failure Contingencies

Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)	Protection Groups	Light Load Results		Peak Load Results	
						EW	WE	EW	WE
BS-1205E-BF	EC	230	[redacted]						
BS-T97-BF	EC	115							

Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)	Protection Groups	Light Load Results		Peak Load Results	
						EW	WE	EW	WE
ML-0802-BF	EC	345	[redacted]						
WM-105-BF	EC	345	[redacted]						
SP-3521-BF	EC	345	[redacted]						
CH-321-BF	EC	345	[redacted]						
CH-174W-BF	EC	115	[redacted]						
CH-175-BF	EC	115	[redacted]						

Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)	Protection Groups	Light Load Results		Peak Load Results	
						EW	WE	EW	WE
PJ-69kV-TIE-BF	EC	69`	[redacted]						
NFLD-2T-BF	EC	345	[redacted]						
PALM-X176-BF	EC	115	[redacted]						
AD-3T5T-BF	EC	115	[redacted]						
STAFF-2728E-BF	EC	115	[redacted]						
STAFF-B128E-BF	EC	115	[redacted]						
STAFF-2728W-BF	EC	115	[redacted]						

Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)	Protection Groups	Light Load Results		Peak Load Results	
						EW	WE	EW	WE
			[redacted]						

Several design contingencies were tested on the transmission system facilities located along the Western and Central Massachusetts transmission corridor.

Table 31 - N-1 Stability Design Contingencies

Contingency Name	Type	kV	Location/ Description	Clearing times (cycles)	Protection Groups	Light Load Results		Peak Load Results	
						EW	WE	EW	WE
V174-CH	NC	115	[redacted]						
V174-ML	NC	115							
E205E-PJ	NC	230							
E205W-BS	NC	230							
354-NFld	NC	345							
354-Ludlow	NC	345							
S197-BS	NC	115							

Contingency Name	Type	kV	Location/ Description	Clearing times (cycles)	Protection Groups	Light Load Results		Peak Load Results	
						EW	WE	EW	WE
E131-BS	NC	115	[redacted]						
Z126-WEB	NC	115							
E5-WARE	NC	69							
E5-F6E-DCT-Millbury	NC	69							
A1S-B2S-DCT-Gardner	NC	69							
A1N-B2N-DCT-Royalston	NC	69							
D4-Vernon	NC	69							
J136N-BELFS	NC	115							

Contingency Name	Type	kV	Location/ Description	Clearing times (cycles)	Protection Groups	Light Load Results		Peak Load Results	
						EW	WE	EW	WE
O15N- PALM	NC	69	[redacted]						
A127-ERV	NC	115	[redacted]						
A127-ST	NC	115	[redacted]						
I135-FP	NC	115	[redacted]						
I135-CHINK	NC	115	[redacted]						
X176E-PALM	NC	115	[redacted]						
X176-LUD	NC	115	[redacted]						
W175W-PALM	NC	115	[redacted]						

Contingency Name	Type	kV	Location/ Description	Clearing times (cycles)	Protection Groups	Light Load Results		Peak Load Results	
						EW	WE	EW	WE
SP-HVDC Bipole	NC	450	[redacted]						
STAFF-2728E-BF-SLG	NC	115	[redacted]						
STAFF-B128E-BF-SLG	NC	115	[redacted]						
STAFF-2728W-BF-SLG	NC	115	[redacted]						
PJ-69kV-TIE-BF-SLG	NC	69`	[redacted]						
BS-1205E-BF-SLG	NC	230	[redacted]						
BS-1205W-BF-SLG	NC	230	[redacted]						

Contingency Name	Type	kV	Location/ Description	Clearing times (cycles)	Protection Groups	Light Load Results		Peak Load Results	
						EW	WE	EW	WE
BS-T97-BF-SLG	NC	115	[redacted]						
BS-T31-BF-SLG	NC	115							
AD-3T5T-BF-SLG	NC	115							

6.12 N-1-1 Stability Contingencies

Several design contingencies were tested with an initial element out of service as shown in the table below. Any generation backdown that is required between contingencies were found not to exceed existing limits.

Table 32 - N-1-1 Stability Design Contingencies

Initial N-1	Post N-1	N-1-1 Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)	Protection Groups	Light Load Results		Peak Load Results	
Line Out	System Adjustments							EW	WE	EW	WE
301/302 345 kV [Ludlow-Millbury]	None	E205E-PJ	NC	230	[redacted]						
		Z126-WEB	NC	115							
		S197-BS	NC	115							
		V174-ML	NC	115							
		NFLD-2T-BF-SLG	NC	345							

Initial N-1	Post N-1	N-1-1 Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)	Protection Groups	Light Load Results		Peak Load Results	
Line Out	System Adjustments							EW	WE	EW	WE
					[redacted]						
		NFLD-9T-BF-SLG	NC	345	[redacted]						
		Ludlow-5T-BF-SLG	NC	345	[redacted]						
		CH-174W-BF-SLG	NC	115	[redacted]						
		381-NFLD	NC	345	[redacted]						
		FITZ-3791-BF-SLG	NC	345	[redacted]						
		SP-HVDC Bipole	NC	450	[redacted]						

Initial N-1	Post N-1	N-1-1 Contingency Name	Type	kV	Location/ Description	Clearing Times (cycles)	Protection Groups	Light Load Results		Peak Load Results	
Line Out	System Adjustments							EW	WE	EW	WE
		BS-T97-BF-SLG	NC	115	[redacted]						
Northfield 345-115 kV auto	none	A127-ST	NC	115	[redacted]						
Fitzwilliam 345-115 kV auto	none	I135-FP	NC	115	[redacted]						
S-197 115 kV line [Bear Swamp-Deerfield]	None	B2S-PJ	NC	69	[redacted]						
A-1S from Pratts to Otter River	None	B2S-CL	NC	69	[redacted]						
E-5E from Millbury – Meadow St	None	O15N-Ware	NC	69	[redacted]						

7 SHORT CIRCUIT ANALYSIS

ASPEN Version 14 was used to conduct the short circuit simulations for this study.

7.1 Short Circuit Models

ISO-NE's N+5 (five year out) short circuit case, dated January 1^{st},2020 was used for this study. Group 1 and 2 DER were already included in this case. The Group 3 DER was modeled at each substation, in an aggregate fashion, with a single equivalent generator at the low side of each substation to which the DER will be connected. The MW size of the single equivalent generator, equaled the total amount of DER (greater than 1 MW) to be connected to that substation.

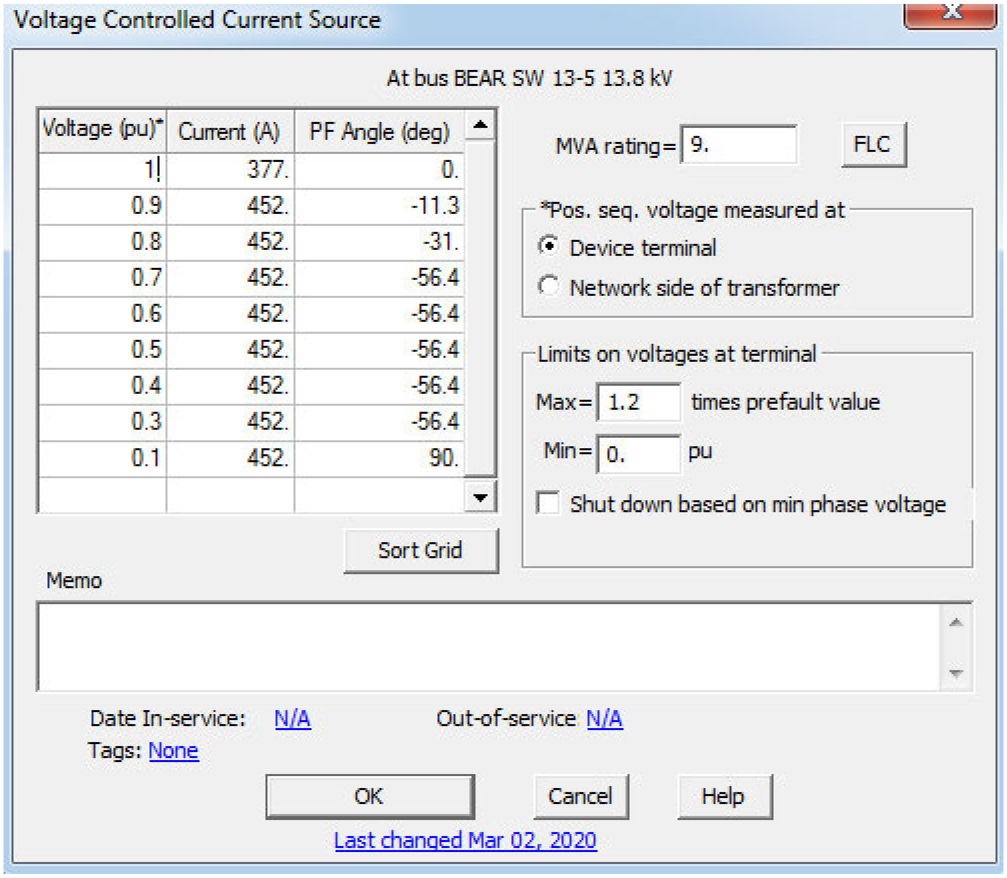
7.2 Methodology and Criteria

The modeling assumptions and short circuit performance criteria, including settings used in Aspen's breaker rating module, are per National Grid's TGP34 'Circuit Breaker Fault Current Assessment Guide' and its associated TGP34 Technical Guidelines.

The aggerate MWs for Group 3 DER was combined with the aggregate MWs for Group 1 and 2 DER, to come up with a single aggerate generator at each substation, as applicable.

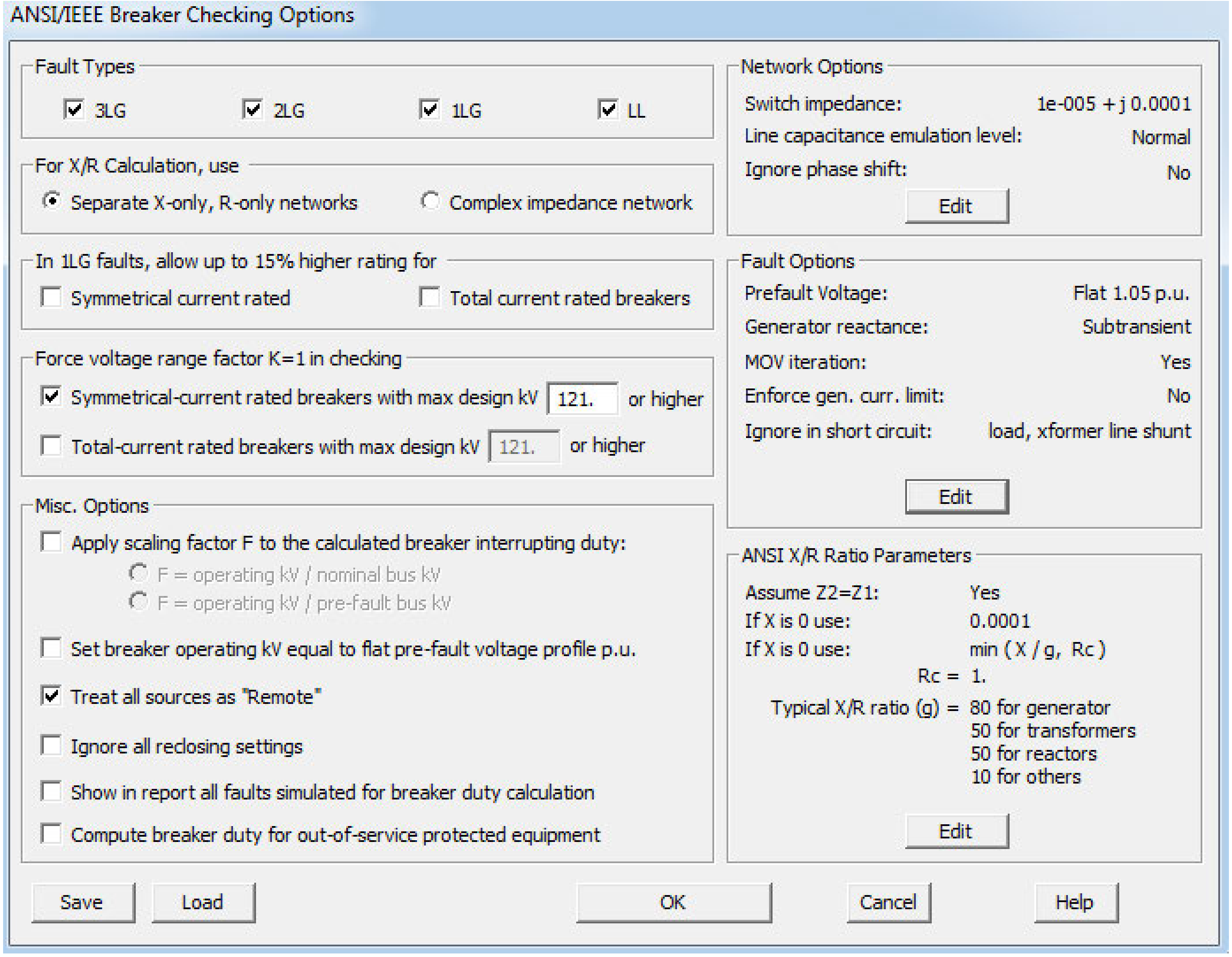
Voltage Controlled Current Source (VCCS) models were used for all PV inverters in Groups 3, as were for Groups 1 and 2. The VCCS models were assumed to deliver up to 1.2 p.u. of its nameplate current during fault conditions. Distinct Power Factor (PF) angles were modeled for several different voltage levels for each inverter. The PF Angle (degrees) for each DER terminal voltage was calculated based on recommendations provided in the ASPEN "Technical Bulletin on Modeling Type-4 Wind Plants and Solar Plants". The following figure is an example of an ASPEN model that was used for a 9 MW aggregate unit.

Figure 14 - Sample VCCS model



The figure below shows the ASPEN solution options assumed for the short circuit analysis. Note that current limits were not enforced for inverter-based generation modeled with current limited synchronous generators. This is a slightly conservative assumption, but not overly conservative since there is very little, if any inverter-based generators modeled with current limited synchronous generators in the study area.

Figure 15 - ASPEN Solution Options Assumed for short circuit analysis



7.3 Results

The following table shows the short circuit duty at each National Grid transmission substation (69 kV and above) in Western Massachusetts, following the additional of all 252 MW of DER associated with Group 3. The table includes the maximum short circuit current in Percentage (Duty_P) and Momentary Breaker Duty in Percentage (M_Duty_P) generated by the ASPEN breaker rating module for all 69 kV and above circuit breakers in Western Massachusetts.

The results show that the short circuit currents are less than 95% of the interrupting capability for all transmission breakers in the study area. Therefore, the PV inverters in Group 3 do not cause any breaker in the system to become overdutied.

Table 33 - ASPEN short circuit Results – Post Group 1 + 2 +3 DER

BUS	Breaker	DUTY A (Maximum short ckt Amps)	BKR_CAPA (Amps)	DUTY P (%)	M DUTY A (Amps)	M BKR CAPA (Amps)	M DUTY P (%)	3LG_AMPS	1LG_AMPS	2LG_AMPS	LL_AMPS
AYER 115kV	AYER 137	16030.5	40000	40.1	23886	64000	37.3	20311	15181.8	19305.5	17526.4
BEAR SWAMP 115.kV	BEAR SWP 131	24167.9	50000	48.3	36869.3	80000	46.1	23019.6	21923.4	22604.4	18959.1
BEAR SWAMP 115.kV	BEAR SWP 197	24167.9	50000	48.3	36869.3	80000	46.1	23019.6	21923.4	22604.4	18959.1
BEAR SWAMP 230.kV	BEARSW 1205E	14306.9	63000	22.7	20816.3	100800	20.7	14204.7	14236.7	14491.6	11345.2
BEAR SWAMP 230.kV	BEARSW 2205E	14306.9	63000	22.7	20816.3	100800	20.7	14204.7	14236.7	14491.6	11345.2
CARPENTER H 115.kV	CARP H 123	30258.9	40000	75.6	46624.1	64000	72.9	29258.4	25351.3	29080	25299.4
CARPENTER H 115.kV	CARP H 173	30258.9	63000	48	46624.1	100800	46.3	29258.4	25351.3	29080	25299.4
CARPENTER H 115.kV	CARP H 174	30258.9	63000	48	46624.1	100800	46.3	29258.4	25351.3	29080	25299.4
CARPENTER H 115.kV	CARP H 175	30258.9	63000	48	46624.1	100800	46.3	29258.4	25351.3	29080	25299.4
CARPENTER H 115.kV	CARP H 1T	30258.9	40000	75.6	46624.1	64000	72.9	29258.4	25351.3	29080	25299.4
CARPENTER H 115.kV	CARP H 2175	30258.9	63000	48	46624.1	100800	46.3	29258.4	25351.3	29080	25299.4
CARPENTER H 115.kV	CARP H 23-1T	24598.7	63000	39	37902.6	100800	37.6	29258.4	25351.3	29080	25299.4
CARPENTER H 115.kV	CARP H 73-74	25884.3	63000	41.1	39625.8	100800	39.3	29258.4	25351.3	29080	25299.4
CHESTNUT HIL 69.kV	Proxy - 69kv	2823.6	40000	7.1	2954.2	64000	4.6	2823.6	1680.5	2617.2	2474.3
Crystal Lake 69.kV	Proxy - 69kv	4104.1	31500	13	4509	50400	8.9	4104.1	2437.6	3802.6	3571.2
DEERFIELD 4 69.kV	Proxy - 69kv	10090.3	40000	25.2	13825.8	64000	21.6	10090.3	8435.9	9693.4	8466.7
E LONGMDW 14 69.kV	Proxy - 69kv	3229.6	40000	8.1	3868.5	64000	6	3229.6	1590.7	2922.4	2821
E LONGMDW 15 69.kV	Proxy - 69kv	4170.9	40000	10.4	6073.4	64000	9.5	4170.9	3698.4	4046.1	3592.7
FLAGG POND 115.kV	1135	17165.8	20000	85.8	23407.7	32000	73.1	17165.8	12456	15487	14501.6
FLAGG POND 115.kV	1136	17165.8	20000	85.8	23407.7	32000	73.1	17165.8	12456	15487	14501.6
FLAGG POND 115.kV	1235	12722.7	20924.4	60.8	17137.7	33479.1	51.2	17165.8	12456	15487	14501.6
FLAGG POND 115.kV	1236	12722.7	36444.4	34.9	17137.7	58311.1	29.4	17165.8	12456	15487	14501.6
FLAGG POND 115.kV	2135	12722.7	18884.4	67.4	17137.7	30215.1	56.7	17165.8	12456	15487	14501.6
FLAGG POND 115.kV	2136	17165.8	20000	85.8	23407.7	32000	73.1	17165.8	12456	15487	14501.6

BUS	Breaker	DUTY A (Maximum short ckt Amps)	BKR_CAPA (Amps)	DUTY P (%)	M DUTY A (Amps)	M BKR CAPA (Amps)	M DUTY P (%)	3LG_AMPS	1LG_AMPS	2LG_AMPS	LL_AMPS
HARRIMAN 69.kV	Proxy - 69kv	7396.6	40000	18.5	11298	64000	17.7	7278.6	7354.7	7396.6	6184.9
HARRIMAN 115.kV	115BT	15632.9	40000	39.1	22648.3	64000	35.4	15632.9	11759.7	14439.4	13195.1
HARRIMAN 115.kV	HARRIM 3810	14752.8	40000	36.9	21206.6	64000	33.1	15632.9	11759.7	14439.4	13195.1
HARRIMAN 115.kV	HARRIM A127	13721.1	40000	34.3	20070.4	64000	31.4	15632.9	11759.7	14439.4	13195.1
HARRIMAN 115.kV	HARRIM B128	14514.7	40000	36.3	21166.7	64000	33.1	15632.9	11759.7	14439.4	13195.1
HARRIMAN 115.kV	HARRIM Y177	13919.7	40000	34.8	20216.5	64000	31.6	15632.9	11759.7	14439.4	13195.1
Harrington 69.kV	Proxy - 69kv	9010.6	40000	22.5	11228.6	64000	17.5	9010.6	5774.6	8186	7596.7
MEADOW ST 69.kV	Proxy - 69kv	10415.2	31500	33.1	13036.9	50400	25.9	10415.2	5931.4	9178.1	8711.6
[redacted]		38768.8	50000	77.5	54798.2	80000	68.5	38779.9	27832.3	35616.1	32887.2
[redacted]		38526.2	50000	77.1	54499.3	80000	68.1	38779.9	27832.3	35616.1	32887.2
[redacted]		38537.9	63000	61.2	54507.8	100800	54.1	38779.9	27832.3	35616.1	32887.2
[redacted]		38779.9	63000	61.6	54817.9	100800	54.4	38779.9	27832.3	35616.1	32887.2
[redacted]		38263.7	50000	76.5	53470.3	80000	66.8	38779.9	27832.3	35616.1	32887.2
[redacted]		38779.9	63000	61.6	54817.9	100800	54.4	38779.9	27832.3	35616.1	32887.2
[redacted]		38779.9	50000	77.6	54817.9	80000	68.5	38779.9	27832.3	35616.1	32887.2
[redacted]		34391.1	50000	68.8	48094.8	80000	60.1	38779.9	27832.3	35616.1	32887.2
[redacted]		38779.9	50000	77.6	54817.9	80000	68.5	38779.9	27832.3	35616.1	32887.2
[redacted]		38779.9	50000	77.6	54817.9	80000	68.5	38779.9	27832.3	35616.1	32887.2
[redacted]		38779.9	50000	77.6	54817.9	80000	68.5	38779.9	27832.3	35616.1	32887.2
[redacted]		35917.3	50000	71.8	50805.7	80000	63.5	38779.9	27832.3	35616.1	32887.2
[redacted]		36382.6	50000	72.8	51475.5	80000	64.3	38779.9	27832.3	35616.1	32887.2
[redacted]		36886.3	50000	73.8	51661.3	80000	64.6	38779.9	27832.3	35616.1	32887.2
[redacted]		38779.9	50000	77.6	54817.9	80000	68.5	38779.9	27832.3	35616.1	32887.2
[redacted]		38503.8	50000	77	54459.7	80000	68.1	38779.9	27832.3	35616.1	32887.2
[redacted]		38779.9	50000	77.6	54817.9	80000	68.5	38779.9	27832.3	35616.1	32887.2
[redacted]		38779.9	50000	77.6	54817.9	80000	68.5	38779.9	27832.3	35616.1	32887.2

BUS	Breaker	DUTY A (Maximum short ckt Amps)	BKR_CAPA (Amps)	DUTY P (%)	M DUTY A (Amps)	M BKR CAPA (Amps)	M DUTY P (%)	3LG_AMPS	1LG_AMPS	2LG_AMPS	LL_AMPS
[redacted]	[redacted]	38779.9	50000	77.6	54817.9	80000	68.5	38779.9	27832.3	35616.1	32887.2
[redacted]	[redacted]	38779.9	50000	77.6	54817.9	80000	68.5	38779.9	27832.3	35616.1	32887.2
[redacted]	[redacted]	38779.9	40000	96.9	54817.9	64000	85.7	38779.9	27832.3	35616.1	32887.2
[redacted]	[redacted]	38779.9	50000	77.6	54817.9	80000	68.5	38779.9	27832.3	35616.1	32887.2
[redacted]	[redacted]	38779.9	50000	77.6	54817.9	80000	68.5	38779.9	27832.3	35616.1	32887.2
[redacted]	[redacted]	38779.9	50000	77.6	54817.9	80000	68.5	38779.9	27832.3	35616.1	32887.2
[redacted]	[redacted]	38779.9	50000	77.6	54817.9	80000	68.5	38779.9	27832.3	35616.1	32887.2
[redacted]	[redacted]	38779.9	50000	77.6	54817.9	80000	68.5	38779.9	27832.3	35616.1	32887.2
[redacted]	[redacted]	38779.9	50000	77.6	54817.9	80000	68.5	38779.9	27832.3	35616.1	32887.2
[redacted]	[redacted]	38779.9	50000	77.6	54817.9	80000	68.5	38779.9	27832.3	35616.1	32887.2
MILLBURY5 B1 69.kV	Proxy - 69kv	20323	31500	64.5	30826.8	50400	61.2	20323	19321.5	19873.1	17228.9
[redacted]	[redacted]	20541.2	40000	51.4	32089.3	64000	50.1	24271.9	22614.5	24015.6	20918.7
OTTER RIV 1 69.kV	Proxy - 69kv	3143.9	22000	14.3	3275.3	35200	9.3	3143.9	2051.3	2886	2759.1
PALMER 69.kV	Proxy - 69kv	14900.8	31500	47.3	22943	50400	45.5	14900.8	13192.6	14155.5	12659.6
PALMER 115 115.kV	PALMER 176T	15499.7	40000	38.7	22992.3	64000	35.9	15499.7	11411.5	14107	13187.4
PALMER 115 115.kV	PALMER 7075	12114.1	40000	30.3	18031.3	64000	28.2	15499.7	11411.5	14107	13187.4
PALMER 115 115.kV	PALMER R170	15499.7	40000	38.7	22992.3	64000	35.9	15499.7	11411.5	14107	13187.4
PALMER 115 115.kV	PALMER W175	15499.7	40000	38.7	22992.3	64000	35.9	15499.7	11411.5	14107	13187.4
PALMER 115 115.kV	PALMER X176	15337.5	40000	38.3	22778	64000	35.6	15499.7	11411.5	14107	13187.4
PRATTS 115 115 kV	PRATTSJ 1110	31827.2	40000	79.6	45641.3	64000	71.3	31827.2	24873.2	29884.6	27369.1
PRATTS 115 115 kV	PRATTSJ 2110	31827.2	40000	79.6	45641.3	64000	71.3	31827.2	24873.2	29884.6	27369.1
PRATTS 115 115 kV	PRATTSJ 3741	29129.3	40000	72.8	41420.6	64000	64.7	31827.2	24873.2	29884.6	27369.1
PRATTS 115 115 kV	PRATTSJ 3842	28691.1	40000	71.7	40622	64000	63.5	31827.2	24873.2	29884.6	27369.1
PRATTS 115 115 kV	PRATTSJ 4A	31827.2	40000	79.6	45641.3	64000	71.3	31827.2	24873.2	29884.6	27369.1
PRATTS 115 115 kV	PRATTSJ 801	31827.2	40000	79.6	45641.3	64000	71.3	31827.2	24873.2	29884.6	27369.1

BUS	Breaker	DUTY A (Maximum short ckt Amps)	BKR_CAPA (Amps)	DUTY P (%)	M DUTY A (Amps)	M BKR CAPA (Amps)	M DUTY P (%)	3LG_AMPS	1LG_AMPS	2LG_AMPS	LL_AMPS
PRATTS 115 115 kV	PRATTSJ 802	31827.2	40000	79.6	45641.3	64000	71.3	31827.2	24873.2	29884.6	27369.1
PRATTS 115 115 kV	PRATTSJ I135	31300.6	40000	78.3	44923.4	64000	70.2	31827.2	24873.2	29884.6	27369.1
PRATTS 115 115 kV	PRATTSJ J136	31317	40000	78.3	44947	64000	70.2	31827.2	24873.2	29884.6	27369.1
PRATTS 115 115 kV	PRATTSJ K137	31827.2	40000	79.6	45641.3	64000	71.3	31827.2	24873.2	29884.6	27369.1
PRATTS 115 115 kV	PRATTSJ L138	31827.2	40000	79.6	45641.3	64000	71.3	31827.2	24873.2	29884.6	27369.1
PRATTS 115 115 kV	PRATTSJ O141	31827.2	40000	79.6	45641.3	64000	71.3	31827.2	24873.2	29884.6	27369.1
PRATTS 115 115 kV	PRATTSJ P142	31827.2	40000	79.6	45641.3	64000	71.3	31827.2	24873.2	29884.6	27369.1
PRATTS 230 230 kV	Pratts E205E	7383.7	50000	14.8	11329.1	80000	14.2	9289.3	8252.5	8974	7953.1
PRATTS JCT 1 69.kV	Proxy - 69kv	26782.7	31500	85	39834.9	50400	79	26782.7	25112.5	26254.5	22989.3
SEARSBURG 69.kV	Proxy - 69kv	5746.1	40000	14.4	8268.6	64000	12.9	5746.1	4584.6	5382.2	4928.6
SHUTESBRY E5 69.kV	Proxy - 69kv	4237.8	31500	13.5	5114.8	50400	10.1	4237.8	2281.2	3687.6	3548.6
Stafford st 115.kV	Proxy	18799.6	40000	47	25829.4	64000	40.4	18799.6	11232.1	17131.6	16204.3
VERNON 115.kV	K186	26529.4	40000	66.3	41305.5	64000	64.5	25824.7	25137.7	25990.5	21146.5
VERNON 115.kV	K40	26529.4	40000	66.3	41305.5	64000	64.5	25824.7	25137.7	25990.5	21146.5
VERNON 115.kV	KT1	26529.4	40000	66.3	41305.5	64000	64.5	25824.7	25137.7	25990.5	21146.5
VERNON 115.kV	KTB1-B1	23286.6	40000	58.2	35581.9	64000	55.6	25824.7	25137.7	25990.5	21146.5
VERNON 115.kV	KTB2-B1	26529.4	40000	66.3	41305.5	64000	64.5	25824.7	25137.7	25990.5	21146.5
VERNON 1 69.kV	Proxy - 69kv	5764.3	40000	14.4	7680	64000	12	5233.2	5535.9	5764.3	4425.4
WARE 69.kV	Proxy - 69kv	10293	31500	32.7	13232.8	50400	26.3	10293	5170	8897.3	8638.9
West Hampden 115.kV	1205	14358.4	40000	35.9	21013.7	64000	32.8	14358.4	10683.9	13280.9	12185.6
West Hampden 115.kV	1976	14358.4	40000	35.9	21013.7	64000	32.8	14358.4	10683.9	13280.9	12185.6
West Hampden 115.kV	3T-05	14331.8	40000	35.8	20974.8	64000	32.8	14358.4	10683.9	13280.9	12185.6
West Hampden 115.kV	70-76	11870.2	40000	29.7	17336.8	64000	27.1	14358.4	10683.9	13280.9	12185.6
West Hampden 115.kV	Proxy 1	14358.4	40000	35.9	21013.7	64000	32.8	14358.4	10683.9	13280.9	12185.6
West Hampden 115.kV	R170	14358.4	40000	35.9	21013.7	64000	32.8	14358.4	10683.9	13280.9	12185.6

BUS	Breaker bus name and nominal kV
BREAKERS	Breaker name
RATINGTYPE	Breaker rating type: S for symmetrical current rated; T for total current rated
DUTY_P	Interrupting duty in percent
DUTY_A	Interrupting current in amps
BKR_CAPA	Calculated interrupting capacity in amps
M_DUTY_P	Momentary duty for total-current rated breakers and close-and-latch duty for symmetrical-current rated breakers in percent
M_DUTY_A	Momentary duty for total-current rated breakers and close-and-latch duty for symmetrical-current rated breakers in amps
M_BKR_CAPA	Calculated momentary capacity of total current rated breakers and close-and-latch capacity for symmetrical current rated breakers in amps
MAX_SC_CASE	Fault with maximum short circuit interrupting current
ISC	Breaker short circuit current in amps
ANSI_X/R	ANSI X/R ratio
FLAG	Rating flag, interrupting duty
FLAG_M	Rating flag, momentary (close-and-latch) duty
3LG_AMPS	Maximum 3LG fault current at breaker bus
3LG_X/R	ANSI X/R ratio in 3LG fault at breaker bus
2LG_AMPS	Maximum 2LG fault current at breaker bus
2LG_X/R	ANSI X/R ratio in 2LG fault at breaker bus
1LG_AMPS	Maximum 1LG fault current at breaker bus
1LG_X/R	ANSI X/R ratio in 1LG fault at breaker bus
LL_AMPS	Maximum LL fault current at breaker bus
LL_X/R	ANSI X/R ratio in LL fault at breaker bus

This appendix has been redacted for Critical Energy/Electric Infrastructure Information (CEII).

Appendix A - Steady State Base Case Summaries

Note:
Base Case Summaries in Appendix A are for the transmission system prior to the dispatch of Group 1,2 and 3 DER

This appendix has been redacted for Critical Energy/Electric Infrastructure Information (CEII).

Appendix B – Stability Case Summaries

Appendix C - Stability Models (IDEV + DYR files) for Group 3 DER Greater Than or Equal To 5MW

IDV File – 100% PV + BESS Discharging

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//NEP-22-G03-034:
BAT_SPLT,113082,930822,'BARRE-GSU', 13.8
BAT_BRANCH_CHNG,113082,930822,'1',,,,,,0.030789,0.024765,,,,,,,,,,,,,;
BAT_SPLT,930822,930821,'BARRE-INV', 0.6
BAT_BUS_CHNG_3,930821,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,930822,930821,'2',1,930822,600,0,0,0,33,0,930822,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0,
1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,930821,930822,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 8.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,930821,930822,'1'
BAT_MBIDBRN,930821,930822,'2','1'
BAT_PLANT_DATA,930821,0, 1.0, 100.0
BAT_MACHINE_DATA_2,930821,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,930821,'D3',,,,,1, 8.0,,0.0,0.0, 8.0,-8.0, 8.0,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-036:
BAT_SPLT,113396,933962,'Cryst-GSU', 13.8
BAT_BRANCH_CHNG,113396,933962,'1',,,,,,0.011195,0.006297,,,,,,,,,,,,,;
BAT_SPLT,933962,933961,'Cryst-INV', 0.6
BAT_BUS_CHNG_3,933961,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933962,933961,'2',1,933962,600,0,0,0,33,0,933962,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0,
1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933961,933962,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 8.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933961,933962,'1'
BAT_MBIDBRN,933961,933962,'2','1'
BAT_PLANT_DATA,933961,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933961,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933961,'D3',,,,,1, 8.0,,0.0,0.0, 8.0,-5.2, 8.0,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-038:
BAT_SPLT,113395,933952,'EWINC-GSU', 13.8
BAT_BRANCH_CHNG,113395,933952,'1',,,,,,0.002457,0.001382,,,,,,,,,,,,,;
BAT_SPLT,933952,933951,'EWINC-INV', 0.6
BAT_BUS_CHNG_3,933951,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933952,933951,'2',1,933952,600,0,0,0,33,0,933952,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0,
1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933951,933952,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 9.4,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933951,933952,'1'
BAT_MBIDBRN,933951,933952,'2','1'
BAT_PLANT_DATA,933951,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933951,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933951,'D3',,,,,1, 9.4,,0.0,0.0, 9.4,-4.6, 9.4,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-039:
BAT_SPLT,113395,993952,'EWINC2-GSU', 13.8
BAT_BRANCH_CHNG,113395,993952,'1',,,,,,0.001785,0.001004,,,,,,,,,,,,,;
BAT_SPLT,993952,993951,'EWINC2-INV', 0.6
BAT_BUS_CHNG_3,993951,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,993952,993951,'2',1,993952,600,0,0,0,33,0,993952,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0,
1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,993951,993952,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 5.5,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,993951,993952,'1'
BAT_MBIDBRN,993951,993952,'2','1'
BAT_PLANT_DATA,993951,0, 1.0, 100.0
BAT_MACHINE_DATA_2,993951,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,993951,'D3',,,,,1, 5.5,,0.0,0.0, 5.5,-4.2, 5.5,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-029:
BAT_SPLT,113070,930702,'LASHA-GSU', 13.2
BAT_BRANCH_CHNG,113070,930702,'1',,,,,,0.005257,0.002957,,,,,,,,,,,,,;
BAT_SPLT,930702,930701,'LASHA-INV', 0.6
BAT_BUS_CHNG_3,930701,2,,,,,,,,,,,;
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BAT_TWO_WINDING_DATA_4,930702,930701,'2',1,930702,600,0,0,0,33,0,930702,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,930701,930702,'2',,,,,,,,,,,,,,2,, 0.009450, 0.056720, 10.0,,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,930701,930702,'1'
BAT_MBIDBRN,930701,930702,'2','1'
BAT_PLANT_DATA,930701,0, 1.0, 100.0
BAT_MACHINE_DATA_2,930701,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,930701,'D3',,,,,,1, 10.0,,0.0,0.0, 10.0,-7.0, 10.0,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-008:
BAT_SPLT,113377,933772,'LAURL-GSU', 13.8
BAT_BRANCH_CHNG,113377,933772,'1',,,,,,,0.010658,0.008573,,,,,,,,,,,,,,;
BAT_SPLT,933772,933771,'LAURL-INV', 0.6
BAT_BUS_CHNG_3,933771,2,,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933772,933771,'2',1,933772,600,0,0,0,33,0,933772,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933771,933772,'2',,,,,,,,,,,,,,2,, 0.009450, 0.056720, 8.0,,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933771,933772,'1'
BAT_MBIDBRN,933771,933772,'2','1'
BAT_PLANT_DATA,933771,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933771,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933771,'D3',,,,,,1, 8.0,,0.0,0.0, 8.0,-4.4, 8.0,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-009:
BAT_SPLT,113392,933922,'MILLB-GSU', 13.8
BAT_BRANCH_CHNG,113392,933922,'1',,,,,,,0.004054,0.00228,,,,,,,,,,,,,,;
BAT_SPLT,933922,933921,'MILLB-INV', 0.6
BAT_BUS_CHNG_3,933921,2,,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933922,933921,'2',1,933922,600,0,0,0,33,0,933922,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933921,933922,'2',,,,,,,,,,,,,,2,, 0.009450, 0.056720, 10.0,,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933921,933922,'1'
BAT_MBIDBRN,933921,933922,'2','1'
BAT_PLANT_DATA,933921,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933921,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933921,'D3',,,,,,1, 10.0,,0.0,0.0, 10.0,-3.5, 10.0,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-011:
BAT_SPLT,113388,933882,'NOXFO1-GSU', 13.2
BAT_BRANCH_CHNG,113388,933882,'1',,,,,,,0.003861,0.003106,,,,,,,,,,,,,,;
BAT_SPLT,933882,933881,'NOXFO1-INV', 0.6
BAT_BUS_CHNG_3,933881,2,,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933882,933881,'2',1,933882,600,0,0,0,33,0,933882,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933881,933882,'2',,,,,,,,,,,,,,2,, 0.009450, 0.056720, 8.0,,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933881,933882,'1'
BAT_MBIDBRN,933881,933882,'2','1'
BAT_PLANT_DATA,933881,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933881,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933881,'D3',,,,,,1, 8.0,,0.0,0.0, 8.0,-6.4, 8.0,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-013:
BAT_SPLT,113388,993882,'NOXFO2-GSU', 13.2
BAT_BRANCH_CHNG,113388,993882,'1',,,,,,,0.008745,0.007034,,,,,,,,,,,,,,;
BAT_SPLT,993882,993881,'NOXFO2-INV', 0.6
BAT_BUS_CHNG_3,993881,2,,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,993882,993881,'2',1,993882,600,0,0,0,33,0,993882,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,993881,993882,'2',,,,,,,,,,,,,,2,, 0.009450, 0.056720, 5.6,,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,993881,993882,'1'
BAT_MBIDBRN,993881,993882,'2','1'
BAT_PLANT_DATA,993881,0, 1.0, 100.0
BAT_MACHINE_DATA_2,993881,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,993881,'D3',,,,,,1, 5.6,,0.0,0.0, 5.6,-4.8, 5.6,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-006:
BAT_SPLT,113383,933832,'PRATT-GSU', 13.8
BAT_BRANCH_CHNG,113383,933832,'1',,,,,,,0.020017,0.011259,,,,,,,,,,,,,,;
```

BAT_SPLT,933832,933831,'PRATT-INV', 0.6
BAT_BUS_CHNG_3,933831,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933832,933831,'2',1,933832,600,0,0,0,33,0,933832,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933831,933832,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 6.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933831,933832,'1'
BAT_MBIDBRN,933831,933832,'2','1'
BAT_PLANT_DATA,933831,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933831,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933831,'D3',,,,,,1, 6.0,,0.0,0.0, 6.0,-4.5, 6.0,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-041:
BAT_SPLT,113084,930842,'ROYAL-GSU', 13.8
BAT_BRANCH_CHNG,113084,930842,'1',,,,,,,0.00271,0.00152,,,,,,,,,,,,,;
BAT_SPLT,930842,930841,'ROYAL-INV', 0.6
BAT_BUS_CHNG_3,930841,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,930842,930841,'2',1,930842,600,0,0,0,33,0,930842,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,930841,930842,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 5.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,930841,930842,'1'
BAT_MBIDBRN,930841,930842,'2','1'
BAT_PLANT_DATA,930841,0, 1.0, 100.0
BAT_MACHINE_DATA_2,930841,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,930841,'D3',,,,,,1, 5.0,,0.0,0.0, 5.0,0.0, 5.0,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-015:
BAT_SPLT,113389,933892,'SNOW1-GSU', 13.2
BAT_BRANCH_CHNG,113389,933892,'1',,,,,,,0.0119375,0.003094,,,,,,,,,,,,,;
BAT_SPLT,933892,933891,'SNOW1-INV', 0.6
BAT_BUS_CHNG_3,933891,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933892,933891,'2',1,933892,600,0,0,0,33,0,933892,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933891,933892,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 5.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933891,933892,'1'
BAT_MBIDBRN,933891,933892,'2','1'
BAT_PLANT_DATA,933891,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933891,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933891,'D3',,,,,,1, 5.0,,0.0,0.0, 5.0,-2.5, 5.0,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-016:
BAT_SPLT,113389,993892,'SNOW2-GSU', 13.2
BAT_BRANCH_CHNG,113389,993892,'1',,,,,,,0.01416,0.00797,,,,,,,,,,,,,;
BAT_SPLT,993892,993891,'SNOW2-INV', 0.6
BAT_BUS_CHNG_3,993891,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,993892,993891,'2',1,993892,600,0,0,0,33,0,993892,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,993891,993892,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 5.5,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,993891,993892,'1'
BAT_MBIDBRN,993891,993892,'2','1'
BAT_PLANT_DATA,993891,0, 1.0, 100.0
BAT_MACHINE_DATA_2,993891,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,993891,'D3',,,,,,1, 5.5,,0.0,0.0, 5.5,-6.5, 5.5,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-017:
BAT_SPLT,113389,983892,'SNOW3-GSU', 13.2
BAT_BRANCH_CHNG,113389,983892,'1',,,,,,,0.0119375,0.003094,,,,,,,,,,,,,;
BAT_SPLT,983892,983891,'SNOW3-INV', 0.6
BAT_BUS_CHNG_3,983891,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,983892,983891,'2',1,983892,600,0,0,0,33,0,983892,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,983891,983892,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 5.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,983891,983892,'1'
BAT_MBIDBRN,983891,983892,'2','1'
BAT_PLANT_DATA,983891,0, 1.0, 100.0
BAT_MACHINE_DATA_2,983891,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,983891,'D3',,,,,,1, 5.0,,0.0,0.0, 5.0,-2.5, 5.0,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-001:

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BAT_SPLT,113363,933632,'STAFF-GSU', 13.8
BAT_BRANCH_CHNG,113363,933632,'1',,,,,,0.00301169,0.00893508,,,,,,,,,,,,,;
BAT_SPLT,933632,933631,'STAFF-INV', 0.6
BAT_BUS_CHNG_3,933631,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933632,933631,'2',1,933632,600,0,0,0,33,0,933632,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0,
1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933631,933632,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 5.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933631,933632,'1'
BAT_MBIDBRN,933631,933632,'2','1'
BAT_PLANT_DATA,933631,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933631,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933631,'D3',,,,,1, 5.0,,0.0,0.0, 5.0,-5.0, 5.0,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-033:
BAT_SPLT,113368,933682,'TREAS-GSU', 13.8
BAT_BRANCH_CHNG,113368,933682,'1',,,,,,0.002457,0.001382,,,,,,,,,,,,,;
BAT_SPLT,933682,933681,'TREAS-INV', 0.6
BAT_BUS_CHNG_3,933681,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933682,933681,'2',1,933682,600,0,0,0,33,0,933682,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0,
1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933681,933682,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 10.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933681,933682,'1'
BAT_MBIDBRN,933681,933682,'2','1'
BAT_PLANT_DATA,933681,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933681,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933681,'D3',,,,,1, 10.0,,0.0,0.0, 10.0,-5.0, 10.0,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-020:
BAT_SPLT,113390,933902,'WCHAR-GSU', 13.2
BAT_BRANCH_CHNG,113390,933902,'1',,,,,,0.005624,0.003164,,,,,,,,,,,,,;
BAT_SPLT,933902,933901,'WCHAR-INV', 0.6
BAT_BUS_CHNG_3,933901,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933902,933901,'2',1,933902,600,0,0,0,33,0,933902,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0,
1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933901,933902,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 5.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933901,933902,'1'
BAT_MBIDBRN,933901,933902,'2','1'
BAT_PLANT_DATA,933901,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933901,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933901,'D3',,,,,1, 5.0,,0.0,0.0, 5.0,-4.5, 5.0,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-021:
BAT_SPLT,113390,993902,'WCHAR2-GSU', 13.2
BAT_BRANCH_CHNG,113390,993902,'1',,,,,,0.00691,0.003887,,,,,,,,,,,,,;
BAT_SPLT,993902,993901,'WCHAR2-INV', 0.6
BAT_BUS_CHNG_3,993901,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,993902,993901,'2',1,993902,600,0,0,0,33,0,993902,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0,
1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,993901,993902,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 10.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,993901,993902,'1'
BAT_MBIDBRN,993901,993902,'2','1'
BAT_PLANT_DATA,993901,0, 1.0, 100.0
BAT_MACHINE_DATA_2,993901,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,993901,'D3',,,,,1, 10.0,,0.0,0.0, 10.0,-4.0, 10.0,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-044:
BAT_SPLT,113085,930852,'WENDE1-GSU', 13.8
BAT_BRANCH_CHNG,113085,930852,'1',,,,,,0.002625,0.001477,,,,,,,,,,,,,;
BAT_SPLT,930852,930851,'WENDE1-INV', 0.6
BAT_BUS_CHNG_3,930851,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,930852,930851,'2',1,930852,600,0,0,0,33,0,930852,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0,
1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,930851,930852,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 8.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,930851,930852,'1'
BAT_MBIDBRN,930851,930852,'2','1'
BAT_PLANT_DATA,930851,0, 1.0, 100.0
BAT_MACHINE_DATA_2,930851,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,930851,'D3',,,,,1, 8.0,,0.0,0.0, 8.0,-7.2, 8.0,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0
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//NEP-22-G03-043:
BAT_SPLT,113085,990852,'WENDE2-GSU', 13.8
BAT_BRANCH_CHNG,113085,990852,'1',,,,,,,0.00271,0.001524,,,,,,,,,,,,,,;
BAT_SPLT,990852,990851,'WENDE2-INV', 0.6
BAT_BUS_CHNG_3,990851,2,,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,990852,990851,'2',1,990852,600,0,0,0,33,0,990852,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0,
1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,990851,990852,'2',,,,,,,,,,,,,,2,, 0.009450, 0.056720, 10.0,,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,990851,990852,'1'
BAT_MBIDBRN,990851,990852,'2','1'
BAT_PLANT_DATA,990851,0, 1.0, 100.0
BAT_MACHINE_DATA_2,990851,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,990851,'D3',,,,,,1, 10.0,,0.0,0.0, 10.0,-8.0, 10.0,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0
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IDV File – 26% PV + BESS Charging

//NEP-22-G03-034:
BAT_SPLT,113082,930822,'BARRE-GSU', 13.8
BAT_BRANCH_CHNG,113082,930822,'1',,,,,,0.030789,0.024765,,,,,,,,,,,,,;
BAT_SPLT,930822,930821,'BARRE-INV', 0.6
BAT_BUS_CHNG_3,930821,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,930822,930821,'2',1,930822,600,0,0,0,33,0,930822,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,930821,930822,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 8.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,930821,930822,'1'
BAT_MBIDBRN,930821,930822,'2','1'
BAT_PLANT_DATA,930821,0, 1.0, 100.0
BAT_MACHINE_DATA_2,930821,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,930821,'D3',,,,,1, -8.0,,0.0,0.0, 8.0,-8.0, 8.0,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-036:
BAT_SPLT,113396,933962,'Cryst-GSU', 13.8
BAT_BRANCH_CHNG,113396,933962,'1',,,,,,0.011195,0.006297,,,,,,,,,,,,,;
BAT_SPLT,933962,933961,'Cryst-INV', 0.6
BAT_BUS_CHNG_3,933961,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933962,933961,'2',1,933962,600,0,0,0,33,0,933962,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933961,933962,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 8.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933961,933962,'1'
BAT_MBIDBRN,933961,933962,'2','1'
BAT_PLANT_DATA,933961,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933961,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933961,'D3',,,,,1, -5.2,,0.0,0.0, 8.0,-5.2, 8.0,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-038:
BAT_SPLT,113395,933952,'EWINC-GSU', 13.8
BAT_BRANCH_CHNG,113395,933952,'1',,,,,,0.002457,0.001382,,,,,,,,,,,,,;
BAT_SPLT,933952,933951,'EWINC-INV', 0.6
BAT_BUS_CHNG_3,933951,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933952,933951,'2',1,933952,600,0,0,0,33,0,933952,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933951,933952,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 9.4,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933951,933952,'1'
BAT_MBIDBRN,933951,933952,'2','1'
BAT_PLANT_DATA,933951,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933951,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933951,'D3',,,,,1, -4.6,,0.0,0.0, 9.4,-4.6, 9.4,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-039:
BAT_SPLT,113395,993952,'EWINC2-GSU', 13.8
BAT_BRANCH_CHNG,113395,993952,'1',,,,,,0.001785,0.001004,,,,,,,,,,,,,;
BAT_SPLT,993952,993951,'EWINC2-INV', 0.6
BAT_BUS_CHNG_3,993951,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,993952,993951,'2',1,993952,600,0,0,0,33,0,993952,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,993951,993952,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 5.5,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,993951,993952,'1'
BAT_MBIDBRN,993951,993952,'2','1'
BAT_PLANT_DATA,993951,0, 1.0, 100.0
BAT_MACHINE_DATA_2,993951,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,993951,'D3',,,,,1, -4.2,,0.0,0.0, 5.5,-4.2, 5.5,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-029:
BAT_SPLT,113070,930702,'LASHA-GSU', 13.2
BAT_BRANCH_CHNG,113070,930702,'1',,,,,,0.005257,0.002957,,,,,,,,,,,,,;
BAT_SPLT,930702,930701,'LASHA-INV', 0.6
BAT_BUS_CHNG_3,930701,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,930702,930701,'2',1,930702,600,0,0,0,33,0,930702,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,930701,930702,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 10.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,930701,930702,'1'
BAT_MBIDBRN,930701,930702,'2','1'

BAT_PLANT_DATA,930701,0, 1.0, 100.0
BAT_MACHINE_DATA_2,930701,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,930701,'D3',,,,,,1, -7.0,,0.0,0.0, 10.0,-7.0, 10.0,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-008:
BAT_SPLT,113377,933772,'LAURL-GSU', 13.8
BAT_BRANCH_CHNG,113377,933772,'1',,,,,,,0.010658,0.008573,,,,,,,,,,,,,;
BAT_SPLT,933772,933771,'LAURL-INV', 0.6
BAT_BUS_CHNG_3,933771,2,,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933772,933771,'2',1,933772,600,0,0,0,33,0,933772,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933771,933772,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 8.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933771,933772,'1'
BAT_MBIDBRN,933771,933772,'2','1'
BAT_PLANT_DATA,933771,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933771,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933771,'D3',,,,,,1, -4.4,,0.0,0.0, 8.0,-4.4, 8.0,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-009:
BAT_SPLT,113392,933922,'MILLB-GSU', 13.8
BAT_BRANCH_CHNG,113392,933922,'1',,,,,,,0.004054,0.00228,,,,,,,,,,,,,;
BAT_SPLT,933922,933921,'MILLB-INV', 0.6
BAT_BUS_CHNG_3,933921,2,,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933922,933921,'2',1,933922,600,0,0,0,33,0,933922,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933921,933922,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 10.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933921,933922,'1'
BAT_MBIDBRN,933921,933922,'2','1'
BAT_PLANT_DATA,933921,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933921,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933921,'D3',,,,,,1, -3.5,,0.0,0.0, 10.0,-3.5, 10.0,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-011:
BAT_SPLT,113388,933882,'NOXFO1-GSU', 13.2
BAT_BRANCH_CHNG,113388,933882,'1',,,,,,,0.003861,0.003106,,,,,,,,,,,,,;
BAT_SPLT,933882,933881,'NOXFO1-INV', 0.6
BAT_BUS_CHNG_3,933881,2,,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933882,933881,'2',1,933882,600,0,0,0,33,0,933882,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933881,933882,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 8.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933881,933882,'1'
BAT_MBIDBRN,933881,933882,'2','1'
BAT_PLANT_DATA,933881,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933881,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933881,'D3',,,,,,1, -6.4,,0.0,0.0, 8.0,-6.4, 8.0,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-013:
BAT_SPLT,113388,993882,'NOXFO2-GSU', 13.2
BAT_BRANCH_CHNG,113388,993882,'1',,,,,,,0.008745,0.007034,,,,,,,,,,,,,;
BAT_SPLT,993882,993881,'NOXFO2-INV', 0.6
BAT_BUS_CHNG_3,993881,2,,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,993882,993881,'2',1,993882,600,0,0,0,33,0,993882,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,993881,993882,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 5.6,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,993881,993882,'1'
BAT_MBIDBRN,993881,993882,'2','1'
BAT_PLANT_DATA,993881,0, 1.0, 100.0
BAT_MACHINE_DATA_2,993881,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,993881,'D3',,,,,,1, -4.8,,0.0,0.0, 5.6,-4.8, 5.6,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-006:
BAT_SPLT,113383,933832,'PRATT-GSU', 13.8
BAT_BRANCH_CHNG,113383,933832,'1',,,,,,,0.020017,0.011259,,,,,,,,,,,,,;
BAT_SPLT,933832,933831,'PRATT-INV', 0.6
BAT_BUS_CHNG_3,933831,2,,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933832,933831,'2',1,933832,600,0,0,0,33,0,933832,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933831,933832,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 6.0,,,,,,,,,,,,,,,,,,,," "," "

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BAT_PURGBRN,933831,933832,'1'
BAT_MBIDBRN,933831,933832,'2','1'
BAT_PLANT_DATA,933831,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933831,'D3',1,600,0,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933831,'D3',,,,,,1, -4.5,,0.0,0.0, 6.0,-4.5, 6.0,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-041:
BAT_SPLT,113084,930842,'ROYAL-GSU', 13.8
BAT_BRANCH_CHNG,113084,930842,'1',,,,,,,0.00271,0.00152,,,,,,,,,,,,,;
BAT_SPLT,930842,930841,'ROYAL-INV', 0.6
BAT_BUS_CHNG_3,930841,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,930842,930841,'2',1,930842,600,0,0,0,33,0,930842,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,930841,930842,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 5.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,930841,930842,'1'
BAT_MBIDBRN,930841,930842,'2','1'
BAT_PLANT_DATA,930841,0, 1.0, 100.0
BAT_MACHINE_DATA_2,930841,'D3',1,600,0,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,930841,'D3',,,,,,1, 0.0,,0.0,0.0, 5.0,0.0, 5.0,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-015:
BAT_SPLT,113389,933892,'SNOW1-GSU', 13.2
BAT_BRANCH_CHNG,113389,933892,'1',,,,,,,0.0119375,0.003094,,,,,,,,,,,,,;
BAT_SPLT,933892,933891,'SNOW1-INV', 0.6
BAT_BUS_CHNG_3,933891,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933892,933891,'2',1,933892,600,0,0,0,33,0,933892,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933891,933892,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 5.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933891,933892,'1'
BAT_MBIDBRN,933891,933892,'2','1'
BAT_PLANT_DATA,933891,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933891,'D3',1,600,0,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933891,'D3',,,,,,1, -2.5,,0.0,0.0, 5.0,-2.5, 5.0,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-016:
BAT_SPLT,113389,993892,'SNOW2-GSU', 13.2
BAT_BRANCH_CHNG,113389,993892,'1',,,,,,,0.01416,0.00797,,,,,,,,,,,,,;
BAT_SPLT,993892,993891,'SNOW2-INV', 0.6
BAT_BUS_CHNG_3,993891,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,993892,993891,'2',1,993892,600,0,0,0,33,0,993892,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,993891,993892,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 5.5,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,993891,993892,'1'
BAT_MBIDBRN,993891,993892,'2','1'
BAT_PLANT_DATA,993891,0, 1.0, 100.0
BAT_MACHINE_DATA_2,993891,'D3',1,600,0,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,993891,'D3',,,,,,1, -6.5,,0.0,0.0, 5.5,-6.5, 5.5,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-017:
BAT_SPLT,113389,983892,'SNOW3-GSU', 13.2
BAT_BRANCH_CHNG,113389,983892,'1',,,,,,,0.0119375,0.003094,,,,,,,,,,,,,;
BAT_SPLT,983892,983891,'SNOW3-INV', 0.6
BAT_BUS_CHNG_3,983891,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,983892,983891,'2',1,983892,600,0,0,0,33,0,983892,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,983891,983892,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 5.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,983891,983892,'1'
BAT_MBIDBRN,983891,983892,'2','1'
BAT_PLANT_DATA,983891,0, 1.0, 100.0
BAT_MACHINE_DATA_2,983891,'D3',1,600,0,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,983891,'D3',,,,,,1, -2.5,,0.0,0.0, 5.0,-2.5, 5.0,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-001:
BAT_SPLT,113363,933632,'STAFF-GSU', 13.8
BAT_BRANCH_CHNG,113363,933632,'1',,,,,,,0.00301169,0.00893508,,,,,,,,,,,,,;
BAT_SPLT,933632,933631,'STAFF-INV', 0.6
BAT_BUS_CHNG_3,933631,2,,,,,,,,,,,;
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BAT_TWO_WINDING_DATA_4,933632,933631,'2',1,933632,600,0,0,0,33,0,933632,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0,
1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933631,933632,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 5.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933631,933632,'1'
BAT_MBIDBRN,933631,933632,'2','1'
BAT_PLANT_DATA,933631,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933631,'D3',1,600,0,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933631,'D3',,,,,1, -5.0,,0.0,0.0, 5.0,-5.0, 5.0,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-033:
BAT_SPLT,113368,933682,'TREAS-GSU', 13.8
BAT_BRANCH_CHNG,113368,933682,'1',,,,,,0.002457,0.001382,,,,,,,,,,,,,;
BAT_SPLT,933682,933681,'TREAS-INV', 0.6
BAT_BUS_CHNG_3,933681,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933682,933681,'2',1,933682,600,0,0,0,33,0,933682,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0,
1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933681,933682,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 10.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933681,933682,'1'
BAT_MBIDBRN,933681,933682,'2','1'
BAT_PLANT_DATA,933681,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933681,'D3',1,600,0,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933681,'D3',,,,,1, -5.0,,0.0,0.0, 10.0,-5.0, 10.0,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-020:
BAT_SPLT,113390,933902,'WCHAR-GSU', 13.2
BAT_BRANCH_CHNG,113390,933902,'1',,,,,,0.005624,0.003164,,,,,,,,,,,,,;
BAT_SPLT,933902,933901,'WCHAR-INV', 0.6
BAT_BUS_CHNG_3,933901,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,933902,933901,'2',1,933902,600,0,0,0,33,0,933902,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0,
1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,933901,933902,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 5.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,933901,933902,'1'
BAT_MBIDBRN,933901,933902,'2','1'
BAT_PLANT_DATA,933901,0, 1.0, 100.0
BAT_MACHINE_DATA_2,933901,'D3',1,600,0,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,933901,'D3',,,,,1, -4.5,,0.0,0.0, 5.0,-4.5, 5.0,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-021:
BAT_SPLT,113390,993902,'WCHAR2-GSU', 13.2
BAT_BRANCH_CHNG,113390,993902,'1',,,,,,0.00691,0.003887,,,,,,,,,,,,,;
BAT_SPLT,993902,993901,'WCHAR2-INV', 0.6
BAT_BUS_CHNG_3,993901,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,993902,993901,'2',1,993902,600,0,0,0,33,0,993902,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0,
1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,993901,993902,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 10.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,993901,993902,'1'
BAT_MBIDBRN,993901,993902,'2','1'
BAT_PLANT_DATA,993901,0, 1.0, 100.0
BAT_MACHINE_DATA_2,993901,'D3',1,600,0,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,993901,'D3',,,,,1, -4.0,,0.0,0.0, 10.0,-4.0, 10.0,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-044:
BAT_SPLT,113085,930852,'WENDE1-GSU', 13.8
BAT_BRANCH_CHNG,113085,930852,'1',,,,,,0.002625,0.001477,,,,,,,,,,,,,;
BAT_SPLT,930852,930851,'WENDE1-INV', 0.6
BAT_BUS_CHNG_3,930851,2,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,930852,930851,'2',1,930852,600,0,0,0,33,0,930852,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0,
1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,930851,930852,'2',,,,,,,,,,,,,2,, 0.009450, 0.056720, 8.0,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,930851,930852,'1'
BAT_MBIDBRN,930851,930852,'2','1'
BAT_PLANT_DATA,930851,0, 1.0, 100.0
BAT_MACHINE_DATA_2,930851,'D3',1,600,0,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,930851,'D3',,,,,1, -7.2,,0.0,0.0, 8.0,-7.2, 8.0,,0.1,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0

//NEP-22-G03-043:
BAT_SPLT,113085,990852,'WENDE2-GSU', 13.8
BAT_BRANCH_CHNG,113085,990852,'1',,,,,,0.00271,0.001524,,,,,,,,,,,,,;
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BAT_SPLT,990852,990851,'WENDE2-INV', 0.6
BAT_BUS_CHNG_3,990851,2,,,,,,,,,,,,;
BAT_TWO_WINDING_DATA_4,990852,990851,'2',1,990852,600,0,0,0,33,0,990852,0,1,0,1,1,1,0.0, 0.0001, 100.0, 1.0,0.0,0.0, 1.0,0.0,0.0,0.0,0.0, 1.0,
1.0, 1.0, 1.0,0.0,0.0, 1.1, 0.9, 1.1, 0.9,0.0,0.0,0.0," "," "
BAT_TWO_WINDING_CHNG_4,990851,990852,'2',,,,,,,,,,,,,,2,, 0.009450, 0.056720, 10.0,,,,,,,,,,,,,,,,,,,,,," "," "
BAT_PURGBRN,990851,990852,'1'
BAT_MBIDBRN,990851,990852,'2','1'
BAT_PLANT_DATA,990851,0, 1.0, 100.0
BAT_MACHINE_DATA_2,990851,'D3',1,600,0,0,0,0,0.0,0.0, 9999.0,-9999.0, 9999.0,-9999.0, 100.0,0.0, 1.0,0.0,0.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0
BAT_MACHINE_CHNG_2,990851,'D3',,,,,,1, -8.0,,0.0,0.0, 10.0,-8.0, 10.0,,0.1,,,,,,,,,;
BAT_FDNS,1,0,0,1,1,0,0,0
```

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///NEP-22-G03-034
930821 'USRMDL' D3 'REGCBU1' 101 1 2 7 5 8 0 1
0.02 0.02 99 -99 10.0 0.01 1.0/

/930821 'REPCA1' D3
/1111 101 1111 '1' 1 0 1
/0.02 0 0 0 0.02 0 0 0 0 999 -999 0 0
/0 0 0.5 0.25 0.02 -0.0006 0.0006 999 -999 1 -1 0.02 20 20/

930821 'USRMDL' D3 'REECDU1' 102 0 6 77 7 20
0 1 0 0 1 0
0.4 1.3 0.02 -0.10 0.10 1 1.0 -1.0 0.00 0
0 0 0.01 0 0 1.05 0.95 0.9 0.9 0.9 0.9
0 0.02 99 -99 1 -1 1.2 0.02
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.02 0.01 1 0.5 1.1 0.04/

993082101 'VTGTPAT' 930821 930821 D3 -1 1.2 0.16 0.0 /
993082102 'VTGTPAT' 930821 930821 D3 -1 1.1 2 0.0 /
993082103 'VTGTPAT' 930821 930821 D3 0.5 5 1.1 0.0 /
993082104 'VTGTPAT' 930821 930821 D3 0.88 5 3 0.0 /
993082105 'FRQTPAT' 930821 930821 D3 56.5 100 0.16 0.0 /
993082106 'FRQTPAT' 930821 930821 D3 58.5 100 300 0.0 /
993082107 'FRQTPAT' 930821 930821 D3 -100 61.2 300 0.0 /
993082108 'FRQTPAT' 930821 930821 D3 -100 62 0.16 0.0 /

///NEP-22-G03-036
933961 'USRMDL' D3 'REGCBU1' 101 1 2 7 5 8 0 1
0.02 0.02 99 -99 10.0 0.01 1.0/

/933961 'REPCA1' D3
/1111 101 1111 '1' 1 0 1
/0.02 0 0 0 0.02 0 0 0 0 999 -999 0 0
/0 0 0.5 0.25 0.02 -0.0006 0.0006 999 -999 1 -1 0.02 20 20/

933961 'USRMDL' D3 'REECDU1' 102 0 6 77 7 20
0 1 0 0 1 0
0.4 1.3 0.02 -0.10 0.10 1 1.0 -1.0 0.00 0
0 0 0.01 0 0 1.05 0.95 0.9 0.9 0.9 0.9
0 0.02 99 -99 1 -1 1.2 0.02
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.02 0.01 1 0.5 1.1 0.04/

993396101 'VTGTPAT' 933961 933961 D3 -1 1.2 0.16 0.0 /
993396102 'VTGTPAT' 933961 933961 D3 -1 1.1 2 0.0 /
993396103 'VTGTPAT' 933961 933961 D3 0.5 5 1.1 0.0 /
993396104 'VTGTPAT' 933961 933961 D3 0.88 5 3 0.0 /
993396105 'FRQTPAT' 933961 933961 D3 56.5 100 0.16 0.0 /
993396106 'FRQTPAT' 933961 933961 D3 58.5 100 300 0.0 /
993396107 'FRQTPAT' 933961 933961 D3 -100 61.2 300 0.0 /
993396108 'FRQTPAT' 933961 933961 D3 -100 62 0.16 0.0 /

///NEP-22-G03-038
933951 'USRMDL' D3 'REGCBU1' 101 1 2 7 5 8 0 1
0.02 0.02 99 -99 10.0 0.01 1.0/

/933951 'REPCA1' D3
/1111 101 1111 '1' 1 0 1
/0.02 0 0 0 0.02 0 0 0 0 999 -999 0 0
/0 0 0.5 0.25 0.02 -0.0006 0.0006 999 -999 1 -1 0.02 20 20/

933951 'USRMDL' D3 'REECDU1' 102 0 6 77 7 20
0 1 0 0 1 0
0.4 1.3 0.02 -0.10 0.10 1 1.0 -1.0 0.00 0
0 0 0.01 0 0 1.05 0.95 0.9 0.9 0.9 0.9
0 0.02 99 -99 1 -1 1.2 0.02
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
```

```
0.01 0.01 0.02 0.01 1 0.5 1.1 0.04/

993395101 'VTGTPAT' 933951 933951 D3 -1 1.2 0.16 0.0 /
993395102 'VTGTPAT' 933951 933951 D3 -1 1.1 2 0.0 /
993395103 'VTGTPAT' 933951 933951 D3 0.5 5 1.1 0.0 /
993395104 'VTGTPAT' 933951 933951 D3 0.88 5 3 0.0 /
993395105 'FRQTPAT' 933951 933951 D3 56.5 100 0.16 0.0 /
993395106 'FRQTPAT' 933951 933951 D3 58.5 100 300 0.0 /
993395107 'FRQTPAT' 933951 933951 D3 -100 61.2 300 0.0 /
993395108 'FRQTPAT' 933951 933951 D3 -100 62 0.16 0.0 /

///NEP-22-G03-039
993951 'USRMDL' D3 'REGCBU1' 101 1 2 7 5 8 0 1
0.02 0.02 99 -99 10.0 0.01 1.0/

/993951 'REPCA1' D3
/1111 101 1111 '1' 1 0 1
/0.02 0 0 0 0.02 0 0 0 0 999 -999 0 0
/0 0 0.5 0.25 0.02 -0.0006 0.0006 999 -999 1 -1 0.02 20 20/

993951 'USRMDL' D3 'REECDU1' 102 0 6 77 7 20
0 1 0 0 1 0
0.4 1.3 0.02 -0.10 0.10 1 1.0 -1.0 0.00 0
0 0 0.01 0 0 1.05 0.95 0.9 0.9 0.9 0.9
0 0.02 99 -99 1 -1 1.2 0.02
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.02 0.01 1 0.5 1.1 0.04/

999395101 'VTGTPAT' 993951 993951 D3 -1 1.2 0.16 0.0 /
999395102 'VTGTPAT' 993951 993951 D3 -1 1.1 2 0.0 /
999395103 'VTGTPAT' 993951 993951 D3 0.5 5 1.1 0.0 /
999395104 'VTGTPAT' 993951 993951 D3 0.88 5 3 0.0 /
999395105 'FRQTPAT' 993951 993951 D3 56.5 100 0.16 0.0 /
999395106 'FRQTPAT' 993951 993951 D3 58.5 100 300 0.0 /
999395107 'FRQTPAT' 993951 993951 D3 -100 61.2 300 0.0 /
999395108 'FRQTPAT' 993951 993951 D3 -100 62 0.16 0.0 /

///NEP-22-G03-029
930701 'USRMDL' D3 'REGCBU1' 101 1 2 7 5 8 0 1
0.02 0.02 99 -99 10.0 0.01 1.0/

/930701 'REPCA1' D3
/1111 101 1111 '1' 1 0 1
/0.02 0 0 0 0.02 0 0 0 0 999 -999 0 0
/0 0 0.5 0.25 0.02 -0.0006 0.0006 999 -999 1 -1 0.02 20 20/

930701 'USRMDL' D3 'REECDU1' 102 0 6 77 7 20
0 1 0 0 1 0
0.4 1.3 0.02 -0.10 0.10 1 1.0 -1.0 0.00 0
0 0 0.01 0 0 1.05 0.95 0.9 0.9 0.9 0.9
0 0.02 99 -99 1 -1 1.2 0.02
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.02 0.01 1 0.5 1.1 0.04/

993070101 'VTGTPAT' 930701 930701 D3 -1 1.2 0.16 0.0 /
993070102 'VTGTPAT' 930701 930701 D3 -1 1.1 2 0.0 /
993070103 'VTGTPAT' 930701 930701 D3 0.5 5 1.1 0.0 /
993070104 'VTGTPAT' 930701 930701 D3 0.88 5 3 0.0 /
993070105 'FRQTPAT' 930701 930701 D3 56.5 100 0.16 0.0 /
993070106 'FRQTPAT' 930701 930701 D3 58.5 100 300 0.0 /
993070107 'FRQTPAT' 930701 930701 D3 -100 61.2 300 0.0 /
993070108 'FRQTPAT' 930701 930701 D3 -100 62 0.16 0.0 /

///NEP-22-G03-008
933771 'USRMDL' D3 'REGCBU1' 101 1 2 7 5 8 0 1
0.02 0.02 99 -99 10.0 0.01 1.0/

/933771 'REPCA1' D3
/1111 101 1111 '1' 1 0 1
/0.02 0 0 0 0.02 0 0 0 0 999 -999 0 0
/0 0 0.5 0.25 0.02 -0.0006 0.0006 999 -999 1 -1 0.02 20 20/
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933771 'USRMDL' D3 'REECDU1' 102 0 6 77 7 20
0 1 0 0 1 0
0.4 1.3 0.02 -0.10 0.10 1 1.0 -1.0 0.00 0
0 0 0.01 0 0 1.05 0.95 0.9 0.9 0.9 0.9
0 0.02 99 -99 1 -1 1.2 0.02
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.02 0.01 1 0.5 1.1 0.04/

993377101 'VTGTPAT' 933771 933771 D3 -1 1.2 0.16 0.0 /
993377102 'VTGTPAT' 933771 933771 D3 -1 1.1 2 0.0 /
993377103 'VTGTPAT' 933771 933771 D3 0.5 5 1.1 0.0 /
993377104 'VTGTPAT' 933771 933771 D3 0.88 5 3 0.0 /
993377105 'FRQTPAT' 933771 933771 D3 56.5 100 0.16 0.0 /
993377106 'FRQTPAT' 933771 933771 D3 58.5 100 300 0.0 /
993377107 'FRQTPAT' 933771 933771 D3 -100 61.2 300 0.0 /
993377108 'FRQTPAT' 933771 933771 D3 -100 62 0.16 0.0 /

///NEP-22-G03-009
933921 'USRMDL' D3 'REGCBU1' 101 1 2 7 5 8 0 1
0.02 0.02 99 -99 10.0 0.01 1.0/

/933921 'REPCA1' D3
/1111 101 1111 '1' 1 0 1
/0.02 0 0 0 0.02 0 0 0 0 999 -999 0 0
/0 0 0.5 0.25 0.02 -0.0006 0.0006 999 -999 1 -1 0.02 20 20/

933921 'USRMDL' D3 'REECDU1' 102 0 6 77 7 20
0 1 0 0 1 0
0.4 1.3 0.02 -0.10 0.10 1 1.0 -1.0 0.00 0
0 0 0.01 0 0 1.05 0.95 0.9 0.9 0.9 0.9
0 0.02 99 -99 1 -1 1.2 0.02
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.02 0.01 1 0.5 1.1 0.04/

993392101 'VTGTPAT' 933921 933921 D3 -1 1.2 0.16 0.0 /
993392102 'VTGTPAT' 933921 933921 D3 -1 1.1 2 0.0 /
993392103 'VTGTPAT' 933921 933921 D3 0.5 5 1.1 0.0 /
993392104 'VTGTPAT' 933921 933921 D3 0.88 5 3 0.0 /
993392105 'FRQTPAT' 933921 933921 D3 56.5 100 0.16 0.0 /
993392106 'FRQTPAT' 933921 933921 D3 58.5 100 300 0.0 /
993392107 'FRQTPAT' 933921 933921 D3 -100 61.2 300 0.0 /
993392108 'FRQTPAT' 933921 933921 D3 -100 62 0.16 0.0 /

///NEP-22-G03-011
933881 'USRMDL' D3 'REGCBU1' 101 1 2 7 5 8 0 1
0.02 0.02 99 -99 10.0 0.01 1.0/

/933881 'REPCA1' D3
/1111 101 1111 '1' 1 0 1
/0.02 0 0 0 0.02 0 0 0 0 999 -999 0 0
/0 0 0.5 0.25 0.02 -0.0006 0.0006 999 -999 1 -1 0.02 20 20/

933881 'USRMDL' D3 'REECDU1' 102 0 6 77 7 20
0 1 0 0 1 0
0.4 1.3 0.02 -0.10 0.10 1 1.0 -1.0 0.00 0
0 0 0.01 0 0 1.05 0.95 0.9 0.9 0.9 0.9
0 0.02 99 -99 1 -1 1.2 0.02
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.02 0.01 1 0.5 1.1 0.04/

993388101 'VTGTPAT' 933881 933881 D3 -1 1.2 0.16 0.0 /
993388102 'VTGTPAT' 933881 933881 D3 -1 1.1 2 0.0 /
993388103 'VTGTPAT' 933881 933881 D3 0.5 5 1.1 0.0 /
993388104 'VTGTPAT' 933881 933881 D3 0.88 5 3 0.0 /
993388105 'FRQTPAT' 933881 933881 D3 56.5 100 0.16 0.0 /
993388106 'FRQTPAT' 933881 933881 D3 58.5 100 300 0.0 /
993388107 'FRQTPAT' 933881 933881 D3 -100 61.2 300 0.0 /
993388108 'FRQTPAT' 933881 933881 D3 -100 62 0.16 0.0 /
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///NEP-22-G03-013
993881 'USRMDL' D3 'REGCBU1' 101 1 2 7 5 8 0 1
0.02 0.02 99 -99 10.0 0.01 1.0/

/993881 'REPCA1' D3
/1111 101 1111 '1' 1 0 1
/0.02 0 0 0 0.02 0 0 0 0 999 -999 0 0
/0 0 0.5 0.25 0.02 -0.0006 0.0006 999 -999 1 -1 0.02 20 20/

993881 'USRMDL' D3 'REECDU1' 102 0 6 77 7 20
0 1 0 0 1 0
0.4 1.3 0.02 -0.10 0.10 1 1.0 -1.0 0.00 0
0 0 0.01 0 0 1.05 0.95 0.9 0.9 0.9 0.9
0 0.02 99 -99 1 -1 1.2 0.02
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.02 0.01 1 0.5 1.1 0.04/

999388101 'VTGTPAT' 993881 993881 D3 -1 1.2 0.16 0.0 /
999388102 'VTGTPAT' 993881 993881 D3 -1 1.1 2 0.0 /
999388103 'VTGTPAT' 993881 993881 D3 0.5 5 1.1 0.0 /
999388104 'VTGTPAT' 993881 993881 D3 0.88 5 3 0.0 /
999388105 'FRQTPAT' 993881 993881 D3 56.5 100 0.16 0.0 /
999388106 'FRQTPAT' 993881 993881 D3 58.5 100 300 0.0 /
999388107 'FRQTPAT' 993881 993881 D3 -100 61.2 300 0.0 /
999388108 'FRQTPAT' 993881 993881 D3 -100 62 0.16 0.0 /

///NEP-22-G03-006
933831 'USRMDL' D3 'REGCBU1' 101 1 2 7 5 8 0 1
0.02 0.02 99 -99 10.0 0.01 1.0/

/933831 'REPCA1' D3
/1111 101 1111 '1' 1 0 1
/0.02 0 0 0 0.02 0 0 0 0 999 -999 0 0
/0 0 0.5 0.25 0.02 -0.0006 0.0006 999 -999 1 -1 0.02 20 20/

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0.4 1.3 0.02 -0.10 0.10 1 1.0 -1.0 0.00 0
0 0 0.01 0 0 1.05 0.95 0.9 0.9 0.9 0.9
0 0.02 99 -99 1 -1 1.2 0.02
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.02 0.01 1 0.5 1.1 0.04/

993383101 'VTGTPAT' 933831 933831 D3 -1 1.2 0.16 0.0 /
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993383103 'VTGTPAT' 933831 933831 D3 0.5 5 1.1 0.0 /
993383104 'VTGTPAT' 933831 933831 D3 0.88 5 3 0.0 /
993383105 'FRQTPAT' 933831 933831 D3 56.5 100 0.16 0.0 /
993383106 'FRQTPAT' 933831 933831 D3 58.5 100 300 0.0 /
993383107 'FRQTPAT' 933831 933831 D3 -100 61.2 300 0.0 /
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 0.0100         1.0000/


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 1.0000         1.0000         -1.0000         0.0000         0.0000
 0.0000         0.0000         0.0100         0.0000         0.0000
 1.1000         0.9000         0.3000         5.0000         0.5000
 0.0000         0.0000         0.0200         99.000         -99.000
 1.0000        -1.0000         1.2000         0.0200
 0.01 0.01  0.499 0.01  0.5 1.0  0.6 1.0  0.9 1.0  1.0 1.0  1.1 1.0  1.2 1.0  1.201 0.01  1.3 0.01
 0.01 0.01  0.499 0.01  0.5 1.0  0.6 1.0  0.9 1.0  1.0 1.0  1.1 1.0  1.2 1.0  1.201 0.01  1.3 0.01
 0.0000         0.0000         0.0000         0.0000         1.0000
 0.5000         1.1000         0.0000/
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993084104 'VTGTPAT' 930841 930841 D3 0.88 5 3 0.0 /
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0 0.02 99 -99 1 -1 1.2 0.02
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.02 0.01 1 0.5 1.1 0.04/

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993389108 'FRQTPAT' 933891 933891 D3 -100 62 0.16 0.0 /

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/0 0 0.5 0.25 0.02 -0.0006 0.0006 999 -999 1 -1 0.02 20 20/

993891 'USRMDL' D3 'REECDU1' 102 0 6 77 7 20
0 1 0 0 1 0
0.4 1.3 0.02 -0.10 0.10 1 1.0 -1.0 0.00 0
0 0 0.01 0 0 1.05 0.95 0.9 0.9 0.9 0.9
0 0.02 99 -99 1 -1 1.2 0.02
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.02 0.01 1 0.5 1.1 0.04/

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999389102 'VTGTPAT' 993891 993891 D3 -1 1.1 2 0.0 /
999389103 'VTGTPAT' 993891 993891 D3 0.5 5 1.1 0.0 /
999389104 'VTGTPAT' 993891 993891 D3 0.88 5 3 0.0 /
999389105 'FRQTPAT' 993891 993891 D3 56.5 100 0.16 0.0 /
999389106 'FRQTPAT' 993891 993891 D3 58.5 100 300 0.0 /
999389107 'FRQTPAT' 993891 993891 D3 -100 61.2 300 0.0 /
999389108 'FRQTPAT' 993891 993891 D3 -100 62 0.16 0.0 /

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983891 'USRMDL' D3 'REECDU1' 102 0 6 77 7 20
0 1 0 0 1 0
0.4 1.3 0.02 -0.10 0.10 1 1.0 -1.0 0.00 0
0 0 0.01 0 0 1.05 0.95 0.9 0.9 0.9 0.9
0 0.02 99 -99 1 -1 1.2 0.02
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.02 0.01 1 0.5 1.1 0.04/

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998389103 'VTGTPAT' 983891 983891 D3 0.5 5 1.1 0.0 /
998389104 'VTGTPAT' 983891 983891 D3 0.88 5 3 0.0 /
998389105 'FRQTPAT' 983891 983891 D3 56.5 100 0.16 0.0 /
998389106 'FRQTPAT' 983891 983891 D3 58.5 100 300 0.0 /
998389107 'FRQTPAT' 983891 983891 D3 -100 61.2 300 0.0 /
998389108 'FRQTPAT' 983891 983891 D3 -100 62 0.16 0.0 /

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        @!/ -------- ICONS ------
        @!/ 1.RateFlag   2.PQpriority
                0          0
        @!/ -------- CONS ------
        @!/ 1.Tg       2.Tflt     3.Iqrmax    4.Iqrmin   5.rrpwr
                0.006      0.006      30.00      -30.00     10.00
        @!/ 6.Te       7.Imax
                0.006      1.00/
@!/--------------------------------------------------------------------------------------------
  933631 'USRMDL' D3 'REECDU1' 102 0 6 77 7 20
        @!/ -------- ICONS ------
        @!/ 1.PFflag      2.Vflag       3.Qflag      4.Pflag     5.PQflag     6.VcmpFlag
                0          0            0          0                                  0          0
        @!/ -------- CONS ------
        @!/ 1.Vdip        2.Vup         3.Trv         4.dbd1       5.dbd2
                0.8500        1.4000        0.0060        -0.001        0.001
        @!/ 6.Kqv         7.Iqh1        8.Iql1        9.Vref0      10.Iqfrz
                2.0000        2.0000        -2.0000        0.0000        0.0000
        @!/ 11.Thld       12.Thld2      13.Tp         14.QMax       15.QMin
                0.0000                        0.0000                        0.0060        1.0000        -1.0000
        @!/ 16.Vmax       17.Vmin       18.Kqp        19.Kqi        20.Kvp
                1.2000        -1.2000        1.0000        5.0000        1.0000
        @!/ 21.Kvi        22.Vbias      23.Tiq        24.dPmax      25.dPmin
                5.0000        0.0000                0.0060        30.000        -30.000
        @!/ 26.Pmax       27.Pmin       28.Imax       29.Tpord      30.Vq1
                1.0000        -1.0000        1.2000        0.0250        0.1000
        @!/ 31.Iq1        32.Vq2        33.Iq2        34.Vq3        35.Iq3
                1.0000        1.1000        1.0000        0.0000        0.0000
        @!/ 36.Vq4        37.Iq4        38.Vq5        39.Iq5        40.Vq6
    0.0000        0.0000        0.0000        0.0000        0.0000
        @!/ 41.Iq6        42.Vq7        43.Iq7        44.Vq8        45.Iq8
    0.0000        0.0000        0.0000        0.0000        0.0000
        @!/ 46.Vq9        47.Iq9        48.Vq10       49.Iq10       50.Vp1
    0.0000        0.0000        0.0000        0.0000        0.1000
        @!/ 51.Ip1        52.Vp2        53.Ip2        54.Vp3        55.Ip3
    1.0000        1.1000        1.0000        0.0000        0.0000
        @!/ 56.Vp4        57.Ip4        58.Vp5        59.Ip5        60.Vp6
    0.0000        0.0000        0.0000        0.0000        0.0000
        @!/ 61.Ip6        62.Vp7        63.Ip7        64.Vp8        65.Ip8
    0.0000        0.0000        0.0000        0.0000        0.0000
        @!/ 66.Vp9        67.Ip9        68.Vp10       69.Ip10       70.Rc
    0.0000        0.0000        0.0000        0.0000        0.0000
        @!/ 71.Xc         72.Tr1        73.Kc         74.Ke         75.Vblkl
    0.0000        0.0060        0.0000        1.0000        0.5000
        @!/ 76.Vblkh      77.Tblk
    1.1000        0.0000/

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993363104 'VTGTPAT' 933631 933631 D3 0.88 5 3 0.0 /
993363105 'FRQTPAT' 933631 933631 D3 56.5 100 0.16 0.0 /
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993363107 'FRQTPAT' 933631 933631 D3 -100 61.2 300 0.0 /
993363108 'FRQTPAT' 933631 933631 D3 -100 62 0.16 0.0 /

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0 0 0.01 0 0 1.05 0.95 0.9 0.9 0.9 0.9
0 0.02 99 -99 1 -1 1.2 0.02
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.02 0.01 1 0.5 1.1 0.04/

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993368102 'VTGTPAT' 933681 933681 D3 -1 1.1 2 0.0 /
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993368104 'VTGTPAT' 933681 933681 D3 0.88 5 3 0.0 /
993368105 'FRQTPAT' 933681 933681 D3 56.5 100 0.16 0.0 /
993368106 'FRQTPAT' 933681 933681 D3 58.5 100 300 0.0 /
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0 1 0 0 1 0
0.4 1.3 0.02 -0.10 0.10 1 1.0 -1.0 0.00 0
0 0 0.01 0 0 1.05 0.95 0.9 0.9 0.9 0.9
0 0.02 99 -99 1 -1 1.2 0.02
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.02 0.01 1 0.5 1.1 0.04/

993390101 'VTGTPAT' 933901 933901 D3 -1 1.2 0.16 0.0 /
993390102 'VTGTPAT' 933901 933901 D3 -1 1.1 2 0.0 /
993390103 'VTGTPAT' 933901 933901 D3 0.5 5 1.1 0.0 /
993390104 'VTGTPAT' 933901 933901 D3 0.88 5 3 0.0 /
993390105 'FRQTPAT' 933901 933901 D3 56.5 100 0.16 0.0 /
993390106 'FRQTPAT' 933901 933901 D3 58.5 100 300 0.0 /
993390107 'FRQTPAT' 933901 933901 D3 -100 61.2 300 0.0 /
993390108 'FRQTPAT' 933901 933901 D3 -100 62 0.16 0.0 /

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/0 0 0.5 0.25 0.02 -0.0006 0.0006 999 -999 1 -1 0.02 20 20/

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0 1 0 0 1 0
0.4 1.3 0.02 -0.10 0.10 1 1.0 -1.0 0.00 0
0 0 0.01 0 0 1.05 0.95 0.9 0.9 0.9 0.9
0 0.02 99 -99 1 -1 1.2 0.02
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01

0.01 0.01 0.02 0.01 1 0.5 1.1 0.04/

999390101 'VTGTPAT' 993901 993901 D3 -1 1.2 0.16 0.0 /
999390102 'VTGTPAT' 993901 993901 D3 -1 1.1 2 0.0 /
999390103 'VTGTPAT' 993901 993901 D3 0.5 5 1.1 0.0 /
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999390108 'FRQTPAT' 993901 993901 D3 -100 62 0.16 0.0 /

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0 0.02 99 -99 1 -1 1.2 0.02
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.02 0.01 1 0.5 1.1 0.04/

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993085103 'VTGTPAT' 930851 930851 D3 0.5 5 1.1 0.0 /
993085104 'VTGTPAT' 930851 930851 D3 0.88 5 3 0.0 /
993085105 'FRQTPAT' 930851 930851 D3 56.5 100 0.16 0.0 /
993085106 'FRQTPAT' 930851 930851 D3 58.5 100 300 0.0 /
993085107 'FRQTPAT' 930851 930851 D3 -100 61.2 300 0.0 /
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/0 0 0.5 0.25 0.02 -0.0006 0.0006 999 -999 1 -1 0.02 20 20/

990851 'USRMDL' D3 'REECDU1' 102 0 6 77 7 20
0 1 0 0 1 0
0.4 1.3 0.02 -0.10 0.10 1 1.0 -1.0 0.00 0
0 0 0.01 0 0 1.05 0.95 0.9 0.9 0.9 0.9
0 0.02 99 -99 1 -1 1.2 0.02
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.499 0.01 0.5 1 0.6 1 0.9 1 1 1 1.1 1 1.2 1 1.201 0.01 1.3 0.01
0.01 0.01 0.02 0.01 1 0.5 1.1 0.04/

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999085103 'VTGTPAT' 990851 990851 D3 0.5 5 1.1 0.0 /
999085104 'VTGTPAT' 990851 990851 D3 0.88 5 3 0.0 /
999085105 'FRQTPAT' 990851 990851 D3 56.5 100 0.16 0.0 /
999085106 'FRQTPAT' 990851 990851 D3 58.5 100 300 0.0 /
999085107 'FRQTPAT' 990851 990851 D3 -100 61.2 300 0.0 /
999085108 'FRQTPAT' 990851 990851 D3 -100 62 0.16 0.0 /

This appendix has been redacted for Critical Energy/Electric Infrastructure Information (CEII).

Appendix D – N-0 and N-1 Thermal and Voltage Results

This appendix has been redacted for Critical Energy/Electric Infrastructure Information (CEII).

Appendix E – Stability Analysis Plots

WMA Group 3 cluster stability plots_pdf.zip

This appendix has been redacted for Critical Energy/Electric Infrastructure Information (CEII).

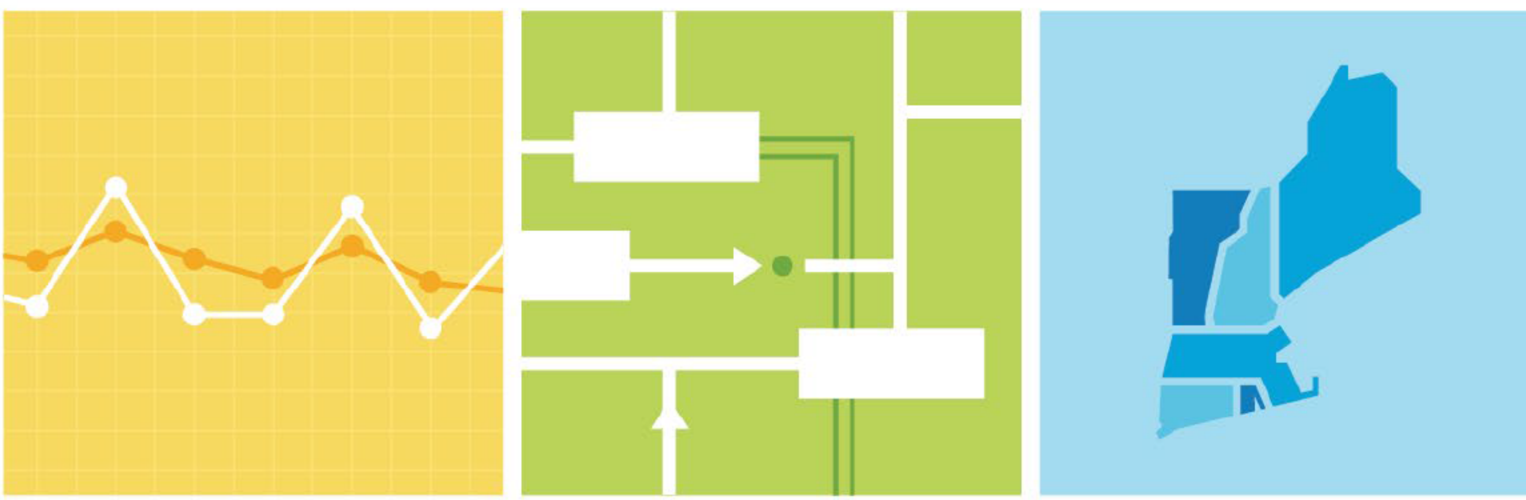
Appendix F – PSCAD Analysis Report

Western MA DER Group 3 PSCAD Report 5_20_2022.pdf

This document has been redacted for Critical Energy/Electric Infrastructure Information (CEII).

Final Western and Central Massachusetts (WCMA) Area 2029 Needs Assessment

MAY 2020



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Figures

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Section 1
Executive Summary

1.1 Study Objective

The objective of the Western and Central Massachusetts Area (WCMA) 2029 Needs Assessment study is to evaluate the reliability performance and identify reliability-based transmission needs in the WCMA study area for the year 2029 while considering the following:

- Future load conditions to reflect the 2019 Capacity, Energy, Loads, and Transmission (CELT) load forecast
- Resource changes in the WCMA study area based on FCA 13 results[1]
    - Harrington Street PV Project – 2.4 MW
- Retirement of resources in the WCMA study area through FCA 14
    - Pinetree Power – 15.8 MW
- Reliability over a range of generation patterns and transfer levels
- All applicable North American Electric Reliability Corporation (NERC), Northeast Power Coordinating Corporation (NPCC) and ISO New England transmission planning reliability standards

This Needs Assessment is the first step in the study process defined in accordance with the Regional Planning Process as outlined in Attachment K of the ISO-NE Open Access Transmission Tariff (OATT). If necessary, development of transmission solutions to address criteria violations identified in this Needs Assessment will be handled using either the Solutions Study process or the Competitive Solution process described in Attachment K of the OATT.

This WCMA 2029 Needs Assessment was initiated on 06/29/2017 for the reasons described in the related Needs Assessment initiation notice to PAC.[2]

1.2 Method and Criteria

The Needs Assessment was performed in accordance with applicable requirements in NERC TPL-001-4[3] "*Transmission System Planning Performance Requirements*", NERC NUC-001-3[4] "*Nuclear Plant Interface Coordination*", NPCC Regional Reliability Reference Directory # 1[5] "*Design and Operation of the Bulk Power System*", and ISO New England Planning Procedure 3[6] "*Reliability Standards for the New England Area Pool Transmission Facilities*", as well as the criteria found in Section 4.1 of this report.

[1] FCA 14 for retirement and permanent de-list bids. FCA 14 was completed soon before the release of this report. A review of the final FCA 14 results (both for de-lists and new capacity supply obligations) showed no need to further modify the study assumptions for the WCMA 2029 Needs Assessment.

[2] https://www.iso-ne.com/static-assets/documents/2017/06/2027_wcma_needs_assessment_study_initiation_pac_notice.pdf

[3] http://www.nerc.com/pa/stand/Pages/ReliabilityStandardsUnitedStates.aspx?jurisdiction=United States - Click on the (TPL) Transmission Planning drop down menu for the latest version of the standard.

[4] http://www.nerc.com/pa/stand/Pages/ReliabilityStandardsUnitedStates.aspx?jurisdiction=United States - Click on the (NUC) Nuclear drop down menu for the latest version of the standard.

[5] https://www.npcc.org/Standards/Directories/Forms/Public%20List.aspx .

[6] https://www.iso-ne.com/participate/rules-procedures/planning-procedures .

1.3 Study Assumptions

The New England steady-state model was developed to be representative of the 10-year projection of the 90/10 summer peak system demand levels to assess reliability performance under stressed system conditions. The peak load base cases represent a 2029 summer peak load condition based on the 2019 CELT forecast. For the peak load levels tested, demand resources (DR) in the form of Active DR that cleared the Forward Capacity Auction (FCA 13), forecasted Energy Efficiency (EE) and distributed solar generation (PV) as a part of the 2019 CELT forecast were modeled as load reductions.

Minimum load level testing at a fixed New England load level of 7,513 MW was performed for the WCMA area.

All transmission and generation facilities that were in-service as of May 15, 2019 were included in the base cases. All future generators with a Capacity Supply Obligation (CSO) through FCA 13 are included.[7] In general, all reliability upgrades critical to the study area in the March 2019 RSP Project List (Table 1a and 1b) that were Proposed, Planned and Under Construction were included in the base cases.

Vineyard Wind, Revolution Wind, and New England Clean Energy Connect (NECEC) have financially binding contracts and were included in the WCMA 2029 Needs Assessment.

The assumptions included consideration of area generating unit unavailability conditions as well as variations in import levels from external areas. These study assumptions are consistent with the applicable requirements of the following:

- NERC TPL-001-4 “Transmission System Planning Performance Requirements”
- NERC NUC-001-3 “Nuclear Plant Interface Coordination”
- Northeast Power Coordinating Council (NPCC) Regional Reliability Reference Directory #1 “Design and Operation of the Bulk Power System”, and
- ISO New England Planning Procedure 3 “Reliability Standards for the New England Area Pool Transmission Facilities”

Steady-state N-0, N-1 and N-1-1 testing was performed. The details of the contingencies evaluated are provided in Section 4.3.1 and the steady-state performance criteria are provided in Section 4.2.1.

The short circuit study evaluated the projected 2023 available fault current levels around the WCMA area. There are no significant projects expected in the 2023 - 2029 timeframe that would impact the short circuit performance of the study area, hence the 2023 case was considered acceptable. Additional information on the short circuit model used for the analysis is provided in Section 3.3.

The ASPEN Circuit Breaker Rating Module software was used to calculate all Pool Transmission Facility (PTF) circuit breaker duties in the WCMA area. The performance criteria used to evaluate

[7] FCA 14 for retirement and permanent de-list bids. FCA 14 was completed soon before the release of this report. A review of the final FCA 14 results (both for de-lists and new capacity supply obligations) showed no need to further modify the study assumptions for the WCMA 2029 Needs Assessment.

the circuit breakers are provided in Section 4.2.3 and additional details on the breakers evaluated are provided in Section 4.3.6.

1.4 Specific Areas of Concern

1.4.1 Steady State Testing Results

The results of the analysis for all of the study work completed at peak load indicated that there were voltage violations that were identified as PTF needs for N-1 and N-1-1 conditions and no thermal violations were identified as PTF needs for N-1, and N-1-1 conditions. No thermal or voltage violations were identified as PTF needs for N-0. All of the N-1 and N-1-1 voltage violations occur within the 69 kV corridor from Vernon to Pratts Jct.

The steady-state testing performed at the minimum load level of 7,513 MW showed no thermal or voltage violations were identified as PTF needs for N-0, N-1, and N-1-1 conditions.

Only PTF needs were shown and discussed in the body of the report. PTF needs are those needs that would be solved during the Solutions Study or the competitive solution processes. Potential non-PTF concerns identified as a result of the analysis are shown in Section 11. No attempt was made to conduct further analysis (e.g. generator re-dispatch) to mitigate the potential non-PTF concerns.

Additionally, system adjustments were not performed between the first and second contingencies to prevent thermal and voltage violations on PTF facilities that are not an NPCC Bulk Power System (BPS) facility if the violation only occurs for multi-element contingencies as a second contingency.[8] These contingencies were excluded because they are not valid second contingencies per NERC TPL-001-4 and ISO-NE PP3. Violations on these elements were reported in Section 11, but were not identified as needs. Note that if these non-BPS elements with thermal or voltage violations are classified as BPS elements in the future, additional analysis will need to be performed to determine if system adjustments are effective in resolving the violations before categorizing the violations as needs.

1.4.2 Review of N-0 Testing

N-0 (also known as "all-lines-in") conditions were reviewed for the cases modeled. The results indicate that under all tested dispatch and transfer level conditions at peak load and minimum load there were no N-0 thermal or voltage violations.

The details of the N-0 peak load testing results are provided in Section 5.2.1.1. The details of the N-0 minimum load testing results are provided in Section 5.2.3.1.

1.4.3 Review of N-1 Testing

The results indicate that under all tested dispatch and transfer level conditions at peak load there were N-1 voltage violations and no N-1 thermal violations seen on PTF facilities WCMA study area.

Time-sensitivity testing was performed for the N-1 peak load violations. All N-1 voltage violations are time-sensitive needs.

[8] The excluded multi-element contingencies are breaker failure contingencies, double-circuit tower contingencies, and bus section contingencies.

The results of the minimum load testing indicate that there were no N-1 thermal violations or voltage violations seen on PTF facilities in the WCMA area.

The details of the N-1 peak load testing results are provided in section 5.2.1.2. The details of the N-1 minimum load testing results are provided in Section 5.2.3.2.

1.4.4 Review of N-1-1- Testing

Initial element-out-of-service (N-1-1) testing included all transmission lines, autotransformers, shunt devices, and generators in the study area that are considered Bulk Electric System (BES) elements as initial elements-out-of-service for the testing. These element-out-of-service conditions were tested against the full set of contingencies used in the N-1 tests, with noted exceptions made for the treatment of no-fault contingencies as described in Section 4.3.1.

The results indicate that under all tested dispatch and transfer level conditions at peak load there were N-1-1 voltage violations and no N-1-1 thermal violations that were identified as PTF needs in the WCMA area.

Time-sensitivity testing was performed for the N-1-1 peak load violations. All N-1-1 violations are time-sensitive needs.

The results of the minimum load testing indicate that there were no N-1-1 thermal or voltage violations were seen on PTF facilities in the WCMA area.

The details of the N-1-1 peak load testing results are provided in Section 5.2.1.3. The details of the N-1-1 minimum load testing results are provided in Section 5.2.3.3.

1.4.5 Short Circuit Testing Results

The short circuit study results indicate that no substations had any PTF breakers that would be over-dutied[9] for 2023 system model conditions in the WCMA study area.

The details of the short circuit testing are provided in Section 5.4.

1.5 Peak Load PV Sensitivity Assessment

A sensitivity analysis was performed incorporating the National Grid Western MA DER Cluster Study Group 1 that consists of 320 MW of PV in the WCMA study area.[10]

The results of the sensitivity with the DER Cluster Study Group 1 PV showed an improvement over the results of the base case without the PV. However the addition of the PV is sufficient to solve all of the voltage violation results.

1.6 Statements of Need

The results of the steady-state assessment conducted of the WCMA area transmission performance against transmission reliability standards for the projected 2029 system conditions in this study

[9] A PTF breaker is considered over-dutied if the short circuit study results are 100% or greater than the breaker's momentary or fault interrupting duty.
[10] https://smd.iso-ne.com/operations-services/ceii/rc/2019/11/a3_5_western_mass_distributed_resource_additions_cluster_roup_1_lvl3_ppa.zip

indicate that there are PTF voltage violations under peak load conditions in the study area. The WCMA area transmission system fails to meet the reliability criteria standards in the study area under the design case testing performed and measures should be developed to mitigate the identified problems.

For the identified peak load needs, time-sensitivity testing was performed and demonstrated that all voltage violations are time-sensitive needs. The need-by date for the peak load time-sensitive needs is set to June 1, 2022 based on the methodology documented in Section 4.1.4 of the Transmission Planning technical guide[11]. The specific worst case criteria violations are summarized in Section 5.2.

1.7 Postponement of Solutions

National Grid is proposing a Western MA DER Cluster Study Group 2 that consists of an additional 391 MW of PV and numerous transmission upgrades in the WCMA study area. Approximately 40 MW of PV is proposed within the 69 kV corridor from Vernon to Pratts Jct.

ISO-NE will not begin the Solutions Study process described in Section 4.2 of Attachment K to develop regulated transmission solutions to solve the time-sensitive needs identified in the WCMA 2029 Needs Assessment at this time. Due to the proposed Western MA DER Study Group 2, there are many proposed transmission topology changes required to interconnect the PV and uncertainty that the DER levels will be achieved within the 69 kV corridor from Vernon to Pratts Jct. Once the level of activity has subsided, and the transmission topology, level of DER realized, and loadings at each station are finalized, the ISO will initiate a new Needs Assessment for the 69 kV corridor from Vernon to Pratts Jct.

[11] https://www.iso-ne.com/static-assets/documents/2017/03/transmission_plannings_techincal_guide_rev5.pdf

Section 2
Introduction and Background Information

2.1 Study Objective

The objective of the Western and Central Massachusetts Area (WCMA) 2029 Needs Assessment study is to evaluate the reliability performance and identify reliability-based transmission needs in the WCMA study area for the year 2029 while considering the following:

- Future load conditions to reflect the 2019 CELT load forecast
- Resource changes in the WCMA study area based on FCA 13 results[12]
    - Harrington Street PV Project – 2.4 MW
- Retirement of resources in the WCMA study area through FCA 14
    - Pinetree Power – 15.8 MW
- Reliability over a range of generation patterns and transfer levels
- All applicable North American Electric Reliability Corporation (NERC), Northeast Power Coordinating Corporation (NPCC) and ISO New England transmission planning reliability standards

This Needs Assessment is the first step in the study process defined in accordance with the Regional Planning Process as outlined in Attachment K of the ISO-NE Open Access Transmission Tariff (OATT). If necessary, development of transmission solutions to address criteria violations identified in this Needs Assessment will be handled using either the Solutions Study process or the Competitive Solution process described in Attachment K of the OATT.

This WCMA 2029 Needs Assessment has been initiated as a follow-up to the Western and Central Massachusetts Needs Assessment Study Initiation posted to the ISO website on June 29, 2017.[13]

2.2 Area(s) Studied

The WCMA study area is the area of Massachusetts south of the Vermont and New Hampshire borders, north of the Connecticut and Rhode Island borders, east of the New York border, and west of the Boston Import Interface. In addition, the Scitico substation which is geographically located in Connecticut but served by the 1976 line from the West Hampden substation and 1394 line from the Franconia substation both located in Massachusetts is considered part of the WCMA study area.

Figure 2-1 shows the geographic map of the study area.

[12] FCA 14 for retirement and permanent de-list bids. FCA 14 was completed soon before the release of this report. A review of the final FCA 14 results (both for de-lists and new capacity supply obligations) showed no need to further modify the study assumptions for the WCMA 2029 Needs Assessment.

[13] https://www.iso-ne.com/static-assets/documents/2017/06/2027_wcma_needs_assessment_study_initiation_pac_notice.pdf

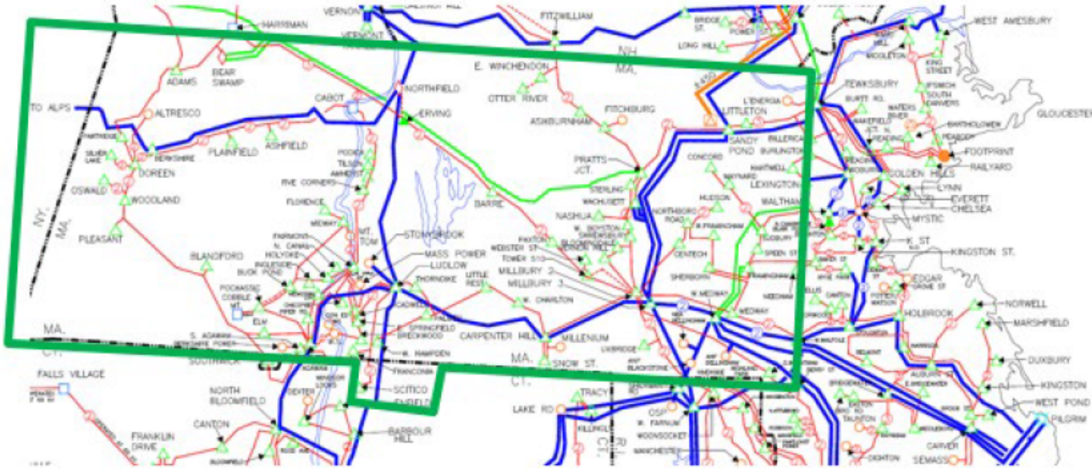


Figure 2-1: WCMA Study Area Map[14]

Figure 2-2 shows the one-line diagram of the study area.

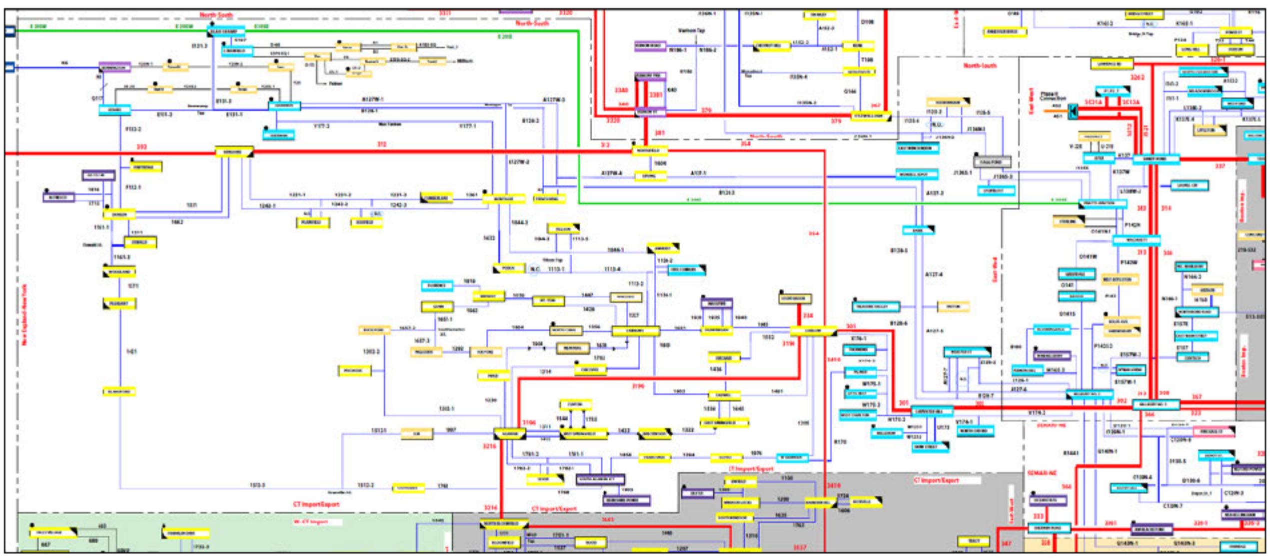


Figure 2-2: WCMA Study Area One Line Diagram[15]

2.3 Study Horizon

This study was focused on the 2029 summer peak load level for the ten-year horizon utilizing the 2019 Capacity, Energy, Loads and Transmission (CELT) Report Forecast.[16] Additional minimum

[14] This area map is for illustrative purposes only. It does not show any future projects in the study area. Although PTF facilities under 100 kV are not shown in the area map, those facilities are included in the study. A high-resolution of the geographical map is available at https://www.iso-ne.com/about/key-stats/maps-and-diagrams

[15] The one-line diagram is for illustrative purposes to show the study area. It does not show any future projects in the area. Although PTF facilities under 100 kV are not shown in the one line, those facilities are included in the study. A high-resolution version of the system diagram is available at https://www.iso-ne.com/about/key-stats/maps-and-diagrams

[16] 2019 CELT Forecast information: https://www.iso-ne.com/static-assets/documents/2019/04/2019_celt_report.xls

load level testing at a fixed New England load level of 7,513 MW was also performed for the WCMA study area.

2.4 Incorporation of Projects with Financially Binding Contracts

Vineyard Wind, Revolution Wind, and New England Clean Energy Connect (NECEC) have financially binding contracts and are included in the WCMA 2029 Needs Assessment based on Section 4.1(f) of Attachment K to the OATT that states that:

> *"the ISO shall incorporate or update information regarding resources in Needs Assessments that have been proposed and (i) have cleared in a Forward Capacity Auction pursuant to Market Rule 1 of the ISO Tariff, (ii) have been selected in, and are contractually bound by, a state-sponsored Request For Proposals, or (iii) have a financially binding obligation pursuant to a contract."*

Vineyard Wind

The Vineyard Wind project is an 800 MW off shore wind project that connects to the Barnstable 115 kV substation. This project is located on Cape Cod in the SEMA area with the injection of power at Barnstable. The contract for Vineyard Wind was approved by the MA DPU on April 12, 2019. The project is modeled at 160 MW[17] (800 MW multiplied by 20%) for the WCMA 2029 Needs Assessment and was represented in all steady state thermal and voltage analysis.

Revolution Wind

The Revolution Wind project is a 704 MW off shore wind project located off the coast of Rhode Island in the SEMA/RI area. The contract for 200 MW of the project was approved by the Connecticut Public Utilities Regulatory Authority on December 19, 2018, and the contract for 400 MW of the project was approved by the Rhode Island Public Utilities Commission (PUC) on May 28, 2019. The project was modeled at 120 MW[17] (600 MW multiplied by 20%) for the WCMA 2029 Needs Assessment and was represented in all steady state thermal and voltage analysis.

NECEC

The NECEC is an HVDC project with a 1,090 MW contract that interconnects to the Larrabee Road 345 kV substation in Maine. The contract for NECEC was approved by the MA DPU on June 25, 2019. The NECEC project interconnection location, though distant from the WCMA study area, has an impact on West to East interface flows proposed in the dispatches described in Section 3.1.3. The project was modeled at 1,090 MW for the WCMA 2029 Needs Assessment and was represented in all steady state thermal and voltage analysis.

2.5 Analysis Description

The study included the evaluation of the reliability of the transmission system serving the WCMA study area for the projected system conditions in 2029. The system was tested under N-0 (all-facilities-in), N-1 (all-facilities-in, first contingency), and N-1-1 (facility-out, first contingency) conditions for a number of possible operating scenarios with respect to generating unit unavailability conditions and import levels from external areas.

[17] Section 2.3.7 of the Transmission Planning Technical Guide states that "when it is needed to support area transmission requirements, on-shore wind generation is modeled at 5% of nameplate and off-shore wind is modeled at 20% of nameplate for transmission Needs Assessment and Solutions Studies". The Transmission Planning Technical Guide is located at https://www.iso-ne.com/static-assets/documents/2017/03/transmission_planning_techincal_guide_rev4.pdf

The following types of analyses were performed:

- **Thermal Analysis** – studies to determine the level of steady-state power flows on transmission circuits under base case conditions and following contingency events.
- **Voltage Analysis** – studies to determine steady-state voltage levels and performance under base case conditions and following contingency events.
- **Short Circuit Analysis** – studies to determine the ability of substation equipment to withstand and interrupt fault current.

Extreme contingency analysis was not performed for this Needs Assessment. The extreme contingency performance of the system will be considered, as necessary, in the study work to evaluate solutions to address identified needs.

The Needs Assessment was performed in accordance with relevant NERC, NPCC, and ISO criteria as described in Section 4.2.

For all thermal and voltage violations observed at peak load levels, an analysis was performed to determine if the need is time-sensitive. Time-sensitivity of the need was utilized to determine whether the Solutions Study process or the competitive solution process described in Attachment K of the OATT will be utilized to develop regulated transmission upgrades.

When determining time-sensitivity for any needs that are identified based on the short-circuit analysis, the time-sensitivity is based on the expected in-service date of the future project that causes the equipment to exceed its capabilities. In the event that equipment is found to exceed its capabilities prior to the implementation of any future projects, the need would be considered time-sensitive.

The thermal and voltage analysis was performed using Siemens PTI PSS®E v33.12.0 and PowerGEM TARA v1802c_RC18 software. The short circuit analysis was performed using ASPEN OneLiner v14.7.

Section 3
Study Assumptions

3.1 Steady State Model Assumptions

3.1.1 Study Assumptions

The New England steady-state model was developed to be representative of the 10-year projection of the 90/10 summer peak system demand levels to assess reliability performance under stressed system conditions. The models external to New England were based on the 2018 Multiregional Modeling Working Group (MMWG) case library. A summary of the two load levels modeled for the WCMA Needs Assessment are provided in Table 3-1.

Table 3-1:
Net New England Load Levels (Excluding Transmission Losses)

Category	Summer Peak 2029 90/10 Load (MW)	Minimum Load 2029 (MW)
2019 CELT Forecast	32,477	N/A
Fixed New England Load	N/A	7,502[18]
Non-CELT Manufacturing load in New England	348	0
New Large Load Supplied at CMP's Belfast Station	21	11
Available 2019 CELT EE Forecast[19] for study year (modeled as negative load)	-5,359	0
Available FCA-13 ADCR (modeled as negative load)	-533	0
Available 2019 CELT PV Forecast for study year (modeled as negative load)	-1,849	0
Net load modeled in New England (Excludes Station Service)	**25,105**	**7,513**

All transmission and generation facilities that were in-service as of May 15, 2019 are included in the base cases. All future generators with a Capacity Supply Obligation (CSO) through FCA 13[20] are included. In general, all reliability upgrades critical to the study area in the March 2019 RSP Project List (Table 1a and 1b) that were Proposed, Planned and Under Construction were included in the base cases.

In addition, Mystic 7, 8, 9 and Jet units were assumed as retired, and thus modeled as out-of- service in the base cases.

18 This New England load is based on a review of historical net load data, which accounts for the impact of PV, EE, and DR under minimum load conditions. Therefore, to avoid double counting, PV, EE, and DR are not explicitly modeled.

19 Starting with 2018 CELT the EE Forecast includes all years in the 10 year planning horizon and the EE forecast data will be used for Years 1-3 in lieu of the Passive DR from the most recent FCA.

20 FCA 14 for retirement and permanent de-list bids. FCA 14 was completed soon before the release of this report. A review of the final FCA 14 results (both for de-lists and new capacity supply obligations) showed no need to further modify the study assumptions for the WCMA 2029 Needs Assessment.

Vineyard Wind, Revolution Wind, and NECEC have financially binding contracts and are included in the WCMA 2029 Needs Assessment. Details on each of the projects can be found in Section 2.4.

All existing and future generators with an FCM obligation were modeled at their Summer Qualified Capacity (QC) rating. The FCA 13 data was used to obtain the Summer QC ratings.

As a part of FCA 13, the Harrington Street PV Project cleared for an additional 2.4 MW in the WCMA study area. When added to the existing capacity of 1.43 MW, the project was modeled at 3.83 MW total. This project was modeled in-service in all peak load cases. In addition, the Killingly Energy Center (KEC) cleared for 631.96 MW in the adjacent area of Connecticut and Three Corners, PV connecting into the Albion Road 115 kV substation in ME cleared for ~123 MW (modeled at ~32 MW or 26% of nameplate). KEC is considered in-service only in the peak load cases with an east to west stress and Three Corners is modeled online, however is too far from the study area to impact the study results.

In addition, as part of FCA 14, Pinetree Power in WCMA, Yarmouth 1 and 2 in Maine and South Meadow 11-14 in Connecticut submitted retirement de-list bids. Therefore, these generators are considered retired in all cases.

Any generator without an FCM obligation that is in-service today is modeled as follows:

- Generators associated with the active mill facilities in Maine that do not have an obligation through the FCM are modeled with a maximum output value equal to the historically established capability for these generators. These resources are dispatched as follows:
    - The renewable generators associated with the mills are dispatched similar to the renewable generators with an FCM obligation
    - The non-renewable generators associated with the mills are dispatched similar to the non-renewable generators with an FCM obligation
    - The total demand into these mills has been modeled:
        - at 0 MW and 0 MVAR under minimum load conditions
        - under peak load conditions, such that loss of the largest generator in each mill results in a power flow into the mill that meets its related contract value. The contractual values for the mill loads are listed in Table 3-2
- PV generators that are a part of the PV forecast are modeled at their summer Network Resource Capability ("NRC") (maximum output at or above 50 degrees Fahrenheit). These generators are dispatched at 26% of their Summer NRC.
- All other in-service New England generators that do not have an FCM obligation are modeled offline in the base cases.

Table 3-2:
Mill Load Contractual Values Under Peak Load Condition

Mill Load	Contractual Load Value
Newpage	85 MVA[21]
Sappi Somerset	105 MW
Sappi Westbrook	22 MVA
Verso Jay	72.45 MVA

Additional details on the MW level at which these generators were dispatched in the base cases are discussed in Section 3.1.4.

The assumptions include consideration of area generation unit unavailability conditions as well as variations in import levels from external areas. These study assumptions are consistent with NERC Standard TPL-001-4, "Transmission System Planning Performance Requirements", NPCC Directory # 1, "Design and Operation of the Bulk Power System", and ISO-NE Planning Procedure No. 3 (PP3), "Reliability Standards for the New England Area Pool Transmission Facilities".

In general, all reliability upgrades in the March 2019 RSP Project List (Table 1a and 1b) that were Proposed, Planned and Under Construction were included in the base cases. Some of the major projects that are included are:

- NH - Seacoast New Hampshire Solution
- MA - Pittsfield/Greenfield Reliability Project
- MA, NH, ME - Greater Boston Reliability Project
- MA, RI - Southeast Massachusetts and Rhode Island Reliability Project
- VT - Connecticut River Valley Project
- CT - Greater Hartford and Central Connecticut (GHCC) Reliability Project
- CT - Southwest Connecticut (SWCT) Reliability Project

Table 3-3 contains the projects listed as Planned on the RSP Project List that are relevant to the WCMA 2029 Needs Assessment which were excluded from the base cases because the need for the projects was to be verified as part of this Needs Assessment. As this report was being created, National Grid signaled their intention to withdraw the PPAs associated with the projects found in Table 3-3 due to the age of the PPAs.

[21] A maximum loading of 45 MVAR is also contractually specified.

Table 3-3:
RSP Projects Excluded from Study Base Cases

RSP ID	Transmission Owner	State	In-service Date	Project
950	National Grid	MA	12/2022	E Winchendon - install 115 kV breaker and 115 kV disconnect switch
951	National Grid	MA	12/2022	Install new Otter River - E Winchendon (H-134) 115 kV line
953	National Grid	MA	12/2022	Otter River - expand substation into 6-breaker ring bus with four 115 kV breakers and install two transformers
954	National Grid	MA	12/2022	Westminster - install new 69 kV breaker, including disconnect switches

The March 2019 RSP Project List also included the transmission upgrades associated with Generation Interconnection projects and Elective Transmission Upgrades. Only the transmission upgrades associated with future resources that have an FCA obligation in FCA 13 were included.

Vineyard Wind, Revolution Wind, and NECEC have financially binding contracts and are included in the WCMA 2029 Needs Assessment. Details on each of the projects can be found in Section 2.4.

All Asset Condition projects that are Planned, Proposed or Under Construction as of the March 2019 Asset Condition list were included in both study base cases.

All future Local System Plan (LSP) projects for which transmission owners had provided modeling data were included in the study base cases.

3.1.2 Source of Power Flow Models

The study files for the 2029 WCMA NA were based on the intermediate study files for the 2029 WCMA NA posted to PAC on December 6, 2019 and are available on the ISO website.[22]

3.1.3 Changes Made to Study Files

No changes were made to intermediate study files.

3.1.4 Peak Load Dispatches

For the creation of peak load case generation dispatches, a cumulative probability distribution for non-renewable generation unavailability was created using outage rates based on historical generation availability. For further information and an explanation of the origin of the values used for the calculation of the generator unavailability probability, please refer to Section 2.3.5 of the Transmission Planning Technical Guide.[23] Renewable resources such as hydro, wind, and PV were modeled in the base cases and were dispatched based on historical data. The renewable resources were thereby excluded from the probability based MW unavailability calculation. A summary of the

[22] https://www.iso-ne.com/system-planning/key-study-areas/ western-and-central-massachusetts/
[23] https://www.iso-ne.com/static-assets/documents/2017/11/transmission_planning_technical_guide_rev2.pdf

renewable generation dispatch assumptions is shown in Table 3-4. For further details, please refer to the Transmission Planning Technical Guide,[23] Sections 2.3.7-2.3.10.

Table 3-4:
Renewable generation dispatch

Renewable Generator Type[24]	Dispatch in Base Case
Daily Cycle Hydro (with CSO)	Min(Historical Output[25], Summer Qualified Capacity (QC))
In-service Daily Cycle Hydro associated with Mills in Maine (w/o CSO)	10% of Summer NRC
Weekly Cycle Hydro (with CSO)	Min(Historical Output[25], Summer QC)
On-shore Wind (with CSO)	Min(5% of summer NRC, Summer QC)
Off-shore Wind (with CSO)	Min(20% of summer NRC, Summer QC)
Photovoltaic (with CSO)	Min(26% of summer NRC, Summer QC)
In-service Photovoltaic included in PV forecast (w/o CSO)	26% of Summer NRC
Pumped Storage Hydro Units[26]	Up to 50% of Summer QC[27]

The most up-to-date voltage schedules obtained from Operation Procedure 12 (OP-12) Appendix B[28] were utilized in this study.

Given the aforementioned assumptions, base case dispatches for 90/10 peak load cases were developed following a three step procedure. Initially, renewable generation was dispatched at the level described in Table 3-4, and all inter-area ties were set up at the desired value while respecting the interface ranges specified in Table 3-5.

[24] In general, renewable generators without a CSO through the FCM are assumed OOS in the base cases. The exceptions to these instances where renewable generators that do not have a CSO are modeled online are noted in the table.

[25] If historical data is not available, 10% of Summer NRC is used.

[26] The pumped storage hydro at Rocky River is treated as a daily cycle unit.

[27] The pumped storage hydro at Northfield or Bear Swamp may be dispatched below 50% if they are being used as reserves.

[28] https://www.iso-ne.com/static-assets/documents/rules_proceds/operating/isone/op12/op12b_rto_final.pdf

Table 3-5:
Interface Ranges for External Interfaces

Inter-area Interface	Minimum Transfer Tested (MW)	Maximum Transfer Tested (MW)
NB-NE	0[29]	700[30]
NY-NE	0[31]	1,400[30]
Phase II Imports	950[32]	1,400[30]
CSC Imports	0[29]	0[30]
Highgate Imports	200[33]	200[30]

For the WCMA study area, the two external interfaces with the most impact are Phase II Import and NY-NE transfers. Phase II Imports are tested at the maximum level of 1,400 MW and NY-NE at the minimum of 0 MW in the East-West dispatches ("A" dispatches). Conversely, Phase II Imports are tested at the minimum level of 950 MW and NY-NE at the maximum of 1,400 MW in the West-East dispatches ("B" dispatches).

MW unavailability was calculated probabilistically for several generator groups. Such generator groups included the study area, the receiving end of any needed system stress, and the combination of the study area with each relevant adjacent area.

Table 3-6 shows the generator characteristics germane to the generator group representing the WCMA study area.

Table 3-6:
WCMA Generator Group Characteristics

Generator Group Characteristic	Value
No. of non-Renewable Generators	23
Total Capacity of Non-Renewable Generators	1,806 MW
Variable Probability Threshold[34]	1.93×10^{-4}
Maximum MW Unavailable at 90/10 Peak Load	388 MW
Capacity of Largest Generator in WCMA	338 MW (Millennium)

Since generators are not evenly distributed throughout the WCMA study area, groups of generators were identified and additional MW unavailability calculations were performed for each of these

[29] There are no long-term contracts for imports on this interface

[30] The maximum import tested on these interfaces is the capacity import capability on the interface. The details of the capacity import capability are in https://smd.iso-ne.com/operations-services/ceii/pac/2017/03/a8_fca_12_zonal_boundary_determination.pdf

[31] While there are currently 81.8 MW of long term contracts in place over the NY to NE interface, they are due to expire on 8/31/2025, which is prior to the study year of 2029 and therefore cannot be relied upon. The 81.8 MW of long term contracts is bounded by the proposed transfer levels of 0 and 1,400 MW.

[32] 950 MW value is based on a review of the Hydro-Quebec Interconnection Capability Credit (HQICC) in the past five FCA auctions.

[33] Highgate is modeled at its capacity import capability based on a long-term contract to import power.

[34] The calculations to obtain the probabilistic threshold are described in section 3.1.3 of the Transmission Planning Technical Guide.

groups. These additional groups of generators and their associated MW unavailable calculations were used to ensure that the probabilistic dispatch methodology is respected on a more granular basis. In the WCMA study area, three (3) groups of generators were identified and shown below. Due to the ISO-NE Information Policy[35] and the sensitive nature of the generator outage history (EFORd values) used in the MW unavailable calculations, the MW unavailable threshold (MWUT) for some generator group(s) may not be reported.

- Berkshire Group – Altresco, Doreen, and Woodland Road (3 units), MWUT not reported
- Springfield Group – Berkshire Power, Front Street Diesels 1-3, Mass Power, Springfield Refuse, Stony Brook and West Springfield (11 units), MWUT = 351 MW
- Eastern Group – Cherry Street (5 units), Lenergia, Shrewsbury Diesels, and WMI Millbury, (8 units), MWUT = 77 MW

For the WCMA 2029 Needs Assessment, the following stresses were evaluated. Each stress is defined by the combination of Study Area and Adjacent Area and the Receiving End of system stress.

Table 3-7:
System Stresses Evaluated

Stress	Adjacent Area	Receiving End of System Stress
E-W Stress (A Dispatches)	CT[36]	Western New England
W-E Stress (B Dispatches)	Boston[37]	Eastern New England

Table 3-8 shows the generator characteristics germane to the generator group representing WCMA and CT.

Table 3-8:
WCMA and CT Generator Group Characteristics

Generator Group Characteristic	Value
No. of non-Renewable Generators	58
Total Capacity of Non-Renewable Generators	8,513 MW
Variable Probability Threshold[34]	4.63×10^{-4}
Maximum MW Unavailable at 90/10 Peak Load	1,242 MW
Capacity of Largest Generator in WCMA + CT	1,283 MW (Millstone 3)

[35] Attachment D to the ISO Tariff, ISO New England Information Policy, https://www.iso-ne.com/static-assets/documents/regulatory/tariff/attach_d/attachment_d.pdf

[36] CT area is equivalent to the State of Connecticut minus the SWCT Import zone.

[37] Boston area is equivalent to the Boston Import zone.

Table 3-9 shows the generator characteristics germane to the generator group representing WCMA and Boston.

Table 3-9:
WCMA and Boston Generator Group Characteristics

Generator Group Characteristic	Value
No. of non-Renewable Generators	53
Total Capacity of Non-Renewable Generators	3,182MW
Variable Probability Threshold[34]	2.48×10^{-4}
Maximum MW Unavailable at 90/10 Peak Load	536 MW
Capacity of Largest Generator in WCMA + Boston	345 MW (Salem 5 or Salem 6)

Table 3-10 shows the generator characteristics germane to the generator group representing Western New England (Western NE) which includes the receiving end of the system stress for the WCMA 2029 Needs Assessment (A dispatches).

Table 3-10:
Western NE Generator Group Characteristics

Generator Group Characteristic	Value
No. of non-Renewable Generators	106
Total Capacity of Non-Renewable Generators	11,992 MW
Variable Probability Threshold[34]	6.03×10^{-4}
Maximum MW Unavailable at 90/10 Peak Load	1,395 MW
Capacity of Largest Generator in Western NE	1,283 MW (Millstone 3)

Table 3-11 shows the generator characteristics germane to the generator group representing Eastern New England (Eastern NE) which includes the receiving end of the system stress for the WCMA 2029 Needs Assessment (B dispatches).

Table 3-11:
Eastern NE Generator Group Characteristics

Generator Group Characteristic	Value
No. of non-Renewable Generators	118
Total Capacity of Non-Renewable Generators	14,831 MW
Variable Probability Threshold[34]	7.17×10^{-4}
Maximum MW Unavailable at 90/10 Peak Load	1,311 MW
Capacity of Largest Generator in Eastern NE	1,299 MW (Seabrook)

Once the unavailability levels for each generator group were defined, initial dispatches were created respecting the maximum unavailable MW levels for each generator group as an "upper" boundary, while also considering all single generator unavailable dispatches to be acceptable.

A few more rules apply when creating dispatches.

- No more than two generators will be assumed to be simultaneously unavailable at a bus/station in any dispatch
- In groupings where there is a large generator along with multiple smaller generators (unit size discrepancy), the upper limit of generation outages is recalculated using the probabilistic method by excluding the large generator(s) for dispatches with the large generator(s) in service

For further information, please refer to the November 16, 2017 PAC presentation[38] and Section 4.1.1 of the Transmission Planning technical guide.[39]

Next, reserves were dispatched off-line following a defined priority order. First priority was given to weekly hydro generators in either the study area or the receiving end of a system stress. The next priority level was assigned to non-renewable generators (including offline fast start units) and pumped storage facilities in the receiving end of the system stress. Lastly, the third priority level was given to non-renewable generators in the sending end. No reserves were established in the load zone containing the area of study, with the exceptions of weekly cycle hydro units. Such generators are dispatched at a de-rated level in the base case, and are assumed to be available for re-dispatch up to their maximum MW rating post first contingency, unless otherwise noted.

Finally, non-renewable generators were turned off as needed in order to establish the proper energy balance that results from the set import levels, the dispatch of renewable generation, and the generators that are offline when establishing unavailable generators and generators used for reserves. Generation may also be turned off to ensure that no transfer limit was violated when establishing generation dispatches, reserves and energy balance.

For the WCMA 2029 Needs Assessment, for dispatches with an East to West stress (A Dispatches), there were 172 MW available for reserves from weekly hydro units in Western New England including the study area (receiving end of system stress) and the remaining 1,028 MW from non-renewable generation in Western New England (receiving end of system stress).

For the WCMA 2029 Needs Assessment, for dispatches with a West to East stress (B Dispatches), there were 187 MW available for reserves from weekly hydro units in the study area and Eastern New England, 704 MW from non-renewable generation in the Eastern New England (receiving end of system stress), and 309 MW of non-renewable generation in the Western New England (sending end of the system stress).

At the end of this process a total of 10 dispatches were created:

- Five East to West stress (A Dispatches)

[38] https://www.iso-ne.com/static-assets/documents/2017/11/a6_transmission_planning_assumptions_methodology_implementation_and_min_load_level.pdf
[39] https://www.iso-ne.com/static-assets/documents/2017/03/transmission_plannings_techincal_guide_rev5.pdf

- Five West to East stress (B Dispatches)

There are two pumped storage hydro plants in the WCMA study area; J. Cockwell (Bear Swamp) and Northfield Mountain. As noted in Table 3-4 above, pumped storage hydro plants are typically dispatched at 50% of QC. However, Section 2.3.9 of the ISO-NE Transmission Planning Technical Guide states "In transmission Needs Assessments and Solutions Studies addressing the area that includes a pumped storage hydro facility, the facility(ies) in that area may also be dispatched at their maximum and/or minimum values to ensure that they can be utilized to serve load when they are available since they are often utilized in operations to provide reserve". For the WCMA Needs Assessment both the 50% of QC and maximum value (100% QC) are used. Specifically, in the East-West dispatches ("A" dispatches) with Western New England as the receiving end of the system stress, Bear Swamp and Northfield Mountain are dispatched at 50% of QC. Conversely, in the West-East dispatches ("B" dispatches) with Eastern New England as the receiving end of the system stress, Bear Swamp and Northfield Mountain are dispatched at 100% of QC.

Major generation units deemed unavailable for each dispatch are provided in Table 3-12 and Table 3-13. The transfer levels and generator groups' maximum unavailability for each dispatch is provided in Table 3-14. Reserve groups are shown in Table 3-15. A complete listing of reserve units for each stress is available in Table 3-16 and Table 3-17. For more detailed information about each dispatch, please refer to the case summaries in Section 9.

Table 3-12:
Generators Unavailable (East – West "A" Dispatches)

90/10 Peak Load Dispatches				
D01A	D02A	D03A	D04A	D05A
ALTRESCO	BERKSHRE_G1	MASS POWER	STONY BROOK	MILLENIUM
WEST SPRINGFIELD 3	LENERGIA	SHREWSBURY	CHERRY 12	SOUTH MEADOW 5
WMI MILLBURY	WOODLAND	FRONT STREET 1	FRONT STREET 1	TORRINGTON
SPRINGFIELD REFUSE	WEST SPRINGFIELD 2	DOREEN	SPRINGFIELD REFUSE	MIDDLETWN_G2
STONY BROOK 2	SOUTH MEADOW 5	WEST SPRINGFIELD 2	WEST SPRINGFIELD 1	MIDDLETWN_G3
SOUTH MEADOW 5	TORRINGTON	SOUTH MEADOW 5	SOUTH MEADOW 5	NEW HAVN HBR 1
TORRINGTON	MIDDLETWN_G2	TORRINGTON	TORRINGTON	JC MCNEIL
MIDDLETWN_G2	MIDDLETWN_G3	MIDDLETWN_G2	MIDDLETWN_G2	
MIDDLETWN_G3	NEW HAVN HBR 1	MIDDLETWN_G3	MIDDLETWN_G3	
NEW HAVN HBR 1	JC MCNEIL	NEW HAVN HBR 1	NEW HAVN HBR 1	
JC MCNEIL		JC MCNEIL	JC MCNEIL	

Legend	
(blue)	Generators Unavailable in Study Area
(gray)	Generators Unavailable in Adjacent Areas
(green)	Generators Unavailable in Receiving End

Table 3-13:
Generators Unavailable (West – East "B" Dispatches)

		90/10 Peak Load Dispatches		
D01B	D02B	D03B	D04B	D05B
ALTRESCO	BERKSHRE_G1	MASS POWER	STONY BROOK	MILLENIUM
WEST SPRINGFIELD 3	LENERGIA	SHREWSBURY	CHERRY 12	OGDEN MARTIN
WMI MILLBURY	WOODLAND	FRONT STREET 1	FRONT STREET 1	MBTA
SPRINGFIELD REFUSE	WEST SPRINGFIELD 2	DOREEN	SPRINGFIELD REFUSE	W. MEDWAY JET
STONY BROOK 2	OGDEN MARTIN	WEST SPRINGFIELD 2	WEST SPRINGFIELD 1	NEWINGTON
OGDEN MARTIN	W. MEDWAY JET	OGDEN MARTIN	OGDEN MARTIN	EDGAR
MBTA	NEWINGTON	MBTA	MBTA	
W. MEDWAY JET	EDGAR	W. MEDWAY JET	W. MEDWAY JET	
NEWINGTON		NEWINGTON	NEWINGTON	
EDGAR		EDGAR	EDGAR	

Legend	
(blue)	Generators Unavailable in Study Area
(gray)	Generators Unavailable in Adjacent Areas
(green)	Generators Unavailable in Receiving End

Table 3-14:
Transfer Levels and Generator Groups Maximum Unavailability

Dispatch	Load Level	Adjacent Area	MW Unavailable in Study Area Adjacent Area (Maximum MW)[40]			MW Unavailable in Receiving End (Maximum MW)[41]		External Interface Targets (Maximum Transfer Capability in MW)					Additional Interfaces (Maximum Transfer Capability in MW)		
			WCM90/10 (388)	WCM+CT 90/10 (1,242)	WCM+ Boston (536)	Western NE 90/10 (1,395)	Eastern NE 90/10 (1,331)	NY-NE (1,400)	NB-NE (700)	Phase II (1,400)	Highgate (200)	CSC (0)	East-West (3,500)	West – East (3,000)	North-South (2,725)
D01A	90/10	CT	366	1,232	NA	1,247	NA	0	700	1,400	200	0	-1,850	1,854	1,908
D02A	90/10	CT	367	1,234	NA	1,216	NA	0	700	1,400	200	0	-1,874	1,878	1,908
D03A	90/10	CT	329	1,196	NA	1,240	NA	0	700	1,400	200	0	-1,852	1,856	1,908
D04A	90/10	CT	346	1,210	NA	1,266	NA	0	700	1,400	200	0	-1,821	1,825	1,909
D05A	90/10	CT	338	1,204	NA	1,263	NA	0	700	1,400	200	0	-1,824	1,827	1,908
D01B	90/10	Boston	366	NA	494	NA	1,312	1,400	0	950	200	0	-1,669	1,681	2,591
D02B	90/10	Boston	367	NA	448	NA	1,298	1,400	0	950	200	0	-1,656	1,670	2,592
D03B	90/10	Boston	329	NA	457	NA	1,282	1,400	0	950	200	0	-1,645	1,658	2,592
D04B	90/10	Boston	346	NA	474	NA	1,273	1,400	0	950	200	0	-1,634	1,647	2,592
D05B	90/10	Boston	338	NA	466	NA	1,268	1,400	0	950	200	0	-1,628	1,641	2,592

[40] Maximum MW is the maximum unavailable MW of non-renewable generators based on probabilistic methods.
[41] Actual interface transfers may vary slightly from the targets due to power flow mismatches.

Table 3-15:
Reserve Groups

Dispatch	Adjacent Area	Stress	Receiving End	Weekly Hydro in Study Area	Weekly Hydro in Receiving End[42]	Pumped Hydro WMA	Non-Renewable Generators in Receiving End	Non-Renewable Generators in Sending End	Total (MW)
D01A	CT	E/W	Western	67	105	0	1,028	0	1,200
D02A	CT	E/W	Western	67	105	0	1,028	0	1,200
D03A	CT	E/W	Western	67	105	0	1,028	0	1,200
D04A	CT	E/W	Western	67	105	0	1,028	0	1,200
D05A	CT	E/W	Western	67	105	0	1,028	0	1,200
D01B	Boston	W/E	Eastern	67	120	0	704	309	1,200
D02B	Boston	W/E	Eastern	67	120	0	704	309	1,200
D03B	Boston	W/E	Eastern	67	120	0	704	309	1,200
D04B	Boston	W/E	Eastern	67	120	0	704	309	1,200
D05B	Boston	W/E	Eastern	67	120	0	704	309	1,200

[42] Weekly Hydro in Receiving End does not include weekly hydro units in the study area.

Table 3-16:
Reserve Units for Western New England Receiving End (A Dispatches)

Unit	Reserve MW[43]
Harriman 1,2,3 (Weekly Hydro)	38.0
Shepaug Hydro (Weekly Hydro)	38.2
Cobble Mountain 1, 2 and 3 (Weekly Hydro)	26.1
Wilder (Weekly Hydro)	28.6
Stevenson (Weekly Hydro)	24.7
Milton (Weekly Hydro)	6.8
Marshfield (Weekly Hydro)	4.0
Sherman Hydro (Weekly Hydro)	3.0
Clark Falls (Weekly Hydro)	2.4
Glen Hydro (Weekly Hydro)	0.1
A.L Pierce (Fast Start)	74.1
Middletown 12 (Fast Start)	48.4
Middletown 13 (Fast Start)	48.4
Middletown 14 (Fast Start)	48.4
Middletown 15 (Fast Start)	48.4
Devon 15 (Fast Start)	48.3
Devon 16 (Fast Start)	48.3
Devon 17 (Fast Start)	48.3

[43] The available reserve MWs are the difference between the modeled PMax and PGen of a given unit. For example, a weekly hydro dispatched at 10 MW, but with a PMax of 30MW, will have a 20MW reserve capability.

Devon 18 (Fast Start)	48.3
Wallingford 1(Fast Start)	48.3
Wallingford 2(Fast Start)	48.3
Wallingford 3(Fast Start)	48.3
Wallingford 4(Fast Start)	48.3
Wallingford 5(Fast Start)	48.3
Wallingford 6(Fast Start)	48.3
Wallingford 7(Fast Start)	48.3
NHHP 2 (Fast Start)	44.9
Cos Cob 11 (Fast Start)	18.7
Cos Cob 12 (Fast Start)	18.7
Bridgeport Harbor 4 (Fast Start)	17.0
Tunnel Jet 10 (Fast Start)	15.6
Branford Jet (Fast Start)	15.8
Montville (Fast Start)	2.7
Waterbury (Fast Start)	97.4

Table 3-17:
Reserve Units for Eastern New England Receiving End (B Dispatches)

Unit	Reserve MW[44]
Harriman 1,2,3 (Weekly Hydro)	38.0
Cobble Mountain 1, 2 and 3 (Weekly Hydro)	26.1
Sherman Hydro (Weekly Hydro)	3.0
Comerford 1,2,3 (Weekly Hydro)	99.8
MCKAY Gen3 (Weekly Hydro)	9.8
Harris Hydro 1 and 4 (Weekly Hydro)	10.6
Canal 3 (Fast Start)	337.9
TA Watson 1 (Fast Start)	53.8
TA Watson 2 (Fast Start)	53.8
Cos Cob 12 (Fast Start)	18.7
Devon 15 (Fast Start)	48.3
Devon 16 (Fast Start)	48.3
Devon 17 (Fast Start)	48.3
Devon 18 (Fast Start)	48.3
West Medway J1 (Fast Start)	102.1
West Medway J2 (Fast Start)	102.1
West Medway J3 (Fast Start)	42.0

[44] The available reserve MWs are the difference between the modeled PMax and PGen of a given unit. For example, a weekly hydro dispatched at 10 MW, but with a PMax of 30 MW, will have a 20 MW reserve capability.

West Tisbury (Fast Start)	5.0
Oak Bluffs (Fast Start)	7.5
Wallingford 6(Fast Start)	48.3
Wallingford 7(Fast Start)	48.3

3.1.5 **Peak Load PV Sensitivity Dispatches**

A sensitivity analysis was performed incorporating the National Grid Western MA DER Cluster Study Group 1 that consists of 320 MW of PV in the WCMA study area. The PV was modeled at 26% of the stated capacity per Table 3-4 above.

The PV was modeled at the locations specified in the National Grid Western MA DER Cluster Study Group 1. The locations are shown in Figure 3-1 and Figure 3-2 below. Figure 3-1 shows the approximate geographical location of all the PV in WCMA while Figure 3-2 shows the PV in the 69 kV corridor between Vernon and Pratts Jct. where the voltage violations discussed in Section 5.2.1 occur. Table 3-18 provides the same information in list format.

Dispatches D03A and D03B were used to conduct the sensitivity analysis. These dispatches were chosen since they consistently produced the lowest post-contingency voltages.

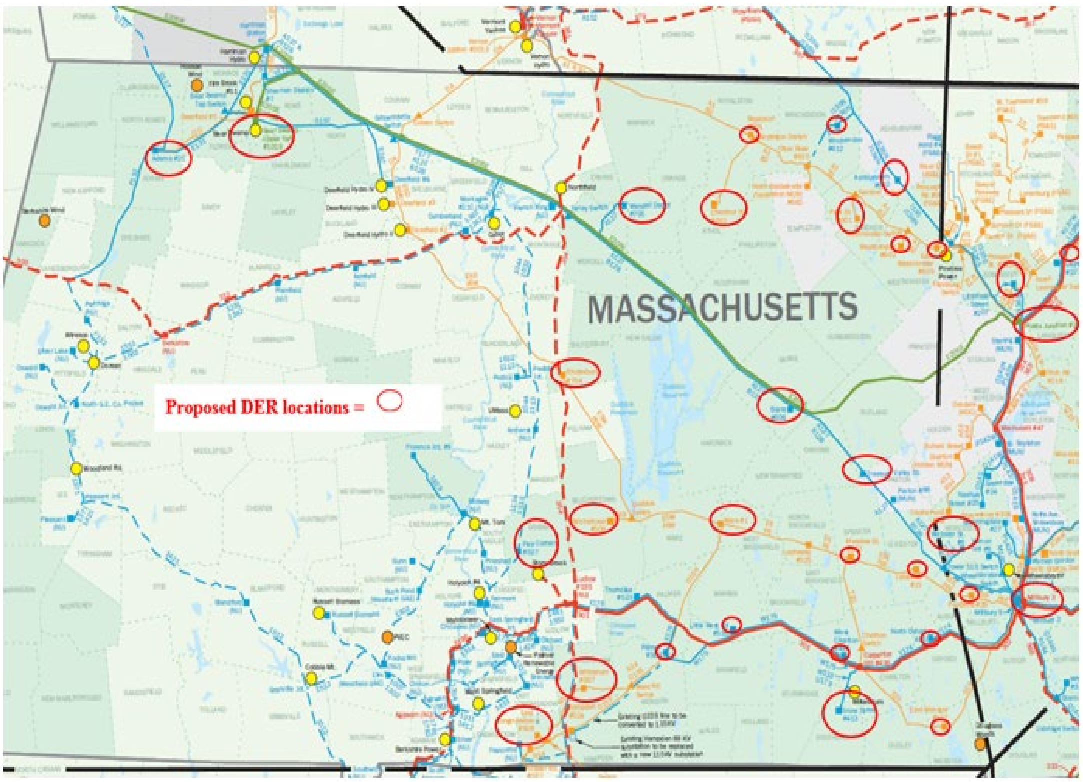


Figure 3-1
Locations of the PV in the National Grid Western MA DER Cluster Study Group 1

[redacted]

Figure 3-2
PV in the A-1 and B-2 69 kV Corridor in the National Grid Western MA DER Cluster Study Group 1

Table 3-18
PV Capacity and PV Modeled in the WCMA NA Sensitivity

Substation	PV Capacity (MW)	PV Modeled (MW) (26% of capacity)	Substation	PV Capacity (MW)	PV Modeled (MW) (26% of capacity)
Adams	20.81	5.41	Little Rest Road	15.43	4.01
Ashburnham	9.51	2.47	Meadow Street	14.17	3.68
Barre	15.12	3.93	Millbury	13.32	3.47
Bear Swamp Upper Yard	2.75	0.72	North Oxford	8.70	2.26
Belchertown	12.98	3.37	Palmer	16.82	4.37
Chestnut Hill	8.94	2.32	Pondville	4.87	1.27
Crystal Lake	16.93	4.40	Snow Street	14.84	3.86
East Webster	4.98	1.29	Thorndike	12.44	3.24

East Westminster	9.96	2.59	Treasure Valley	4.23	1.10
East Winchendon	3.90	1.01	West Charlton	22.51	5.85
East Longmeadow	8.99	2.34	Ware	13.14	3.42
Five Corners	3.00	0.78	Wendell Depot	14.97	3.89
Lashaway	17.17	4.46	West Hampden	15.67	4.07
Leicester	2.58	0.67	Westminster	4.87	1.27
Litchfield	4.95	1.29	Wilbraham	6.4	1.66

3.1.6 **Minimum Load Dispatch**

A single minimum load generation dispatch was evaluated for the WCMA 2029 minimum load study. The single dispatch evaluated two levels of New York to New England transfers; 0 MW and 1,400 MW. In addition, Phase II imports were model at three levels; 0 MW, 500 MW and 1,400 MW. The Norwalk Northport Cable was set to 0 MW in all cases. Table 3-19 summarizes system stresses applied to the minimum load dispatch.

Table 3-19:
Minimum Load Case Stress Summary

Case Stress	NY to NE (MW)	Phase II (MW)
1A	0	1,400
1B	1,400	0
1C	0	500

In the WCMA study area, there are resources that run most hours of the year. These units include refuse/biomass resources and hydro units. These generators were assumed online. Table 3-20 lists the status of generators with a PMax of 5 MW or greater significant to the WCMA study area that are in-service in the dispatch. All other generators with a PMax of 5 MW or greater significant to the WCMA study area are assumed out-of-service. The pumped hydro units in western Massachusetts are kept offline. The dispatches have low transfers across major interfaces internal to New England. The details of the minimum load dispatches are available in the case summaries in Section 9.

Table 3-20:
Dispatched Generators in Minimum Load in the WCMA

Generator	PMax (MW)	WCMA Minimum Load Status
Vernon	32.0	On
WMI Millbury	39.8	On
Cabot	61.5	On
Springfield Refuse	5.3	On
Deerfield	18.6	On

Due to the electrical distance between the NECEC, Vineyard Wind and Revolution Wind projects and the WCMA study area, the reactive capability of the projects is not expected to have a significant impact on minimum load needs in the WCMA area. Therefore, the projects were excluded from the minimum load analysis.

3.1.7 Reactive Resource and Dispatch Assumptions

All area shunt reactive resources were assumed available and dispatched when required. Reactive output of generating units were modeled to reflect defined limits. A summary of the reactive output of units and shunt devices connected to the transmission system that played a significant role in the study area can be found in the power flow case summaries included in Section 9.

For the minimum load study base cases, all area shunt capacitors were assumed offline and all shunt reactors were assumed to be available.

3.1.8 Protection and Control System Devices Included in the Study Area

There are 4 Special Protection Systems that affect the WCMA study area:

- Carpenter Hill 115 kV [redacted]
- Altresco [redacted]
- Carpenter Hill Line [redacted]
- Tillson [redacted]

[redacted]

[redacted]

The SPS(s) above are assumed to operate for all normal contingencies that would require SPS operation. Additionally, the impact of the failure of a breaker to operate when initiated by an SPS was also evaluated if the SPS is operated for the following events:

a. Breaker opening without a fault
b. Permanent phase-to-ground fault with normal fault clearing on any
    i. Transmission Circuit
    ii. Transformer
    iii. Bus Section
    iv. Shunt device
    v. Generator
c. Loss of the following without a fault:
    i. Transmission Circuit
    ii. Transformer
    iii. Bus Section
    iv. Shunt device
    v. Generator

The Carpenter Hill 115 kV Breaker Failure SPS is initiated solely for breaker failure contingencies which are not covered in the events listed above, and hence no additional analysis is required.

[redacted]

3.1.9 Explanation of Operating Procedures and Other Modeling Assumptions

There are no operating procedures or other modeling assumptions that affect the WCMA study area.

3.2 Stability Modeling Assumptions

Not applicable for this study.

3.3 Short Circuit Model Assumptions

3.3.1 Study Assumptions

The short circuit study evaluated the projected 2023 available fault current levels around the WCMA area. There are no significant projects expected in the 2023-2029 timeframe that would impact the short circuit performance of the study area, and hence the 2023 case was considered acceptable.

A short-circuit analysis was performed with all transmission and generation projects that received a Proposed Plan Application (PPA) approval before May 1, 2019 included. NECEC and Revolution Wind do not have PPA approval while Vineyard Wind does have PPA approval. Regardless of whether the projects have PPA approval or not, the projects are not expected to have a significant impact on WCMA area short-circuit duties. Therefore, the projects were excluded from the short-circuit analysis.

Mystic 7 and Jet have accepted retirement de-list bids, will be retired on or before May 31, 2022, and therefore were excluded from the short circuit case. Although Mystic 8 and 9 have been retained on a cost-of-service basis pursuant to Tariff language that permits retentions for fuel security reasons, they are to be retired on May 31, 2024. Therefore they have been modeled as out of service.

All generators with the exception of Mystic 8 and 9 were considered online for this analysis.

3.3.2 Short Circuit Model

The ASPEN Circuit Breaker Rating Module software was used to calculate all PTF circuit breaker duties. The 2023 short circuit base case is a base case that includes the impact of all PPA approved transmission projects and all reliability projects that are "Proposed", "Planned" or "Under Construction" in the RSP Project listing. There are no significant projects expected in the 2023 - 2029 timeframe that would impact the short circuit performance of the study area, hence the 2023 base case was considered acceptable.

The 2023 short circuit base case also includes any changes that have been submitted by transmission owners to existing transmission equipment. The models for the 345/115 kV autotransformers located at Mystic and K Street were updated to reflect the neutral grounding reactors that were installed as a part of PPA ES-19-T02 and ES-19-T03.[45]

The significant difference between the steady-state model used for the Needs Assessment and the short circuit model is that the short circuit model includes the impact of all Queue projects that do not have an FCM obligation which have a PPA approval before May 1, 2019. While these facilities cannot be relied to resolve a reliability need (and are therefore not considered in the steady state

[45] https://smd.iso-ne.com/operations-services/ceii/rc/2019/02/a2_1a_neutral_grounding_reactor_installation_for_mystic_and_k_street_lvl1_ppas_es_19_t02_es_19_t03.zip

analysis), they do contribute to the available short circuit current as they may be in service as part of the energy dispatch of the system.

3.3.3 Other Relevant Modeling Assumptions

Not applicable for this study.

Section 4
Analysis Methodology

4.1 Planning Standards and Criteria

The applicable NERC, NPCC and ISO-NE standards and criteria were tested as part of this evaluation. Descriptions of each of the NERC, NPCC and ISO-NE standard tests that are used to assess system performance are discussed later in this section.

4.2 Performance Criteria

4.2.1 **Steady State Criteria**

The Needs Assessment was performed in accordance with the applicable requirements of the following:

- NERC TPL-001-4 "*Transmission Planning Performance Requirements*",
- NUC-001-3 "*Nuclear Plant Interface Coordination*",
- NPCC Regional Reliability Reference Directory #1, *"Design and Operation of the Bulk Power System*", dated 09/30/15, and
- ISO Planning Procedure No. 3, "*Reliability Standards for the New England Area Pool Transmission Facilities*", dated 09/15/2017.

4.2.1.1 *Steady State Thermal and Voltage Limits*

Loadings on all PTF in the WCMA study area and in the neighboring portions of CT, NH, VT and Boston were monitored. The thermal violation screening criteria defined in Table 4-1 was applied.

Table 4-1:
Steady-State Thermal Criteria for Planning Contingencies

System Condition	Maximum Allowable Facility Loading
All Lines In	Normal Rating
Post-Contingency Post Switching	Long Time Emergency (LTE) Rating

Voltages were monitored at all PTF buses in the WCMA study area and in portions of the CT, NH, VT, and Boston neighboring areas which are in close proximity to the WCMA study area. System bus voltages outside of limits identified in Table 4-2 were identified for all normal (pre-contingency) and post-contingency conditions.

Table 4-2:
Steady-State Voltage Criteria for Planning Contingencies

Facility Owner[46]	Voltage Level (kV)	Bus Voltage Limits (Per-Unit)		
		Normal Conditions (N-0)	Emergency Conditions (Post-Contingency)	
			Pre-Switching	Post-Switching
Eversource	69 and above	0.95-1.05	0.90-1.05	0.95-1.05
National Grid	69 to 115	0.95-1.05	0.90-1.05	0.95[47]-1.05
	230 and above	0.98-1.05		0.95-1.05
Vermont Electric Power Company	115	0.95-1.05	0.90-1.05	0.95-1.05
	230 and above	0.98-1.05		
Millstone/Seabrook[48]	345	1.00-1.049	1.00-1.049	1.00-1.049
Sandy Pond HVDC Terminals	345	1.00-1.05	1.00-1.05	1.00-1.05

Additionally, the transmission ties to the New York control area were monitored.

Note that when applying thermal and voltage criteria the following applicability was used:

46 For buses owned by municipalities, the interconnecting TO's voltage criteria is used.

47 All non-BPS National Grid buses can have a voltage as low as 0.9 p.u. as long as the post contingency, post adjustment, voltage deviation is less than 10%.

48 This is in compliance with NUC-001-3, *"Nuclear Plant Interface Coordination Reliability Standard,"* adopted August 5, 2009. Further information is documented in the appendices to the Master Local Control Center Procedure 1.

Table 4-3:
Criteria Applicability

Criteria Contingencies	Criteria Contingencies applied to	Elements monitored for Criteria Violations
NERC TPL-001-4 Planning Events	Elements 100 kV or higher[49,50]	PTF portion of the BES
NPCC Directory 1 Planning Contingencies	Elements 69 kV or higher[49,50]	PTF portion of the BPS
ISO-NE PP3 Contingency Events	Elements 69 kV or higher[49,50]	PTF

As a part of the analysis, non-PTF facilities that are 69 kV and above were monitored and any overloads or voltage violations on these facilities were reported in Section 12. However, these violations are not reported as needs in the body of the Needs Assessment report.

4.2.1.2 *Steady State Solution Parameters*

The steady-state analysis was performed with pre-contingency solution parameters that allow for adjustment of load tap-changing transformers (LTCs), shunt reactive devices (including automatically-switched capacitors), and Phase Shifting Transformers (PST). Table 4-4 displays these solution parameters.

Table 4-4:
Study Solution Parameters

Case	Area Interchange Control	LTC Adjustments	Adjust Phase Shift	Shunt Reactive Device Adjustment		DC Taps
				Discrete	Continuous[51]	
Base	Tie Lines and Loads Enabled	Stepping	Enabled	Adjusting	Adjusting	Adjusting
Contingency Pre-Switching	Disabled	Disabled	Disabled	Disabled	Adjusting	Disabled
Contingency Post-Switching	Disabled	Stepping[52]	Disabled	Disabled	Adjusting	Adjusting

[49] This includes generators and generator step-up transformers connected directly to 69 kV or higher.

[50] Excludes distribution transformers connected to 69 kV or higher.

[51] Continuous shunt reactive device includes: FACTS devices like SVC, STATCOM, etc., that are modeled by a shunt device on continuous control in the power flow cases.

[52] Applies only to transformers on automatic control.

4.2.2 Stability Performance Criteria

Not applicable for this study.

4.2.3 Short Circuit Performance Criteria

This study was performed in accordance with appropriate IEEE C37 standards and specific design parameters of the circuit breakers. This included specific considerations for total-current rated and symmetrical-current rated breakers as appropriate.

The PTF circuit breakers were evaluated for short circuit adequacy based on the following criteria:

- *Marginal duty*: Circuit breaker momentary and fault interrupting duty less than or equal to 95% and greater than 90% of the available fault current. No action required.
- *High duty*: Circuit breaker momentary and fault interrupting duty greater than 95% and less than or equal to 100% of the available fault current. No action required.
- *Over duty Condition*: Circuit breaker momentary and fault interrupting duty greater than 100%. This is considered an unacceptable operating condition requiring a solution to be developed to eliminate the over-duty condition.

The generator breakers in the study area were evaluated for informational purposes only. The generator breakers are not PTF facilities and the Needs Assessment does not identify needs for non-PTF equipment.

4.2.4 Other Performance Criteria

Not applicable for this study.

4.3 System Testing

4.3.1 Steady State Contingencies

Each base case was subjected to single element contingencies such as the loss of a transmission circuit or an autotransformer. In addition, single contingencies that may cause the loss of multiple transmission circuit facilities, such as those on a common set of tower line structures, were simulated. The steady-state contingency events in this study also included circuit breaker failures and substation bus fault conditions that could result in removing multiple transmission elements from service. A comprehensive set of contingency events, listed in Section 8, was tested to monitor thermal and voltage performance of the WCMA area and neighboring Pool Transmission Facilities. A listing of all contingency types that were tested is included in Table 4-5. Additional analyses evaluated N-1-1 conditions with an initial outage of an element followed by a contingency event. The initial elements-out-of-service that are considered is consistent with NERC TPL-001-4, NPCC Directory #1 and ISO-NE PP3 and included transmission lines, transformers, reactive devices and generators. The N-1-1 analyses examined the summer peak load and minimum load cases. For these N-1-1 cases, regional reliability standards, including ISO-NE PP3, allowed specific manual system adjustments, such as fast-start generation re-dispatch, phase-angle regulator adjustment or HVDC adjustments prior to the next design contingency event.

A class of contingencies was the loss of elements without a fault. A distinction was made in this assessment based on the nature of a no-fault contingency as follows:

- Type 1: No-fault contingencies involving the opening of a line section, that may be disconnected by the opening of more than one breaker (Designated as NF_ contingencies)
- Type 2: Breaker Open contingencies that involves the opening of a single breaker (Designated as BO_ contingencies)

For N-1 testing, all Type 1 and Type 2 contingencies above were simulated. However, for N-1-1 testing only the Type 2 contingencies were simulated as second contingencies.

To simulate Type 1 and Type 2 contingencies where the line end is open and the line charging can affect voltages on the other end of the line, separate contingencies were developed for the WCMA 2029 Needs Assessment. These contingencies are not included in the Base Case Database (BCDB) because the database that was released as a part of the 2019 Transmission Planning Base Case library does not have the contingency element type that would simulate the open end of the line. A total of 27 Type 1 and 3 Type 2 contingencies were developed for the transmission facilities in the WCMA study area.

The following rules were used to include contingencies that are critical to the WCMA study area:

1. All contingencies in the WCMA study area were included
2. All contingencies that are connected to the following substations were included: North Bloomfield, Manchester, West Medway, Fitzwilliam, Vernon, and Tewksbury 345 kV (note that Tewksbury 115 kV is included in the WCMA study area mentioned in number 1 above).

A listing of all contingency types that were tested is included in Table 4-5 and a summary of Element-out scenarios tested are provided in Table 4-6. A complete listing of the element-out scenarios can be seen in Section 8.

Table 4-5:
Summary of NERC, NPCC and/or ISO-NE Category Contingencies to be Included

Standard	Event Categories
NERC TPL-001-4	P0, P1, P2, P3, P4, P5, P6, P7
NPCC Directory 1	Performance Requirement iii, I.1, I.2, I.3, I.4[53], I.6, I.7, I.8[54], II
ISO PP3	1.0-1.6, 2.1-2.4

[53] For the purposes of this study, NPCC Category I.5 events will be covered by testing Category I.4 events; in steady state, these two types of events are modeled similarly.

[54] For the purposes of this study, NPCC Category I.9 events will be covered by testing Category I.8 events; in steady state, these two types of events are modeled similarly.

Table 4-6:
Summary of Normal Contingencies Evaluated

Normal Contingency	Number of Element Out Scenarios	Number of Contingencies Tested For N-1 Analysis	Number of Contingencies Tested For N-1-1 Analysis
Transmission Circuit	207	207	207
Transformer	94	96	96
Generator	51	52	52
Reactive Devices[55]	18	19	19
Breaker Failure[56]	N/A	505	505
Loss of Element w/o Fault[57]	N/A	189	38
Double Circuit Tower	N/A	64	64
Bus Section	N/A	27	27
Special Protection System	N/A	11	11
Special Protection System Failure[58]	N/A	15	15
Failure of a Relay (TPL P5)	N/A	0[59]	0[60]
High Voltage Direct Current (HVDC) facility	2	3	3
Total Number of Normal Contingencies	372	1,174	1,037

4.3.2 **Generation Re-Dispatch Testing**

As outlined in PP3, allowable actions after the first contingency event and prior to the second contingency event included re-dispatch of generation available within ten minutes. This was also consistent with NPCC Directory #1 and NERC TPL-001-4 where system adjustments are permitted in between contingencies for N-1-1 testing. To simulate these actions in power flow analysis, the Security Constrained Re-Dispatch (SCRD) tool in the TARA software package was used.

[55] Multiple independently switched reactive devices that are protected by a single breaker will be considered independent elements out for N-1-1 first element out.

[56] Includes the evaluation of breaker failure and bus tie contingencies.

[57] It includes breaker open without a fault and loss of an element without a fault.

[58] It includes the evaluation of failure of a breaker to operate when initiated by an SPS for events specified in Planning Procedure 3 and NPCC Directory 1.

[59] The modeling of all P5 events (loss of an element with failure of non-redundant relay) is identical to the loss of the element without a failure of a relay in steady-state studies. Hence no additional contingencies were considered to model P5 events.

[60] Modeling of TPL-001 P5 events (loss of an element with failure of non-redundant relay) is not required for N-1-1 analysis.

During the analysis, all on-line generation was allowed to be reduced or turned off to mitigate a thermal violation, with the exception of nuclear units. Simultaneously, up to 1,200 MW of reserves were modeled as available to be dispatched on. The reserve units are comprised of fast start units, units dispatched at less of their PMax, and other categories as described in Table 3-13. For base cases with imports modeled from adjacent areas, the transfer levels on the import interface could be reduced to 0 MW while respecting the maximum of 1,200 MW of resources that were allowed to be dispatched on within New England.

Note that system adjustments were not performed between the first and second contingencies to prevent thermal and voltage violations on PTF facilities that are not an NPCC Bulk Power System (BPS) facility if the violation only occurs for multi-element contingencies as a second contingency.[61] These contingencies were excluded because they are not valid second contingencies per NERC TPL-001-4 and ISO-NE PP3 criteria. Violations on these elements were reported in Section 12, but were not identified as needs. Note that if these non-BPS elements with thermal or voltage violations are classified as BPS elements in the future, additional analysis will need to be performed to determine if system adjustments are effective in resolving the violations before categorizing the violations as needs.

4.3.3 **Critical Load Level (CLL) Analysis**

Based on stakeholder feedback at the March 15, 2018 PAC meeting, ISO-NE has discontinued performing critical load level (CLL) analysis as part of Needs Assessments.

4.3.4 **Time-Sensitivity and Need-by date Determination**

A time-sensitivity analysis was performed for each PTF need that is identified at peak load levels as a part of steady-state analysis. For all time-sensitive needs observed at peak load, the need-by date is set to June 1st of the time-sensitive year based on the methodology documented in Section 4.1.4 of the Transmission Planning technical guide[62]. All thermal and voltage violations observed at the minimum load level of 7,513 MW are considered time-sensitive because the load level is possible under current day system conditions.

For the WCMA 2029 Needs Assessment, the need-by date for the peak load time-sensitive needs is set to June 1, 2022.

4.3.5 **Stability Contingencies / Faults Tested**

Not applicable for this study.

4.3.6 **Short Circuit Faults Tested**

This study included testing of all PTF substations and breakers in the WCMA study area as well as select substations and breakers in neighboring portions of the CT, NH, VT and Boston. Additionally, generator breakers in the study area for which modeling information is available in the short circuit base case were evaluated.

[61] The excluded multi-element contingencies are breaker failure contingencies, double-circuit tower contingencies, and bus section contingencies.

[62] https://www.iso-ne.com/static-assets/documents/2017/03/transmission_plannings_techincal_guide_rev5.pdf

The ASPEN circuit breaker rating module software was used to calculate all circuit breaker duties. The pre-fault operating voltage for the WCMA study area buses are as shown in Table 4-7. Figure 4-1, Figure 4-2, and Figure 4-3 show the ASPEN options that were used in this study.

Table 4-7:
Pre-fault voltages for short-circuit study

Pre-Fault Voltages for Short Circuit Study	
Transmission Owner	**Voltage (p.u.)**
National Grid	1.03
Eversource - NSTAR	1.03
Eversource - CL&P, WMECO, PSNH	1.04
Vermont Electric Power Company	1.05

Figure 4-1
Short Circuit Testing Parameters—Fault Simulation Options

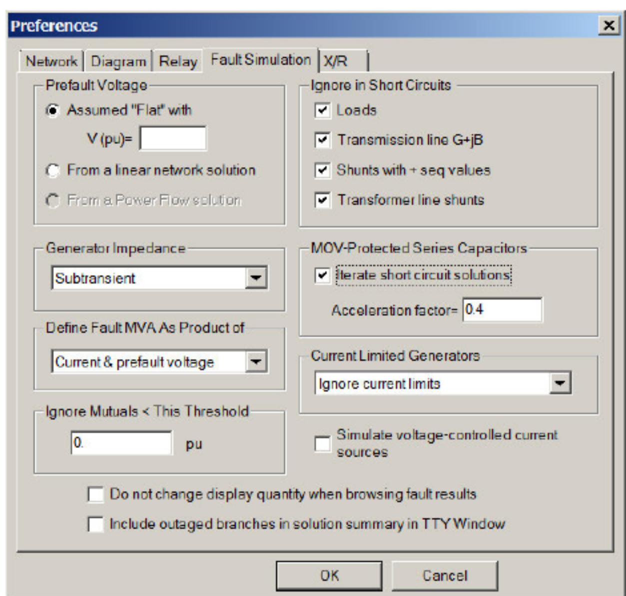


Figure 4-2
Short Circuit Testing Parameters—X/R Options

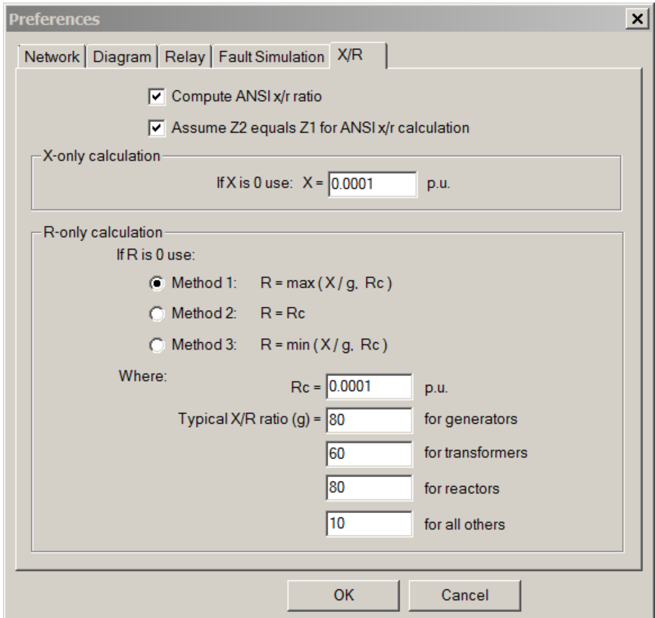
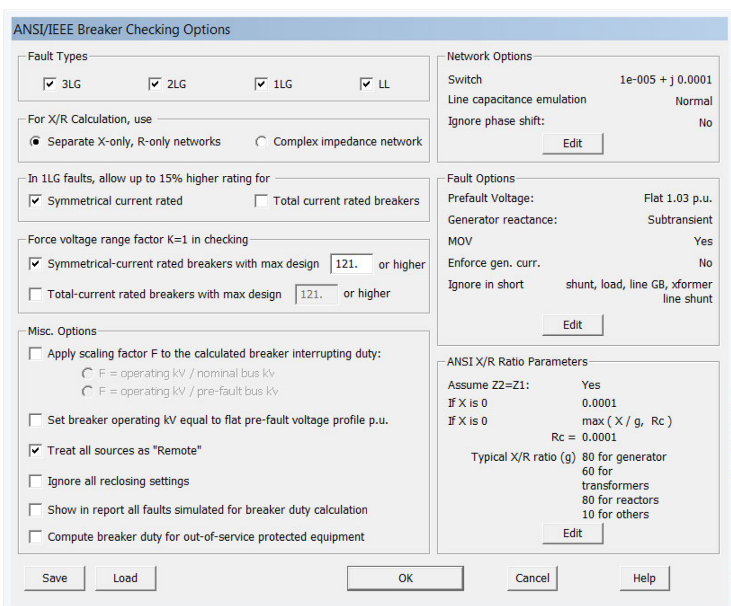


Figure 4-3
Short Circuit Testing Parameters—ANSI/IEEE Breaker Checking Options



Section 5
Results of Needs Assessment

5.1 Overview of Results

Only PTF needs are shown and discussed in the body of the report. PTF needs are those needs that will be solved during the Solutions Study or the competitive solution process. Potential non-PTF concerns identified as a result of the analysis are shown in Section 11. No attempt was made to conduct further analysis, e.g. generator re-dispatch, to mitigate the potential non-PTF concerns.

Additionally, system adjustments were not performed between the first and second contingencies to prevent thermal and voltage violations on PTF facilities that are not an NPCC BPS facility if the violation only occurs for multi-element contingencies as a second contingency[63]. These contingencies were excluded because they are not valid second contingencies per NERC TPL-001-4 and ISO-NE PP3. Violations on these elements were reported in Section 11, but were not identified as needs. Note that if these non-BPS elements with thermal or voltage violations are classified as BPS elements in the future additional analysis will need to be performed to determine if system adjustments are effective in resolving the violations before categorizing the violations as needs.

The WCMA Needs Assessment included steady-state analysis and short circuit analysis. The steady-state analysis was performed at the peak load level and at the minimum load level. The details of the steady-state analysis are provided in Section 5.2. The details of the short circuit analysis are provided in section 5.4.

5.2 Steady-State Results

No thermal or voltage violations were observed for the studied N-0 conditions. A number of post-contingency voltage violations and no thermal violations were observed in the peak load cases modeled for the N-1 and N-1-1 conditions. There were no thermal or voltage violations observed in the minimum load case modeled under N-1, and N-1-1 conditions.

5.2.1 Steady State Peak Load Results

5.2.1.1 *N-0 Thermal and Voltage Violations Summary*

N-0 (also known as "all-lines-in") conditions were reviewed for the cases modeled. The results indicate that under all tested dispatch and transfer level conditions at peak load there were no N-0 thermal overloads and no N-0 voltage violations.

The details of the N-0 testing results are together with N-1 results included in Section 12.

5.2.1.2 *N-1 Thermal and Voltage Violations Summary*

N-1 testing was performed for all of the system conditions described in Section 4.3. The results indicate that under all tested dispatch and transfer level conditions at peak load there were no N-1

[63] The excluded multi-element contingencies are breaker failure contingencies, double-circuit tower contingencies, and bus section contingencies.

thermal violations and there were N-1 voltage violations in the WCMA study area. The N-1 voltage violations are shown below in Table 5-1 and Figure 5-1 and Figure 5-2.

Table 5-1
N-1 WCMA Voltage Violations

Bus Name	Base kV	Dispatch	Contingency	Base Case Voltage (p.u.)	Worst Case Post Contingency Post switching Voltage (p.u.)[47]	Delta V (p.u.)[47]
East Westminster B2	69	A and B	BF_PRAT_TIE (Loss of the 1 and 2 69 kV busses)	1.028	0.912	0.116
Crystal Lake	69	A	BF_PRAT_TIE	1.026	0.920	0.106
Westminster B2	69	A and B	BF_PRAT_TIE	1.027	0.913	0.113

[redacted]

[redacted]

Figure 5-2
WCMA N-1 Voltage Violations Diagram

The voltage violations occurred in all tested dispatches for a single N-1 contingency event; a breaker failure of the Pratts Jct. 69 kV bus tie breaker (BF_PRAT_TIE). This breaker failure contingency results in the loss of both the Pratts Jct. 69 kV buses which disconnects the 69 kV lines at Pratts Jct. The A-1S and B-2S 69 kV lines are served radially from Vernon 69 kV, the U-21S and V-22S 69 kV lines are served radially from Ayer 69 kV, and the N-40 line is served radially from the Fitch Road 69 kV. The resulting voltage levels are greater than 0.90 p.u., however the post contingency, post adjustment, voltage deviation is greater than 10% which violates National Grid's voltage criteria from Table 4-2.

The details of the N-1 testing results are included in Section 12.

5.2.1.3 *N-1-1 Thermal and Voltage Violations Summary*

N-1-1 testing was performed for all of the system conditions described in Section 4.3. The results indicate that under all tested dispatch and transfer level conditions at peak load there were no N-1-1 thermal violations and there were N-1-1 voltage violations in the WCMA study area. The N-1-1 voltage violations were limited to four conditions which are discussed below.

N-1-1 condition: LN_D-4 followed by the BO_A-1S

The N-1-1 voltage violations for this condition are shown Table 5-2 and Figure 5-3 below.

Table 5-2
N-1-1 WCMA Voltage Violations for the LN_D-4 followed by the BO_A-1S

Bus (69 kV)	Dispatch	Initial Element Outage	Contingency	Worst Pre-switching Voltage (p.u.)	Worst Post-Switching Voltage (p.u.)
Otter River	A	LN_D-4 (Deerfield No. 4 – Vernon 69 kV)	BO_A-1S	0.832	0.832
North Baldwinville A	A	LN_D-4	BO_A-1S	[redacted]	[redacted]
Royalston	A	LN_D-4	BO_A-1S	0.840	0.840
Chestnut Hill	A	LN_D-4	BO_A-1S	0.850	0.850
Templeton	A	LN_D-4	BO_A-1S	[redacted]	[redacted]
East Westminster A	A	LN_D-4	BO_A-1S	0.820	0.820
Westminster A	A	LN_D-4)	BO_A-1S	0.822	0.823

[redacted]

Figure 5-3
N-1-1 condition: LN_D-4 followed by the BO_A-1S

The voltage violations occurred in the "A" dispatch cases ("A" dispatches) for the N-1-1 condition of the D-4 line OOS followed by the breaker opening contingency of the Pratts Jct. A130-N 69 kV breaker that connects the A-1S line to Pratts Jct. No voltage violations occurred for the "B" dispatch cases ("B" dispatches). The result of this condition is that the load in the 69 kV corridor between Vernon and Pratts Jct. is served radially via the B-2S line from Pratts Jct.

As noted in the paragraph above, voltage violations were only seen in the "A" dispatches and not in the "B" dispatches. This is due to the base case voltages at Vernon 69 kV being slightly higher in the "A" dispatches (1.040 p.u.) than in the "B" dispatches (1.035 p.u.) as a result of the "A" dispatches versus "B" dispatches system stress. The higher voltages in the "A" dispatches caused high voltage violations at Chestnut Hill 69 kV for the N-1-1 condition of the D-4 line OOS followed by the A-1 69 kV line (Royalston to Otter River). This configuration leaves Chestnut Hill 69 kV connected radially to Vernon 69 kV. To mitigate the high voltages, it was assumed that, as part of operator actions, the two 2.7 MVAR 13.8 kV capacitors at Chestnut Hill would be switched off following the D-4 line outage as the initial element out for the "A" dispatches. This operator action was not needed in the "B" dispatches since the "B" dispatches started with a slightly lower base case voltage at Vernon 69 kV. Therefore, the two 2.7 MVAR 13.8 kV capacitors at Chestnut Hill remained in service after the N-1-1 contingency of the D-4 line OOS followed by the A-1 69 kV line (Royalston to Otter River) and mitigated any low voltage conditions in the area.

N-1-1 condition: LN_D-4 followed by the BO_B-2S

The N-1-1 voltage violations for this condition are shown Table 5-3 and Figure 5-4 below.

Table 5-3
N-1-1 WCMA Voltage Violations for the LN_D-4 followed by the BO_B-2S

Bus (69 kV)	Dispatch	Initial Element Outage	Contingency	Worst Pre-switching Voltage (p.u.)	Worst Post-Switching Voltage (p.u.)
Vernon	A	LN_D-4	BO_B-2S	0.658	0.658
Otter River	A	LN_D-4	BO_B-2S	0.865	0.865
North Baldwinville A	A	LN_D-4	BO_B-2S	[redacted]	[redacted]
Royalston	A	LN_D-4	BO_B-2S	0.833	0.833
Chestnut Hill	A	LN_D-4	BO_B-2S	0.795	0.795
North Baldwinville B	A	LN_D-4	BO_B-2S	[redacted]	[redacted]
Templeton	A	LN_D-4	BO_B-2S	[redacted]	[redacted]
Westminster A	A	LN_D-4	BO_B-2S	0.463	0.463
East Westminster B	A	LN_D-4	BO_B-2S	0.462	0.462
Crystal Lake	A	LN_D-4	BO_B-2S	0.478	0.478
Westminster B	A	LN_D-4	BO_B-2S	0.464	0.464

[redacted]

Figure 5-4
N-1-1 condition: LN_D-4 followed by the BO_B-2S

Voltage violations occurred in the "A" dispatches for the N-1-1 condition of the D-4 line OOS followed by the breaker opening contingency of the Pratts Jct. B230-N 69 kV breaker that connects the B-2S line to Pratts Jct. The result of this condition is that the load in the 69 kV corridor between Vernon and Pratts Jct. is served radially via the A-1S line from Pratts Jct. As noted in the table above, violations are only reported in the "A" dispatches and not in the "B" dispatches. This is due to the "B" dispatches not converging which is discussed in the N-1-1 Non-convergence section below. Even though the "A" cases converged the extremely low voltage is indicative of a voltage collapse in the of the 69 kV corridor between Vernon and Pratts Jct.

N-1-1 condition: LN_A-1S followed by the BO_B-2S

The N-1-1 voltage violations for this condition are shown Table 5-4 and Figure 5-5 below.

Table 5-4
N-1-1 WCMA Voltage Violations for the LN_A-1S followed by the BO_B-2S

Bus (69 kV)	Dispatch	Initial Element Outage	Contingency	Worst Pre-switching Voltage (p.u.)	Worst Post-Switching Voltage (p.u.)
North Baldwinville B	A and B	LN_A-1S (Pratts Jct. – Otter River 69 kV)	BO_B-2S	[redacted]	[redacted]
Westminster A	A and B	LN_A-1S	BO_B-2S	0.806	0.805
East Westminster A	A and B	LN_A-1S	BO_B-2S	0.803	0.801
East Westminster B	A and B	LN_A-1S	BO_B-2S	0.803	0.801
Crystal Lake	A and B	LN_A-1S	BO_B-2S	0.823	0.822
Westminster B	A and B	LN_A-1S	BO_B-2S	0.807	0.806

[redacted]

Figure 5-5
N-1-1 condition: LN_A-1S followed by the BO_B-2S

Voltage violations occurred in all tested dispatches for the N-1-1 condition of the A-1S line OOS followed by the breaker opening contingency of the Pratts Jct. B230-N 69 kV breaker that connects the B-2S line to Pratts Jct. The result of this condition is that the load in the 69 kV corridor between Vernon and Pratts Jct. is served radially via the A-1N and B-2N lines from Vernon.

N-1-1 condition: LN_B-2S followed by the BO_A-1S

The N-1-1 voltage violations for this condition are shown Table 5-5 and Figure 5-6 below.

Table 5-5
N-1-1 WCMA Voltage Violations for the LN_B-2S followed by the BO_A-1S

Bus (69 kV)	Dispatch	Initial Element Outage	Contingency	Worst Pre-switching Voltage (p.u.)	Worst Post-Switching Voltage (p.u.)
Otter River	A and B	LN_B-2S (Pratts Jct. – Crystal Lake 69 kV)	BO_A-1S	0.811	0.811
North Baldwinville A	A and B	LN_B-2S	BO_A-1S	[redacted]	[redacted]
Royalston	A and B	LN_B-2S	BO_A-1S	0.829	0.829
Chestnut Hill	A and B	LN_B-2S	BO_A-1S	0.851	0.851
Templeton	A and B	LN_B-2S	BO_A-1S	[redacted]	[redacted]
Westminster A	A and B	LN_B-2S	BO_A-1S	0.784	0.784
East Westminster A	A and B	LN_B-2S	BO_A-1S	0.781	0.781
East Westminster B	A and B	LN_B-2S	BO_A-1S	0.781	0.781
Westminster A	A and B	LN_B-2S	BO_A-1S	0.785	0.785

[redacted]

Figure 5-6
N-1-1 condition: LN_B-2S followed by the BO_A-1S

Voltage violations occurred in all tested dispatches for the N-1-1 condition of the Crystal Lake - Pratts Jct. 69 kV B-2S line OOS followed by the breaker opening contingency of the Pratts Jct. A130-N 69 kV breaker that connects the A-1S line to Pratts Jct. The result of this condition is that the load in the 69 kV corridor between Vernon and Pratts Jct. is served radially via the A-1N and B-2N lines from Vernon.

N-1-1 Non-convergence

A singe N-1-1 condition resulted in non-converged cases. The non-convergence was for the D-4 line OOS followed by the breaker opening contingency of the Pratts Jct. B230-N 69 kV breaker shown in Figure 5-4 above. The non-convergence was caused by low voltage conditions on the 69 kV corridor between Vernon and Pratts Jct. The cases of non-convergence are shown below in Table 5-6 below.

Table 5-6
N-1-1 WCMA Non-Convergent Cases

Dispatch	Initial Element OOS	Contingency	Count of Non-Convergent Cases
B	LN_D-4	BO_B-2S-1	5

5.2.2 **Steady State Peak Load PV Sensitivity Results**

The results of the sensitivity analysis performed with the National Grid Western MA DER Cluster Study Group 1 consisting of 320 MW of PV in the WCMA study area showed an improvement over the results of the base case without the PV. However the addition of PV is not sufficient to solve all of the voltage violation results. Specifically, the N-1 violation and the N-1-1 conditions that failed to converge no longer result in voltage violations. However, the N-1-1 voltage violations remained in two of the four N-1-1 conditions discussed above with only slightly improved voltages.

5.2.2.1 *N-0 Thermal and Voltage Violations Summary*

N-0 (also known as “all-lines-in”) conditions were reviewed for the peak load PV sensitivity cases modeled. The results indicate that under all tested dispatch and transfer level conditions at peak load there were no N-0 thermal overloads and no N-0 voltage violations.

The details of the N-0 testing results are together with N-1 results included in Section 12.

5.2.2.2 *N-1 Thermal and Voltage Violations Summary*

The results indicate that under all tested dispatch and transfer level conditions at peak load for the PV sensitivity cases, there were no N-1 thermal and voltage violations seen on PTF facilities in the WCMA study area.

The details of the N-1 testing results are included in Section 12.

5.2.2.3 *N-1-1 Thermal and Voltage Violations Summary*

N-1-1 condition: LN_B-2S followed by the BO_A-1S

Table 5-7
N-1-1 WCMA Voltage Violations for the LN_B-2S followed by the BO_A-1S with and Without PV

Bus (69 kV)	Dispatch	Initial Element Outage	Contingency	Without PV		With PV	
				Worst Pre-switching Voltage (p.u.)	Worst Post-Switching Voltage (p.u.)	Worst Pre-switching Voltage (p.u.)	Worst Post-Switching Voltage (p.u.)
Otter River	A and B	LN_B-2S	BO_A-1S	0.811	0.811	0.833	0.835
North Baldwinville A	A and B	LN_B-2S	BO_A-1S	[redacted]	[redacted]	[redacted]	[redacted]
Royalston	A and B	LN_B-2S	BO_A-1S	0.829	0.829	0.847	0.849
Chestnut Hill	A and B	LN_B-2S	BO_A-1S	0.851	0.851	0.864	0.866
Templeton	A and B	LN_B-2S	BO_A-1S	[redacted]	[redacted]	[redacted]	[redacted]
Westminster A	A and B	LN_B-2S	BO_A-1S	0.784	0.784	0.813	0.816
East Westminster A	A and B	LN_B-2S	BO_A-1S	0.781	0.781	0.811	0.814
East Westminster B	A and B	LN_B-2S	BO_A-1S	0.781	0.781	0.811	0.814
Westminster A	A and B	LN_B-2S	BO_A-1S	0.785	0.785	0.814	0.817

Voltage violations occurred in the "A" and "B" dispatches for the N-1-1 condition of the B-2S line OOS followed by the breaker opening contingency of the Pratts Jct. A130-N 69 kV breaker that connects the A-1S line to Pratts Jct. The result of this condition is that the load in the 69 kV corridor between Vernon and Pratts Jct. is served radially via the A-1N and B-2N lines from Vernon. A breaker diagram of the 69 kV corridor between Vernon and Pratts Jct. showing the LN_B-2S followed by the BO_A-1S condition is shown in Figure 5-6 above.

N-1-1 condition: LN_D-4 followed by the BO_B-2S

Table 5-8
N-1-1 WCMA Voltage Violations for the LN_D-4 followed by the BO_B-2S with and Without PV

Bus (69 kV)	Dispatch	Initial Element Outage	Contingency	Without PV		With PV	
				Worst Pre-switching Voltage (p.u.)	Worst Post-Switching Voltage (p.u.)	Worst Pre-switching Voltage (p.u.)	Worst Post-Switching Voltage (p.u.)
Vernon	A	LN_D-4	BO_B-2S	0.658	0.658	>0.95	>0.95
Otter River	A	LN_D-4	BO_B-2S	0.865	0.865	>0.95	>0.95
North Baldwinville A	A	LN_D-4	BO_B-2S	[redacted]	[redacted]	[redacted]	[redacted]
Royalston	A	LN_D-4	BO_B-2S	0.833	0.833	>0.95	>0.95
Chestnut Hill	A	LN_D-4	BO_B-2S	0.795	0.795	>0.95	>0.95
North Baldwinville B	A	LN_D-4	BO_B-2S	[redacted]	[redacted]	[redacted]	[redacted]
Templeton	A	LN_D-4	BO_B-2S	[redacted]	[redacted]	[redacted]	[redacted]
Westminster A	A	LN_D-4	BO_B-2S	0.463	0.463	0.850	0.853
East Westminster B	A	LN_D-4	BO_B-2S	0.462	0.462	0.850	0.853
Crystal Lake	A	LN_D-4	BO_B-2S	0.478	0.478	0.857	0.860
Westminster B	A	LN_D-4	BO_B-2S	0.464	0.464	0.851	0.854

Voltage violations occurred in the "A" dispatches for the N-1-1 condition of the D-4 line OOS followed by the breaker opening contingency of the Pratts Jct. B230-N 69 kV breaker that connects the B-2S line to Pratts Jct. The result of this condition is that the load in the 69 kV corridor between Vernon and Pratts Jct. is served radially via the A-1S line from Pratts Jct. A breaker diagram of the 69 kV corridor between Vernon and Pratts Jct. showing the LN_D-4 followed by the BO_B-2S condition is shown in Figure 5-4 above.

5.2.3 **Steady State Minimum Load Results**

5.2.3.1 *N-0 Thermal and Voltage Violation Summary*

N-0 (also known as "all-lines-in") conditions were reviewed for the cases modeled. The results indicate that under minimum load conditions there were no N-0 thermal or voltage violations in the WCMA study area.

5.2.3.2 *N-1 Thermal and Voltage Violations Summary*

N-1 testing was performed for all of the system conditions described in Section 4.3. The results indicate that under all tested dispatch and transfer level conditions at minimum load there were no N-1 thermal or voltage violations in the WCMA study area.

5.2.3.3 *N-1-1 Thermal and Voltage Violations Summary*

N-1-1 testing was performed for all of the system conditions described in Section 4.3. The results indicate that under all tested dispatch and transfer level conditions at minimum load there were no N-1-1 thermal or voltage violations in the WCMA study area.

5.3 Stability Results

Not applicable for this study.

5.4 Short-Circuit Results

The short circuit study results indicated that no substations had any PTF breakers that would be over-dutied[64] for 2023 system model conditions in the WCMA study area. In addition no substations had any PTF breakers greater than 90% of their interrupting duty or momentary duty. The detailed study results are included in Section 13.

[64] A PTF breaker is considered over-dutied if the short circuit study results are 100% or greater than the breaker's momentary or fault interrupting duty.

Section 6
Time-Sensitivity Testing

For each transmission need identified at peak load levels in the steady-state analysis additional analysis was performed to determine the time-sensitivity of the need. Transmission needs identified in this study have been deemed time-sensitive if they have a year of need within three years of the completion of this Needs Assessment[65]. Since the publishing date of this assessment occurs before June 1, 2020, the threshold for determining time-sensitive needs is the 2022 summer peak. If a transmission need identified in this study (2029) exists in cases that represent the 2022 summer peak, then those needs are deemed time-sensitive.

6.1 Creation of the Time-Sensitive Base Cases

The time-sensitive base cases are created by modifying the loads in the 10-year projection of the 90/10 summer peak load base case (study horizon base cases) to represent the time-sensitive year summer peak load levels. The 2029 peak load base cases were modified to represent 2022 peak load base cases. Table 6-1 provides a comparison of loads between the study horizon year and time-sensitive year base cases.

Table 6-1:
Comparison of Net NE Load Levels Study Horizon Year vs Time-Sensitive Year
(Excluding Transmission Losses)

Category	Summer Peak 2029 90/10 Load (MW)	Summer Peak 2022 90/10 Load (MW)
CELT 2019 Forecast	32,477	30,809
Non-CELT Manufacturing load in New England	348	348
New Large Load Supplied at CMP's Belfast Station	21	21
Available 2019 CELT EE Forecast[66] for study year (modeled as negative load)	-5,359	-3,957
Available FCA-13 ADCR (modeled as negative load)	-533	-533
Available 2019 CELT PV Forecast for study year (modeled as negative load)	-1,849	-1,188
Net load modeled in New England (Excludes Station Service)	**25,105**	**25,500**

The transmission and generation topology in the study horizon base cases is maintained in the time-sensitive base cases.

[65] Section 4.1(i) of Attachment K from Section II of the OATT.

[66] Starting with 2018 CELT the EE Forecast includes all years in the 10 year planning horizon and the EE forecast data will be used for Years 1-3 in lieu of the Passive DR from the most recent FCA.

6.2 Generation Dispatch in the Time-Sensitive Base Cases

There is one retired generator (Pinetree Power) in the WCMA study area and two retired generators in the adjacent area of Boston (Mystic 8 and 9) which have retirement dates beyond June 1, 2022 and should be assumed available in the time-sensitivity base cases.

The Mystic 8 and 9 units were brought on-line in the adjacent area of Boston which was offset by shutting off Edgar and Canal in the "A" Dispatches and Kleen and Milford in the "B" Dispatches.

Pinetree Power (15.7 MW) was brought on-line in the study area, however no further changes to the dispatches were needed since the size of Pinetree Power would not cause a meaningful change to the Maximum MW Unavailability in the study area.

Other than the adjustments described above, the dispatches shown in Table 3-12 and Table 3-13 for the study horizon base cases were used for the time-sensitive base cases.

6.3 Results of Time-Sensitivity Testing

Time-sensitivity testing results are shown in Table 6-2 through Table 6-7. All voltage violations identified in the 2029 peak load conditions are time-sensitive needs.

Table 6-2
N-1 WCMA Time-Sensitivity Voltage Violations

Bus Name	Base kV	Dispatch	Contingency	Base Case Voltage (p.u.)	Worst Case Post Contingency Post switching Voltage (p.u.)	Delta V (p.u.)[47]
East Westminster B2	69	A and B	BF_PRAT_TIE	1.02	0.874	0.146
Crystal Lake	69	A	BF_PRAT_TIE	1.017	0.884	0.133
Westminster B2	69	A and B	BF_PRAT_TIE	1.019	0.876	0.143

Table 6-3
N-1-1 WCMA Time-Sensitivity Voltage Violations for the LN_D-4 followed by the BO_A-1S

Bus (69 kV)	Dispatch	Initial Element Outage	Contingency	Worst Pre-switching Voltage (p.u.)	Worst Post-Switching Voltage (p.u.)
Otter River	A	LN_D-4	BO_A-1S	0.766	0.766
North Baldwinville A	A	LN_D-4	BO_A-1S	[redacted]	[redacted]
Royalston	A	LN_D-4	BO_A-1S	0.776	0.776
Chestnut Hill	A	LN_D-4	BO_A-1S	0.788	0.788
Templeton	A	LN_D-4	BO_A-1S	[redacted]	[redacted]
East Westminster A	A	LN_D-4	BO_A-1S	0.753	0.753
Westminster A	A	LN_D-4	BO_A-1S	0.756	0.756

Table 6-4
N-1-1 WCMA Time-Sensitivity Voltage Violations for the LN_D-4 followed by the BO_B-2S

Bus (69 kV)	Dispatch	Initial Element Outage	Contingency	Worst Pre-switching Voltage (p.u.)	Worst Post-Switching Voltage (p.u.)
Vernon	A	LN_D-4	BO_B-2S	0.647	0.647
Otter River	A	LN_D-4	BO_B-2S	0.850	0.850
North Baldwinville A	A	LN_D-4	BO_B-2S	[redacted]	[redacted]
Royalston	A	LN_D-4	BO_B-2S	0.821	0.821
Chestnut Hill	A	LN_D-4	BO_B-2S	0.782	0.782
North Baldwinville B	A	LN_D-4	BO_B-2S	[redacted]	[redacted]
Templeton	A	LN_D-4	BO_B-2S	[redacted]	[redacted]
Westminster A	A	LN_D-4	BO_B-2S	0.451	0.451
East Westminster B	A	LN_D-4	BO_B-2S	0.450	0.450
Crystal Lake	A	LN_D-4	BO_B-2S	0.466	0.466
Westminster B	A	LN_D-4	BO_B-2S	0.452	0.452

Table 6-5
N-1-1 WCMA Time-Sensitivity Voltage Violations for the LN_A-1S followed by the BO_B-2S

Bus (69 kV)	Dispatch	Initial Element Outage	Contingency	Worst Pre-switching Voltage (p.u.)	Worst Post-Switching Voltage (p.u.)
North Baldwinville A	A and B	LN_A-1S	BO_B-2S	[redacted]	[redacted]
Westminster A	A and B	LN_A-1S	BO_B-2S	0.542	0.542
East Westminster A	A and B	LN_A-1S	BO_B-2S	0.803	0.801
East Westminster B	A and B	LN_A-1S	BO_B-2S	0.537	0.537
Crystal Lake	A and B	LN_A-1S	BO_B-2S	0.571	0.571
Westminster B	A and B	LN_A-1S	BO_B-2S	0.543	0.543

Table 6-6
N-1-1 WCMA Time-Sensitivity Voltage Violations for the LN_B-2S followed by the BO_A-1S

Bus (69 kV)	Dispatch	Initial Element Outage	Contingency	Worst Pre-switching Voltage (p.u.)	Worst Post-Switching Voltage (p.u.)
Otter River	A and B	LN_B-2S	BO_A-1S	0.592	0.592
North Baldwinville A	A and B	LN_B-2S	BO_A-1S	[redacted]	[redacted]
Royalston	A and B	LN_B-2S	BO_A-1S	0.622	0.622
Chestnut Hill	A and B	LN_B-2S	BO_A-1S	0.660	0.660
Templeton	A and B	LN_B-2S	BO_A-1S	[redacted]	[redacted]
Westminster A	A and B	LN_B-2S	BO_A-1S	0.548	0.548
East Westminster A	A and B	LN_B-2S	BO_A-1S	0.543	0.543
East Westminster B	A and B	LN_B-2S	BO_A-1S	0.543	0.543
Westminster A	A and B	LN_B-2S	BO_A-1S	0.549	0.549

Table 6-7
N-1-1 WCMA Time-Sensitivity Non-Convergent Cases

Dispatch	Initial Element OOS	Contingency	Count of Non-Convergent Cases
B	LN_D-4	BO_B-2S-1	5

6.4 Time-Sensitivity of Short Circuit Needs

Not applicable for this study because no short circuit needs were found in the 2023 system model conditions in the WCMA study area.

Section 7
Needs Analysis Conclusions

The results of the steady-state assessment conducted of the WCMA area transmission performance against transmission reliability standards for the projected 2029 system conditions in this study indicate that there are PTF voltage violations under peak load conditions in the study area. The WCMA area transmission system fails to meet the reliability criteria standards in the study area under the design case testing performed and measures should be developed to mitigate the problems identified.

For peak load needs, the voltage violations are time-sensitive needs. The need-by date for the peak load time-sensitive needs is set to June 1, 2022.

The results of the steady-state assessment conducted of the WCMA area transmission performance against transmission reliability standards for the projected 2029 system conditions in this study indicate that there are no PTF violations under minimum load conditions in the study area.

The results of the short circuit assessment conducted for the WCMA study area PTF breakers for the projected 2023 system model conditions indicate that there are no PTF breakers that are over-dutied for the planned system condition.

The WCMA Assessment was performed in accordance with NERC TPL-001-4 "*Transmission Planning Performance Requirements*", NERC NUC-001-3 "*Nuclear Plant Interface Coordination*", NPCC Regional Reliability Reference Directory #1 "*Design and Operation of the Bulk Power System*" dated 09/30/15, and ISO Planning Procedure No. 3 "*Reliability Standards for the New England Area Pool Transmission Facilities*" dated 09/15/2017.

7.1 Reliability Determination of Time-Sensitive Needs

7.1.1 Review of Time-sensitive Needs

Table 5-1 through Table 5-6 list the time-sensitive needs observed at the peak load levels in the WCMA study area. The need-by date for the peak load time-sensitive needs is set to June 1, 2022.

7.1.2 Review of Non-Transmission Options

The WCMA Needs Assessment already considers existing and new generating capacity resources with FCM obligations and all resources with a binding contract. There are no Elective Transmission Upgrades (ETUs) in WCMA with a Forward Capacity Auction commitment that would resolve these violations. Non-transmission options are not adequate to relieve the reliability criteria violations in the WCMA study area.

7.1.3 Postponement of Solution Development

National Grid is in the process of submitting a PPA in Q2 2020 for the Western MA DER Cluster Study Group 2 that consists of an additional 391 MW of PV and numerous transmission upgrades in the WCMA study area including the following in the 69 kV corridor from Vernon to Pratts Jct.:

- New PV installations at the following locations
    - Chestnut Hill – 1.4 MW

  - Crystal Lake – 30.6 MW
  - East Westminster – 10.3 MW
  - Royalston – 5.0 MW
- Retirement of the Westminster substation
- Load shifts within the 69 kV corridor and to other surrounding 115 kV substations
- A1/B2 line rebuild and reconductor[67]
- Vernon 69 kV substation rebuild[67]
- Chestnut Hill substation upgrades[67]
- Addition of two 16 MVAR DVARs at Otter River

ISO-NE will not begin the Solutions Study process described in Section 4.2 of Attachment K to develop regulated transmission solutions to resolve the time-sensitive needs identified in the WCMA 2029 Needs Assessment at this time. Due to the proposed Western MA DER Study Group 2, there are many proposed transmission topology changes required to interconnect the PV and uncertainty that the DER levels will be achieved within the 69 kV corridor from Vernon to Pratts Jct. It would not be prudent to begin the Solutions Study process with the proposed upgrades shown above. Once the PPA has been approved for the Western MA DER Cluster Study Group 2, the ISO will initiate a new Needs Assessment for the area of the 69 kV corridor from Vernon to Pratts Jct.

7.2 Reliability Determination of Needs that are Not Time-Sensitive

Not applicable for this study.

[67] These projects are being done due to asset condition and the rebuilds are expected to be completed by 2027.

Section 8
Appendix A: N-1 Contingency List

8.1 Appendix A: WCMA 2029 Needs Assessment Scope of Work N-1 Contingencies Summary Report

Appendix A is included in the zip file titled "Final_ceii_wcma_2029_na_appendices.zip" which is posted on the ISO website under the key study area for Western and Central Massachusetts Key Study area . [68]

Appendix_A1-A_N-1_ in_WCMA_Contingency_Report.pdf

Appendix_A2-A_Element_Out_in_WCMA_Contingency_Report.pdf

Appendix_A3-A_N-1-1_in_WCMA_Contingency_Report.pdf

Appendix_A4-A_N-1_NF_BO_WCMA_Contingency_Report.pdf

Appendix_A5-A_N-1-1_BO_WCMA_Contingency_Report

Appendix_A6-A_Loss_of_Source_Contingency_Report.pdf

[68] https://www.iso-ne.com/system-planning/key-study-areas/western-and-central-massachusetts/

Section 9
Appendix B: Case Summaries

The case summaries for the WCMA 2029 Needs Assessment load dispatches are available in Appendix B in the zip file titled “Final_ceii_wcma_2029_na_appendices.zip” which is posted on the ISO website under the key study area for Western and Central Massachusetts Key Study area .[69]

Appendix B1 - WCMA_Peak_Load_Dispatches.pdf

Appendix B2 - WCMA_Min_Load_Dispatches.pdf

Appendix B3-WCMA_Time_Sensitive_Load Dispatches.pdf

Appendix B4-WCMA_Cluster1_Sensitivity_Load Dispatches.pdf

[69] https://www.iso-ne.com/system-planning/key-study-areas/western-and-central-massachusetts/

Section 10
Appendix C: TARA Options and Process Used for Analysis

Appendix_C_TARA_Options_and_Process_Used_for_Analysis.pdf

Section 11
Appendix D: Rating Changes

Appendix_D_Eversource_Rating_Changes.pdf

Section 12
Appendix E: Steady-State Results

The steady state results for the WCMA 2029 Needs Assessment Peak load ,Minimum load ,Time-sensitive and Cluster1 sensitivity results are in Appendix E in the zip file titled "Final_ceii_wcma_2029_na_appendices.zip" which is posted on the ISO website under the key study area for Western and Central Massachusetts Key Study area .[70]

Appendix_E1_2029_N-1_PK_Results.xlsx

Appendix_E2_2029_N-1-1_PK_Results.xlsx

Appendix_E3_2029_N-1_MIN_Results.xlsx

Appendix_E4_2029_N-1-1_MIN_Results.xlsx

Appendix_E5_2022_N-1_Results.xlsx

Appendix_E6_2022_N-1-1_Results.xlsx

Appendix_E7_2029_N-1_Cluster1_Results.xlsx

Appendix_E8_2029_N-1-1_Cluster1_Results.xlsx

[70] https://www.iso-ne.com/system-planning/key-study-areas/western-and-central-massachusetts/

Section 13
Appendix F: Short Circuit Results

Appendix_F_Short_Circuit_Results.xlsx

Western and Central Massachusetts (WCMA) 2029 Needs Assessment Addendum - November 2021

1. Background and Objective

The Western and Central Massachusetts (WCMA) 2029 Needs Assessment results were discussed with the Planning Advisory Committee (PAC) on February 20, 2020[1] and the WCMA 2029 Needs Assessment was posted to the ISO external website on May 5, 2020[2]. The WCMA 2029 Needs Assessment identified:

- Time-sensitive, N-1 and N-1-1 PTF voltage violations under peak load conditions along the A-1 and B-2 69 KV line corridor between Vernon station in Vermont and Pratts Junction station in Massachusetts (A-1 and B-2 corridor).
- No other thermal or voltage violations in the WCMA study area.

The ISO posted the Notice of Initiation of the WCMA 2029 Solutions Study to the ISO external website on February 24, 2021[3] and followed up with the WCMA 2029 Solutions Study PAC presentation discussed at the March 17, 2021 PAC meeting[4]. At the March PAC meeting, the ISO stated that National Grid's asset condition projects[5], which included the A-1 and B-2 69 kV line asset condition project, would be included in the cases before solution alternatives would be developed.

The objective of the WCMA 2029 Needs Assessment Addendum (Addendum) effort is to rerun an updated peak load and short circuit analysis[6] in the WCMA study area with the inclusion of National Grid's A-1 and B-2 line asset condition project[7] and report the results. The WCMA 2029 Needs Assessment, posted to the ISO external website on May 5, 2020, is updated by this Addendum.

No changes were made to the study area, the study horizon, the inclusion of resources with financially binding contracts, or the types of analyses that were studied in the WCMA 2029 Needs Assessment.

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[1] https://smd.iso-ne.com/operations-services/ceii/pac/2020/02/a3_wcma_2029_needs.pdf

[2] https://smd.iso-ne.com/operations-services/ceii/pac/2020/05/final_ceii_wcma_2029_na.pdf

[3] https://www.iso-ne.com/static-assets/documents/2021/02/wcma_solutions_study_notice_of_initiation.pdf

[4] https://www.iso-ne.com/static-assets/documents/2021/03/a5_wcma_2029_solution_study_scope_of_work_update.pdf

[5] https://smd.iso-ne.com/operations-services/ceii/pac/2020/04/a2-national-grid-asset-condition-projects.zip

[6] Since several low voltage violations at peak load were the only needs identified in the WCMA 2029 Needs Assessment, the Addendum analysis was conducted at peak load only. To ensure that the inclusion of National Grid's A-1 and B-2 line asset condition project did not introduce short circuit issues in the study area, a short circuit analysis was also conducted.

[7] https://smd.iso-ne.com/operations-services/ceii/pac/2021/09/a2_a1_b2_69kv_asset_condition_project_ceii.pdf

2. Study Assumptions

No changes were made to the model assumptions that were studied in the WCMA 2029 Needs Assessment with the exception of the inclusion of National Grid's A-1 and B-2 line asset condition project[8].

3. Analysis Methodology

No changes were made to the analysis methodology that was used in the WCMA 2029 Needs Assessment.

4. Results

The ISO performed an N-1 and N-1-1 contingency analysis with National Grid's A-1 and B-2 line asset condition project included using all of the peak load dispatches from the WCMA 2029 Needs Assessment. The updated analysis showed all of the N-1 and N-1-1 voltage violations identified along the A-1 and B-2 corridor in the WCMA 2029 Needs Assessment were no longer observed and that no other violations were found.

The ISO performed a short circuit analysis with National Grid's A-1 and B-2 line asset condition project included. The updated analysis showed no over-dutied breakers.

5. Conclusion

The results of the updated peak load and short circuit analyses showed that with the addition of National Grid's A-1 and B-2 69 kV line asset condition project, the N-1 and N-1-1- voltage violations along the A-1 and B-2 corridor were no longer observed. In addition, no other violations in the WCMA area were observed.

National Grid's A-1 and B-2 line asset condition project was discussed at the September 2021 PAC meeting and the project transitioned from the status of Concept to Proposed. The new status will be updated in the October 2021 Asset Condition List.

Since there are no criteria violations observed in the Addendum analysis, there is no need to conduct a WCMA 2029 Solutions Study. The WCMA 2029 study effort is concluded as there are no remaining criteria violations in the study area.

The WCMA 2029 Needs Assessment Addendum and study files are posted under the Western and Central Massachusetts Key Study Area on the ISO-NE external website.

[8] Out of the four asset condition projects, the National Grid's A-1 and B-2 line asset condition project was selected to be added to the Addendum cases because the project has the greatest potential impact on the criteria violations observed in the WCMA 2029 Needs Assessment. The Deerfield #4, Vernon and Chestnut Hill station rebuild layouts were unknown at the time the analysis was performed. National Grid presented the cost estimate and in-service date of A-1 and B-2 Line asset condition project at the September 2021 PAC meeting which changed the status of the project from Concept to Proposed.

SEPTEMBER 30, 2022 | BOSTON, MASSACHUSETTS

ISO New England's Ongoing Transmission Planning and Planning Improvement Efforts

New England Electricity Restructuring Roundtable

Robert Ethier

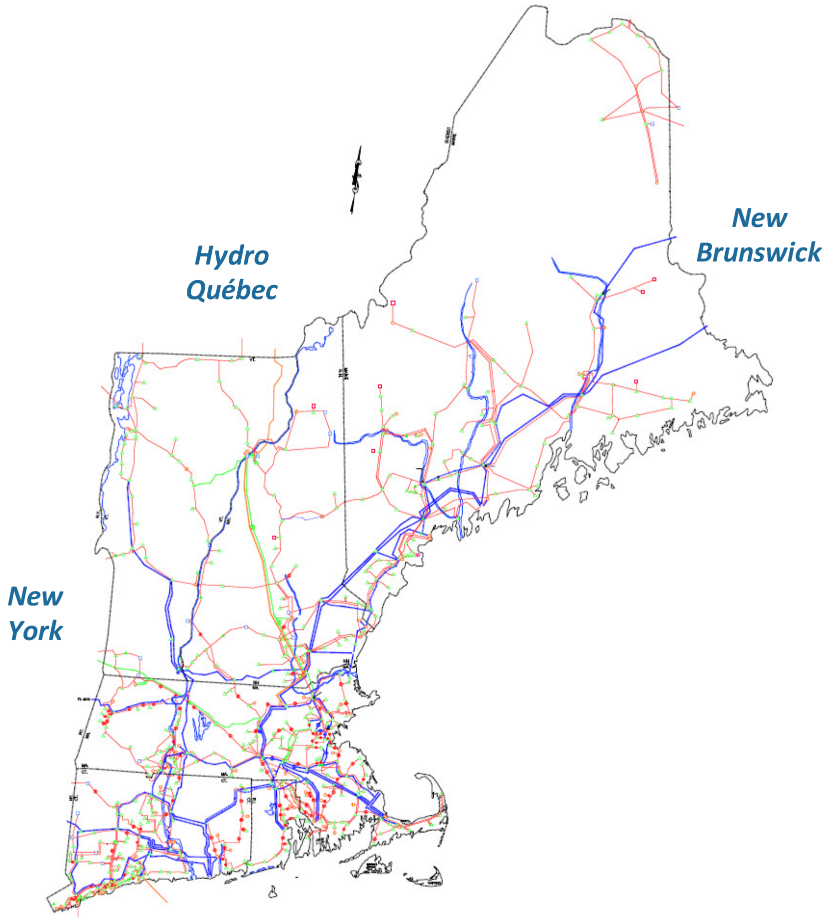
VICE PRESIDENT, SYSTEM PLANNING

Main Points

- Review the **historical context** for transmission planning in New England and **public policies** shaping the resource mix
- **Offshore wind** has the potential to add large amounts of supply from the east, close to load
- **Electrification** will reverse the recent trend of essentially flat growth in peak and overall electricity demand
- Transmission **planning horizons** are evolving to support the New England State's clean energy policies
- Innovations in the interconnection study space evaluate **clusters of offshore wind** in southern New England

New England's Transmission Grid Is the Interstate *and Interregional* Highway System for Electricity

- New England saw little investment in transmission infrastructure before electric industry restructuring
- $12 billion invested in the two decades since then to strengthen system ***reliability*** has enabled the ***clean energy transition*** by allowing older fossil generators (coal and oil) to retire
- The region has had success, historically, building ***transmission to access power from neighboring systems***, with potential for further expansion if more recent siting and legal challenges can be overcome
- Region is a ***net importer*** of electricity

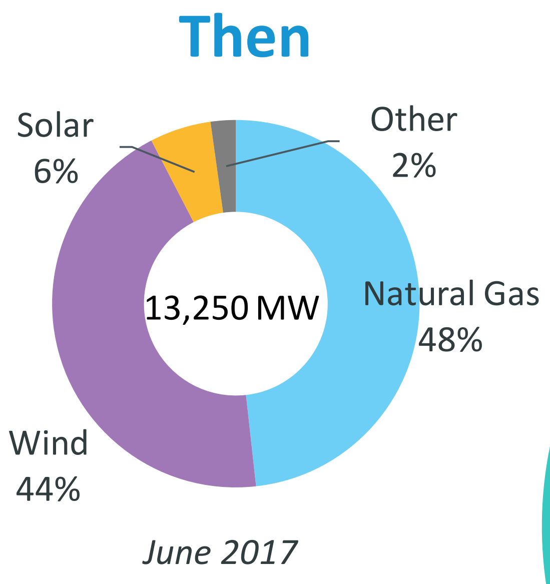


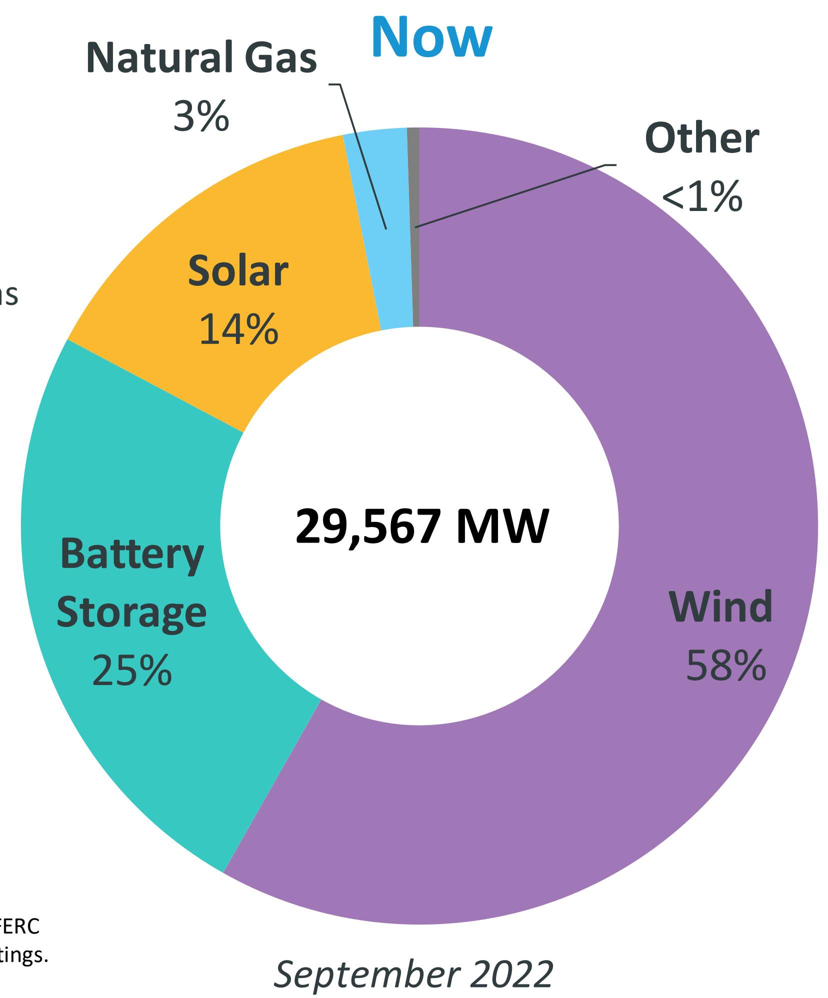
State Laws Target Deep *Reductions* in CO_2 Emissions and *Increases* in Renewable and Clean Energy

≥80% by 2050	Five states mandate greenhouse gas reductions economy wide: MA, CT, ME, RI, and VT (mostly below 1990 levels)
Net-Zero by 2050 80% by 2050	MA emissions requirement MA clean energy standard
90% by 2050	VT renewable energy requirement
100% by 2050 Carbon-Neutral by 2045	ME renewable energy goal ME emissions requirement
100% by 2040	CT zero-carbon electricity requirement
100% by 2030	RI renewable energy requirement

The ISO Generator Interconnection Queue Provides a Snapshot of the Future Resource Mix

Dramatic shift in types of proposed resources from natural gas to wind





Offshore Wind

CT	2,400 MW
MA	11,763 MW
ME	12 MW
RI	704 MW

Onshore Wind

ME	2,330 MW

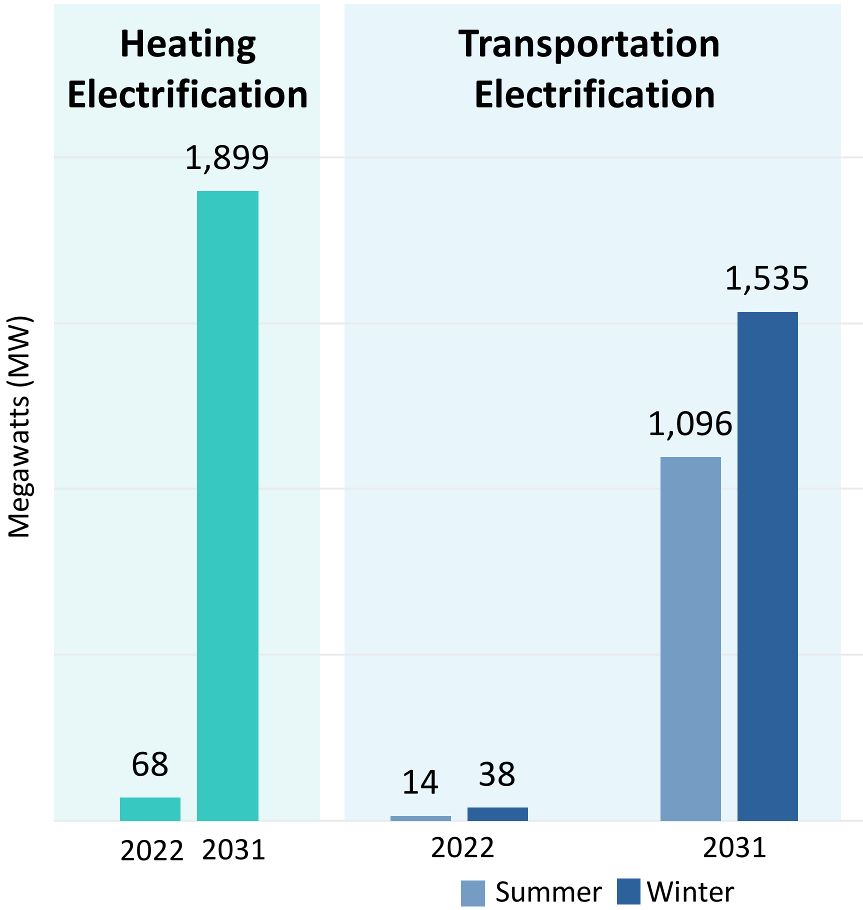
Source: ISO Generator Interconnection Queue, FERC Jurisdictional Proposals; Nameplate Capacity Ratings.

ISO's Electrification Forecast Shows Demand Growth

- The ISO began including **forecasted impacts** of heating and transportation electrification on state and regional electric energy and demand in the 2020 CELT report
- In New England by **2031**, the ISO forecasts that there will be:

  > 1.1 million air-source heat pumps

  > 1.5 million electric vehicles



Sources: : ISO New England 2022-2031 Forecast Report of Capacity, Energy, Loads, and Transmission (2022 CELT Report) (May 2022), Final 2022 Transportation Electrification Forecast, and Final 2022 Heating Electrification Forecast

2050 TRANSMISSION STUDY

Evaluating the transmission system in 2035, 2040, and 2050

2050 Transmission Study: A High-Level Study for the Years 2035, 2040, and 2050

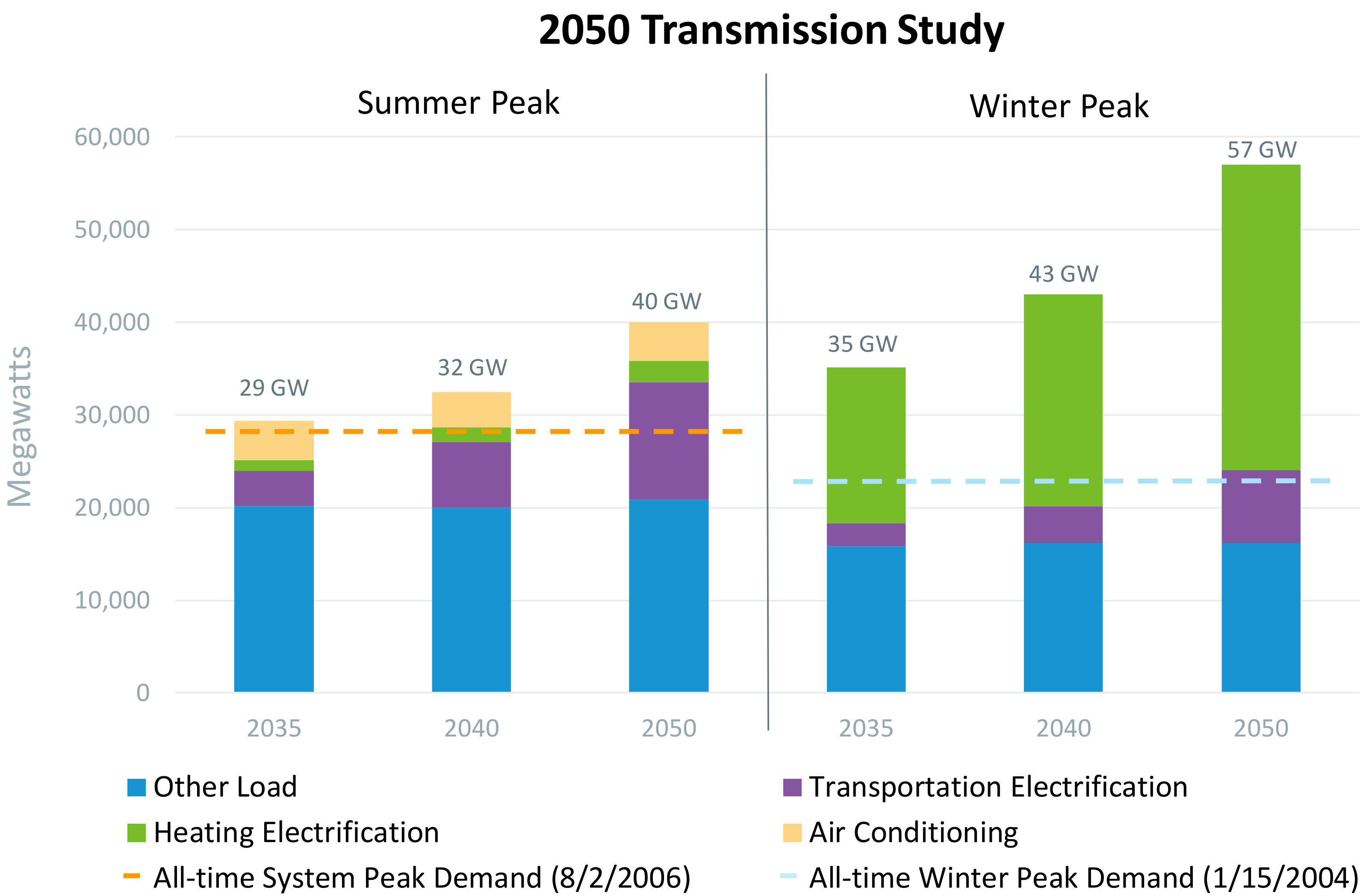
- Initial study scope and assumptions developed **in conjunction with the states**
- Aims to **inform the region** of the amount, type, and high-level cost estimates of **transmission infrastructure** that would be *needed to cost-effectively and reliably serve peak loads*, including electrified transportation and heating, in a clean-energy future
- Study looks **well beyond** the ISO's typical 10-year horizon for transmission planning
- It is ***not*** a plan to build specific projects

The most up-to-date information on the 2050 study is available at the Planning Advisory Committee and Longer-Term Transmission Studies webpages.

2050 Transmission Study Overview

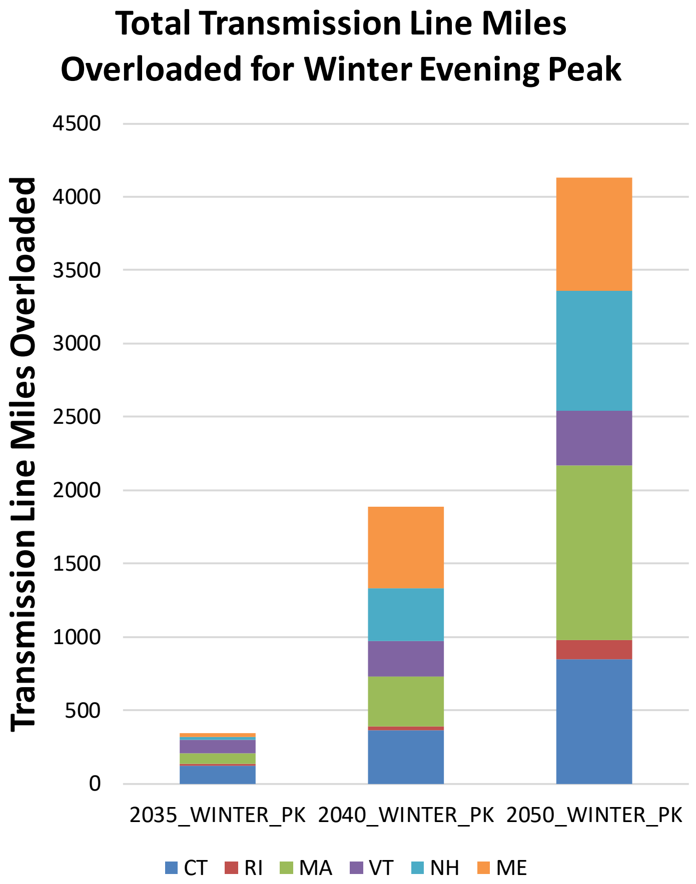
- The assumptions used for the 2050 Transmission Study represent numerous **paradigm shifts** for New England
  - Shift from a *summer-peaking* area to a *winter-peaking* area
  - Rapid growth in the development of *renewable* resources
  - Electrification of *heating* and *transportation* more than doubles the amount of peak power consumption by 2050
- Achieving a **load-generation balance** with the input assumptions requires:
  - The dispatch of *some fossil units* for energy balance in all snapshots
  - Additional resources beyond the input assumptions to meet the load in the Summer Evening and Winter snapshots
- Significant **new transmission** may be needed to reliably serve load under the assumptions analyzed in this study
  - With the current resource location assumptions, the *paths between North and South* would need significant upgrades to transfer surplus generation in Northern New England to generation-deficient Southern New England

New England System Peak Grows Substantially and Shifts to Winter-Peaking



Results Show Overloads on Half of Region's Transmission Lines

- Results show overloads on approximately 50% of New England's transmission line mileage by 2050
- Further analysis showed fewer overloads at a lower, 51 GW (winter peak) level, so that will be the focus of the primary solution set



Solution Development Progress

- Solution development has focused initially on Boston
  - As the major load center, it drives many transmission needs
- Challenges to solution development in Boston:
  - Underground cables with low ratings must both serve load and handle through-flow from one part of the Boston area to another
  - Due to the large number of overloads, adjustments to generation and phase shifters tend to solve one problem while worsening another
- Outside of dense urban areas, many concerns can likely be resolved through incremental upgrades (rebuilding/reconductoring existing lines)
- ISO-NE is currently evaluating bids from consultants to provide high-level cost estimates for conceptual transmission upgrades
  - To save time and study costs, minor/incremental upgrades will rely on per-mile cost assumptions rather than detailed estimates

Solution Development: Initial Takeaways

- Generator interconnection locations are critical
  - Interconnecting in southern New England rather than northern New England tends to reduce transmission needs because supply would not be competing for space to move along an already constrained North-South transmission corridor
- Additional 345/115 kV transformation capacity is required
  - Serving peak load from remote renewable resources requires long-distance transmission at high voltage, and then transformation to reach local substations
  - Generator interconnections directly to the 115 kV network may help, but often require upgrades on the 115 kV system instead

Next Steps

- Continue transmission solution development for the "primary" 2050 solution set
- Determine subsets of upgrades required for 2035 and 2040
- Expand solutions set to fully address the original 57 GW winter peak snapshot
- Work with selected consultant to develop cost estimates
- Next update to NESCOE/PAC likely to occur in Q4 2022
  - Updates on solution development
  - Solution alternatives for 2050 in selected areas of New England

2050 Transmission Study: Two Phases

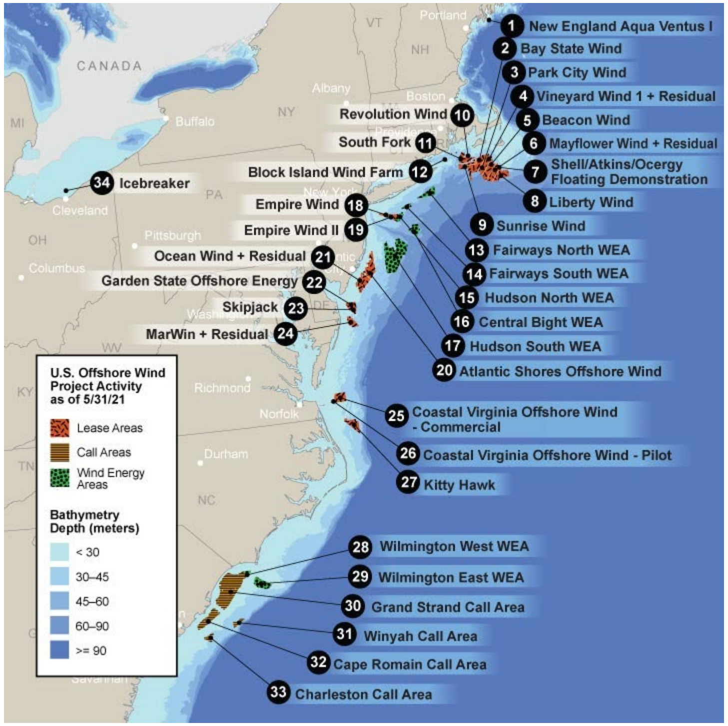
- **Extended-Term/Longer-Term Transmission Planning**
  - In 2022, FERC approved the first phase of changes to Attachment K of the OATT, creating a process that *allows the New England States to request* the ISO to perform planning analyses that may extend beyond the 10-year planning horizon that would provide visibility into the transmission investment needed to further state energy policy objectives
    - The current 2050 transmission study meets these criteria
  - The second phase of changes is intended to provide a process for the states to move public policy-related transmission investments forward along with the associated cost-allocation methodology
    - The process is intended to allow conversion of longer-term transmission studies into developable projects
  - Stakeholder discussions on Phase 2 are planned to begin in late 2022/early 2023, with a potential FERC filing in Q2/Q3 2023
    - Ongoing processes at FERC may further inform this effort

OFFSHORE WIND INTERCONNECTION EFFORTS

Regional Offshore Wind Transmission Study and Cape Cod Cluster Studies

ISO-NE Is Participating in the Atlantic Offshore Wind Transmission Study with the US DOE National Labs

- **US DOE Study Objectives**:
  - Evaluate coordinated transmission solutions to enable offshore wind deployment along the U.S. Atlantic Coast, addressing gaps in previous analyses
  - Compare different transmission technologies and topologies, quantify costs, assess reliability and resilience, and evaluate key environmental and ocean co-use issues
  - Produce timely results to inform decision making and offer feasible solutions, data, and models that may benefit stakeholders in their own planning processes.
- Research is being conducting by the National Renewable Energy Laboratory and Pacific Northwest National Laboratory
- Report expected by Fall 2023

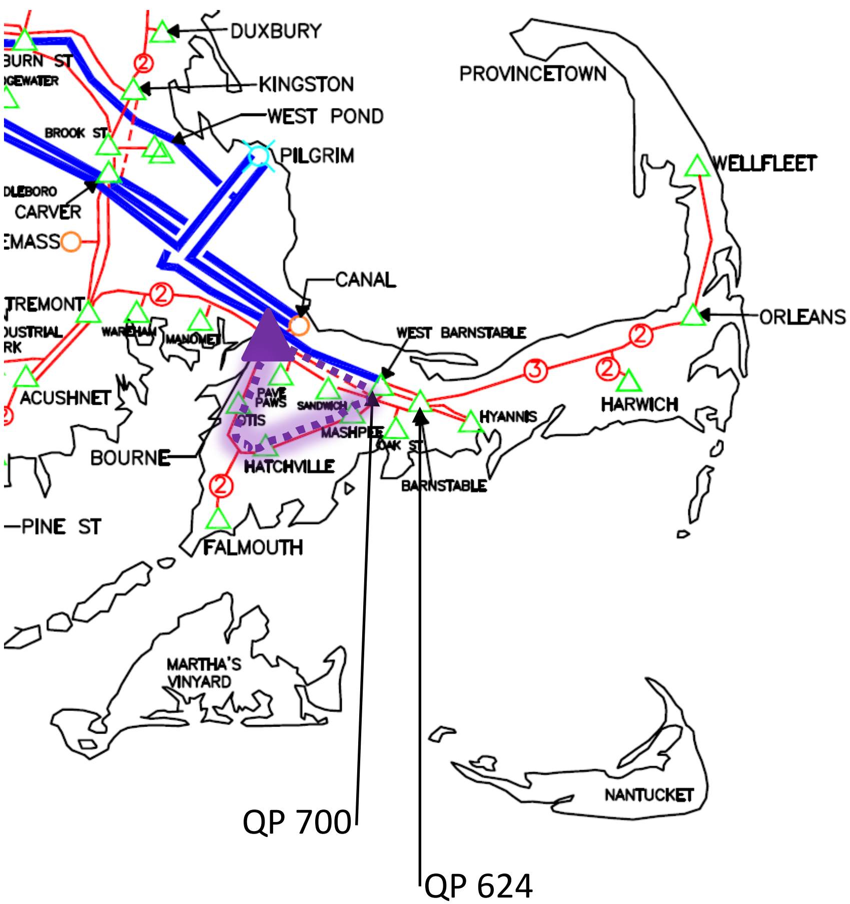


The locations of the current U.S. Atlantic Coast offshore wind projects being considered or developed as of April 30, 2021. *Image from the Offshore Wind Market Report: 2021 Edition*

Source: https://www.nrel.gov/wind/atlantic-offshore-wind-transmission-study.html

First Cape Cod Offshore Wind Cluster Study (2020)

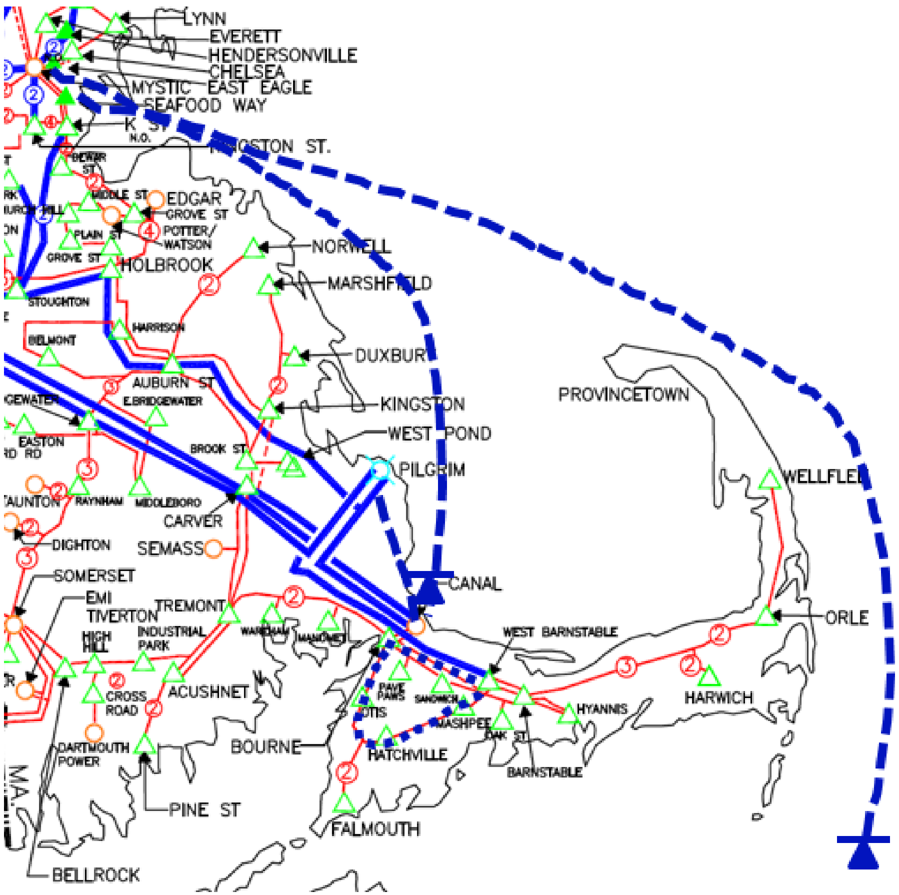
ISO Initiated the First Cape Cod Resource Integration (CCRIS) Study to Maximize Interconnection of Offshore Wind



- **1,600 MW** of offshore wind on Cape Cod have completed System Impact Studies and can interconnect immediately
- The ISO initiated the Cape Cod Resource Integration Study (CCRIS) to identify infrastructure upgrades to enable the interconnection of an additional 1,200 MW of offshore wind
- The First CCRIS determine that with the addition of a new 345 kV line on Cape Cod (Bourne – West Barnstable), **a total of 2,800 MW of offshore wind can interconnect on Cape Cod**
- The Cluster System Impact Study has filled and the study is progressing towards completion

Second Cape Cod Resource Integration Study (2021)

Builds on the First CCRIS by addressing issues identified for offshore wind additions greater than 2,800 MW in the Cape Cod area



- Approximately 1,200 MW of offshore generation is seeking to interconnect to Cape Cod and near Pilgrim Substation.
- Together the First and Second CCRIS **seek to interconnect ~4,000 MW of offshore wind.**
- Preliminary findings indicate that that the CETU for the Second CCRIS will be a radial 1,200 MW HVDC line from offshore wind lease areas directly to Boston
- The ISO anticipates concluding the Second CCRIS in the fourth quarter of 2022

Questions

DECEMBER 13, 2022 | WEBEX

2050 Transmission Study

Solution Development Update

Dan Schwarting, P.E.

MANAGER | TRANSMISSION PLANNING

Purpose & Outline of Today's Presentation

- Today's presentation is a progress update on transmission solution development for the 2050 Transmission Study
- All results presented today are preliminary and subject to change as the study progresses
- Today's presentation will cover the following topics:
  - 2050 Transmission Study Overview
  - Key Lessons Learned to Date
  - Solution Development Progress
  - Summary & Next Steps

2050 TRANSMISSION STUDY OVERVIEW

2050 Transmission Study Overview

- In accordance with a recommendation from NESCOE's October 2020 "*New England States' Vision for a Clean, Affordable, and Reliable 21st Century Regional Electric Grid*," ISO-NE is conducting the 2050 Transmission Study in order to determine:
  - Transmission needs in order to serve load while satisfying NERC, NPCC, and ISO-NE reliability criteria in 2035, 2040, and 2050
  - Transmission upgrade "roadmaps" to satisfy those needs considering both constructability and cost
- ISO-NE has coordinated with NESCOE throughout this study
  - In November 2021, ISO-NE introduced the 2050 Transmission Planning Study Scope of Work, preliminary assumptions, and methodology
  - ISO-NE presented results showing transmission reliability concerns in peak load snapshots in March 2022, April 2022, and July 2022
- Today's presentation is an update on transmission solution development

2050 Study Solution Development Process

Presented
April 28, 2022
PAC Meeting

2035 & 2040

- Subsets of primary solution set to fully address needs in 2035 and 2040

Primary Set

- 2050 Winter Evening Sensitivity (51 GW load)
- 2050 Summer Daytime Peak Sensitivity
- 2050 Summer Evening A & B

57 GW Winter

- Additional solutions to fully address original 2050 Winter Peak (57 GW load)

2050 Study Solution Development: Current Status

2035 & 2040

- Subsets of primary solution set to fully address needs in 2035 and 2040

Primary Set

- 2050 Winter Evening Sensitivity (51 GW load)
- 2050 Summer Daytime Peak Sensitivity
- 2050 Summer Evening A & B

57 GW Winter

- Additional solutions to fully address original 2050

Currently, solution development is underway for the primary solution set. Details on the exact work performed so far will follow later in this presentation.

KEY LESSONS LEARNED TO DATE

Key Lessons Learned To Date

- While solution development is still in progress, the process has already revealed a number of key lessons
- These lessons may help illuminate:
  - General approaches to developing the transmission system needed for 2035, 2040, and 2050
  - Strategic decisions that the region will face while interconnecting new renewable energy sources
  - Questions to be answered prior to undertaking more detailed studies

Key Lessons Learned To Date

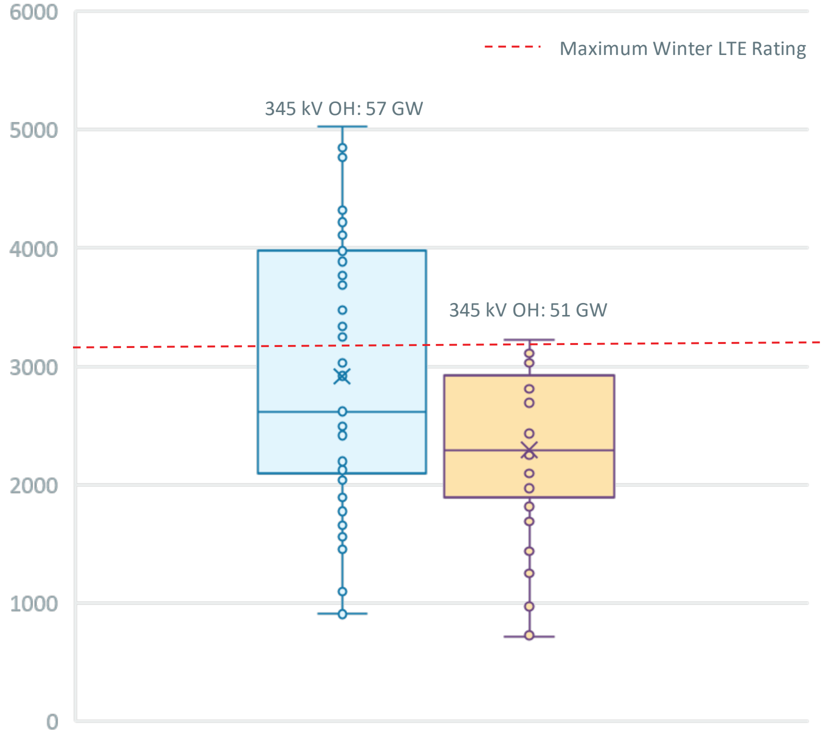
The following slides will discuss each of these lessons in further detail:

- Increasing Capacity of Existing Lines Is Effective
- 345/115 kV Transformers Are Critical
- Generator Sizes and Locations Can Affect Overloads
- Solutions Are Sensitive To Load Distribution

Increasing Capacity of Existing Lines Is Effective

- In many locations in New England, fully utilizing existing overhead transmission rights-of-way is enough to address many load-serving concerns in 2035, 2040, and 2050
- Solutions may include:
  - Reconductoring existing lines to increase current-carrying capacity
  - Replacing single conductors with double-bundled conductors
  - Rebuilding existing lines to accommodate the weight of larger conductors
  - Upgrading lines to higher operating voltage (e.g. 230 kV to 345 kV)

Increasing Capacity of Existing Lines Is Effective: Example



- Each dot on the graph represents the loading on an overloaded 345 kV line in the 51 GW and 57 GW 2050 Winter Peak snapshots
- The red line represents the typical maximum winter LTE rating of a 345 kV line
- Many overloads can be resolved by upgrading 345 kV lines to the largest standard conductor, rather than building brand-new lines
- Similar trend is true for 115 kV lines

345/115 kV Transformers Are Critical

- New England’s future transmission system will need to transfer power from remote renewable sources to dense population centers on 345 kV lines, and then step power down to 115 kV to serve individual substations
- In the 51 GW 2050 Winter Peak snapshot, 62 of New England’s 345/115 kV transformers are overloaded
- These transformers are expensive, and have a long lead time between the time an order is placed and delivery

Addressing 345/115 kV Transformer Overloads

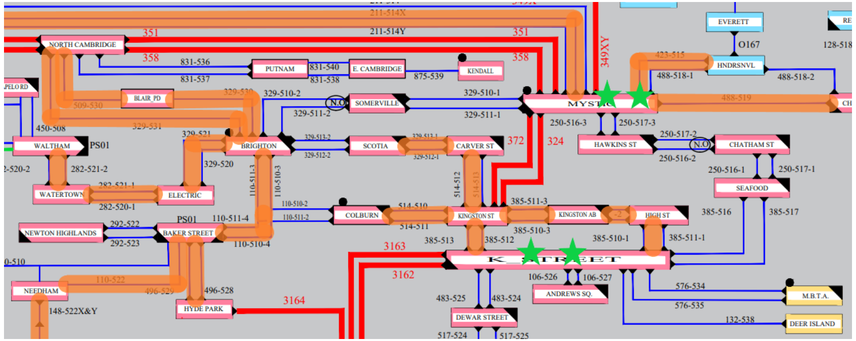
- In some cases, a single new 345/115 kV transformer can mitigate overloads on multiple existing transformers
- At other substations, overloads are severe enough that two new transformers are required
- When new renewable sources interconnect in or near load centers, interconnecting at 115 kV rather than 345 kV can reduce the need for additional 345/115 kV capacity

Generator Sizes and Locations Can Affect Overloads

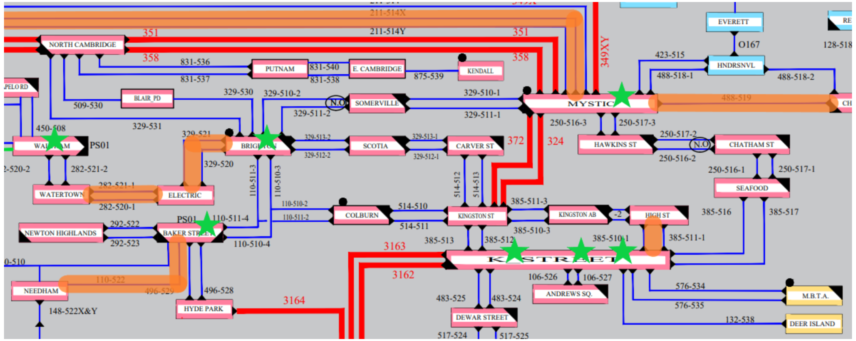
- Strategically locating points of interconnection (POIs) for new generating resources can reduce transmission overloads
- Previous 2050 Transmission Study presentations discussed locating generation in southern New England to reduce North-South stresses
- Further analysis has shown that location on a finer scale is also critical to limiting overloads
  - Choice of individual substations in urban areas
  - Choice of voltage level within a substation (115 vs. 345 kV)

Impacts of Generator Size and Location

Original approach: multiple large offshore wind interconnections at Mystic and K Street 345 kV



Potential optimized approach: smaller individual offshore wind interconnections at various 115 kV stations in and around Boston (including relocations from outside Boston)



In both figures, orange highlights show overloaded lines in the 51 GW 2050 Winter Peak snapshot. **Green** stars show the location of offshore wind interconnections.

Generator Size: Inherent Trade-Offs

- Large offshore wind interconnections, especially in Boston, can lead to overloads leaving the point of interconnection
- Smaller offshore wind interconnections can avoid this problem, but a trade-off exists:

Smaller wind interconnections
- Lower transmission upgrade costs
- Higher number of offshore connections
- Higher number of HVDC converters
- Higher generator lead costs

Larger wind interconnections
- Higher transmission upgrade costs
- Lower number of offshore connections
- Lower number of HVDC converters
- Lower generator lead costs

Generator Size: Proposal for Further Analysis

- To ensure efficient solution development in the Boston area, ISO-NE proposes to continue optimizing wind farm POI locations
- The trade-off between wind farm size and transmission upgrades will be addressed by choosing a standard wind farm size of 1200 MW for POIs in the Greater Boston area
  - 1200 MW is a common size in European offshore wind interconnections
  - Minimizes the number of HVDC converter stations and offshore connections without exceeding the 1200 MW source loss limit or requiring extensive transmission upgrades at the POIs
- Substations with multiple offshore wind interconnections (totaling greater than 1200 MW) will remain outside of Greater Boston, where fewer overloads are encountered in moving large amounts of wind out of POIs

Solutions Are Sensitive to Load Distribution

- Distribution of load among the substations in New England plays a critical role in transmission line/transformer loading
- Maximum load loss criteria of 300 MW for an N-1-1 contingency pair further sensitizes results to load distribution
- Load distribution is unlikely to drastically change the New England-wide total cost of upgrades, but influences the exact solutions chosen for longer-term transmission studies

Load Distribution: Examples

- A 115 kV load-serving substation in the Boston area is fed by two 115 kV lines, and has 308 MW of load
  - To avoid a 300 MW N-1-1 load loss, at least one new transmission line is required
  - A 10 MW reduction in load would eliminate this requirement
  - Other stations in the Boston area have just under 300 MW, and could drive new transmission lines if load is slightly increased
- A 115 kV overhead transmission line in central Vermont is loaded to 101.3% of its LTE rating
  - A small (~5 MW) shift in load from one end of the line to the other could be enough to drop the line's flow below 100% of LTE, eliminating an upgrade from the final solutions set

Load Distribution: Future Data Requirements

- In the 2050 Transmission Study, ISO-NE assumed that electrification leads to equal rates of load growth at each substation in a state
- Unequal load growth rates and changes in load distribution over time may eliminate some concerns identified in this study, or lead to other concerns not identified here
- In future longer-term transmission studies, ISO-NE may request substation-specific load growth information from transmission/distribution companies

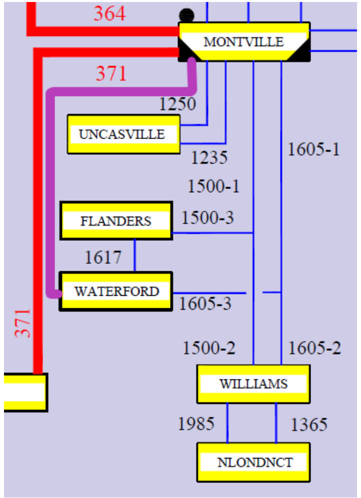
SOLUTION DEVELOPMENT PROGRESS

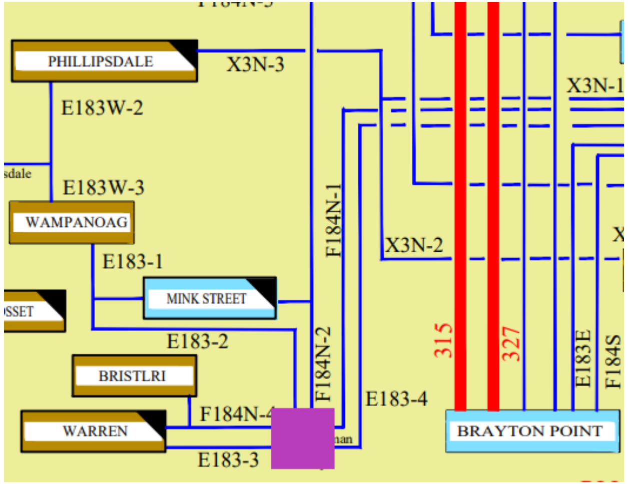
Solution Development Approach

- Most solution development so far has focused on urban areas
  - Highest density of load
  - More underground transmission, which cannot be upgraded in-place as easily as overhead transmission
  - The 2050 Transmission Study will suggest solutions for any location in New England where overloads are observed, whether in an urban area or not
- Focus is initially on the 51 GW 2050 Winter Peak snapshot
  - Winter peak snapshot shows the greatest extent of overloads, and solutions for winter peak will likely address summer peak overloads
  - Offshore wind POI relocation is occasionally spot-checked in summer peak snapshots, where wind output is assumed to be lower, to ensure that solutions remain effective during summer peak conditions

Solutions to Address 300 MW N-1-1 Load Loss

- A number of solutions are proposed to address N-1-1 contingency pairs that result in the loss of >300 MW of load
- For example:
  - Third line into an area served by two lines (center)
  - Switching station to break up line with multiple tapped load-serving stations (at right)





Overhead Line Rebuilds

- As described in the April 2022 PAC presentation, ISO-NE will use per-mile cost assumptions for line rebuild/reconductoring
- Cost assumptions have been developed through an analysis of past asset condition rebuilds
- Assumed costs shown at right

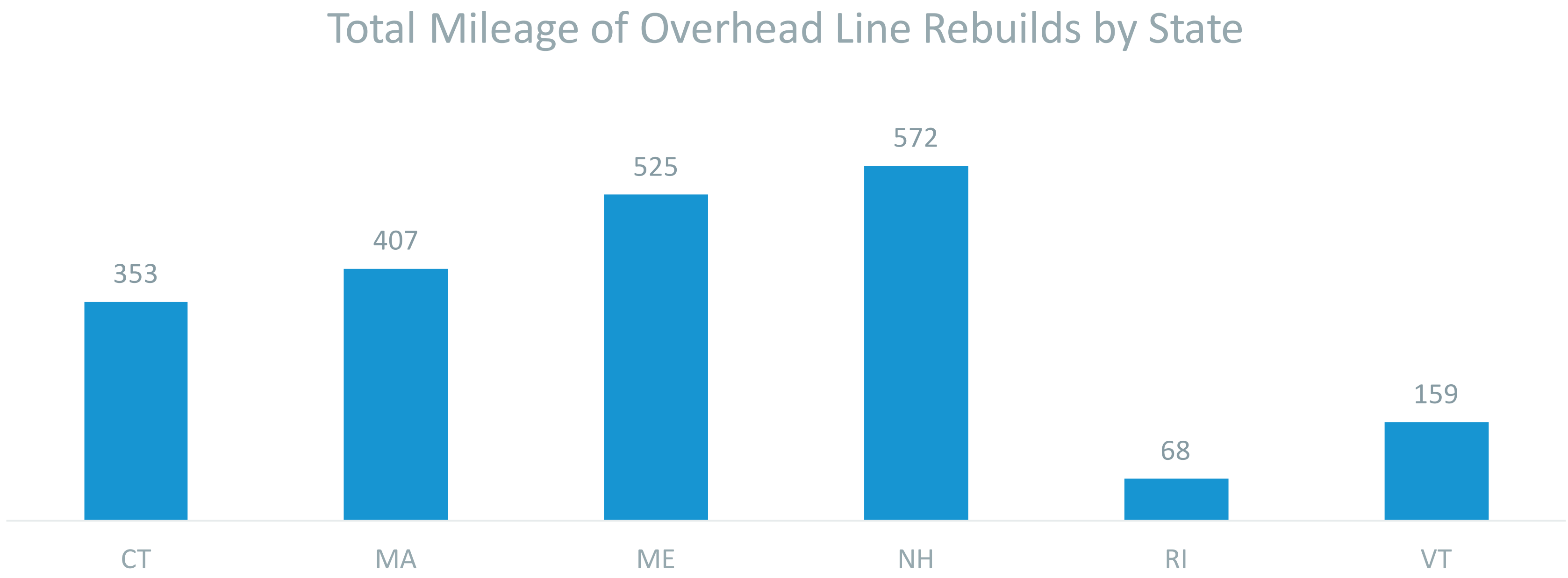
Voltage	Assumed Cost
69 kV	$2M/mile
115 kV	$2M/mile
230 kV	$3M/mile
345 kV	$5M/mile

Overhead Line Rebuilds

- Preliminary total mileage of existing lines to be rebuilt for higher capacity, and assumed cost, shown here
  - Breakdown of mileage by state shown on the next slide
- Some lines may need to be rebuilt for asset condition by 2050, so estimated costs may partially overlap with asset condition projects

Voltage	Miles of Rebuilt Lines	Assumed Cost
69 kV	111	$0.22 billion
115 kV	1,491	$2.98 billion
230 kV	63	$0.19 billion
345 kV	419	$2.09 billion
Total	**2,084**	**$5.48 billion**

Overhead Line Rebuilds: Mileage by State



Numbers indicate preliminary total mileage of existing lines to be rebuilt for higher capacity. Results subject to change as study progresses.

Southwest Connecticut: Preliminary Solutions

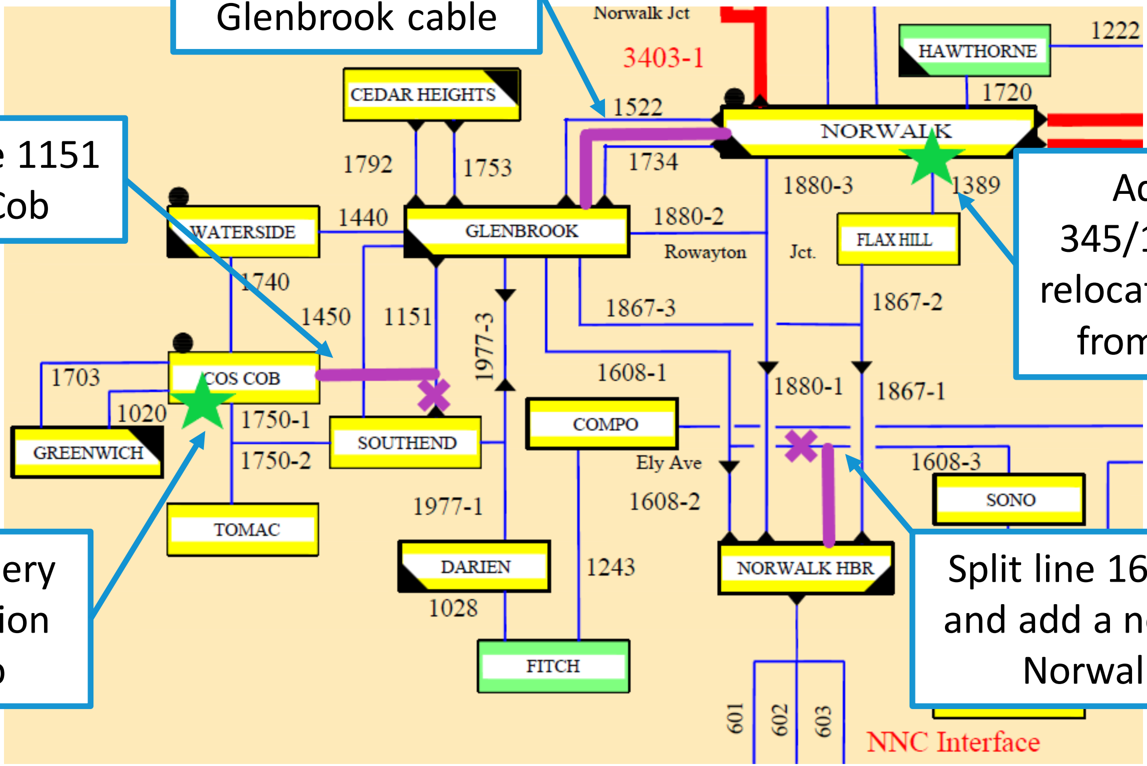
Third Norwalk-Glenbrook cable

Extend line 1151 to Cos Cob

Add third Norwalk 345/115 kV transformer, relocate offshore wind POI from 345 kV to 115 kV

Relocate battery interconnection to Cos Cob

Split line 1608 at Ely Ave and add a new cable into Norwalk Harbor



Boston Area: Solution Development Progress

- Strategic relocation of offshore wind POIs has reduced the extent of overloads in Boston
  - Preliminary list of POIs shown at right

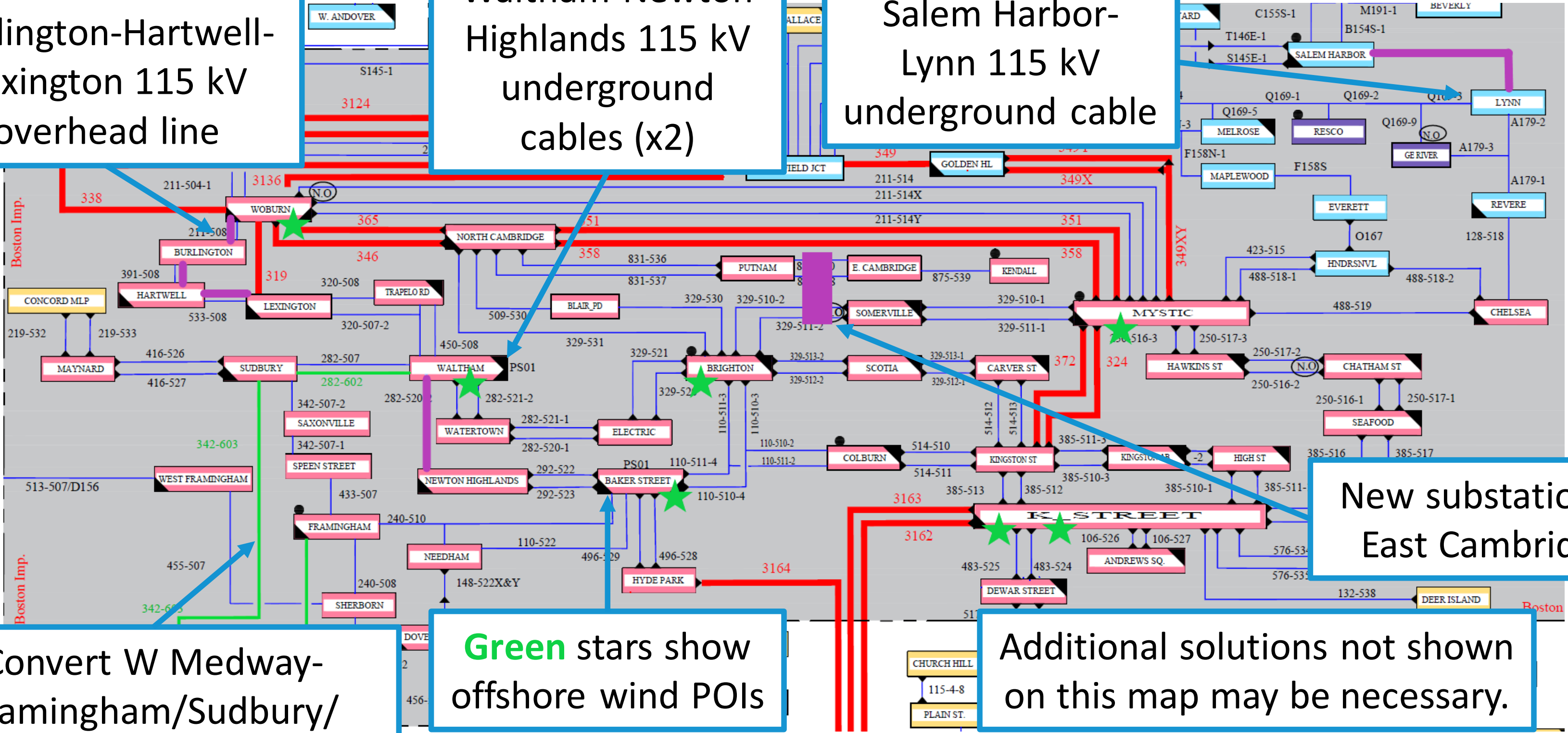
Substation	OSW Size
K Street 345 kV	1200 MW
Mystic 115 kV	1200 MW
K Street 115 kV	1200 MW
Woburn 115 kV	1200 MW
Brighton 115 kV	1200 MW
Waltham 115 kV	1200 MW
Baker Street 115 kV	1200 MW

Boston Area: Preliminary Solutions

Second Woburn-Burlington-Hartwell-Lexington 115 kV overhead line

Waltham-Newton Highlands 115 kV underground cables (x2)

Salem Harbor-Lynn 115 kV underground cable



New substation in East Cambridge

Convert W Medway-Framingham/Sudbury/ Waltham 230 kV to 345 kV

Green stars show offshore wind POIs

Additional solutions not shown on this map may be necessary.

SUMMARY AND NEXT STEPS

Summary and Key Take-Aways

Increasing Capacity of Existing Lines Is Effective

345/115 kV Transformers Are Critical

Generator Sizes and Locations Can Affect Overloads

Solutions Are Sensitive To Load Distribution

Solution development is still in progress, so exact transmission solutions shown today should be regarded as preliminary and subject to change.

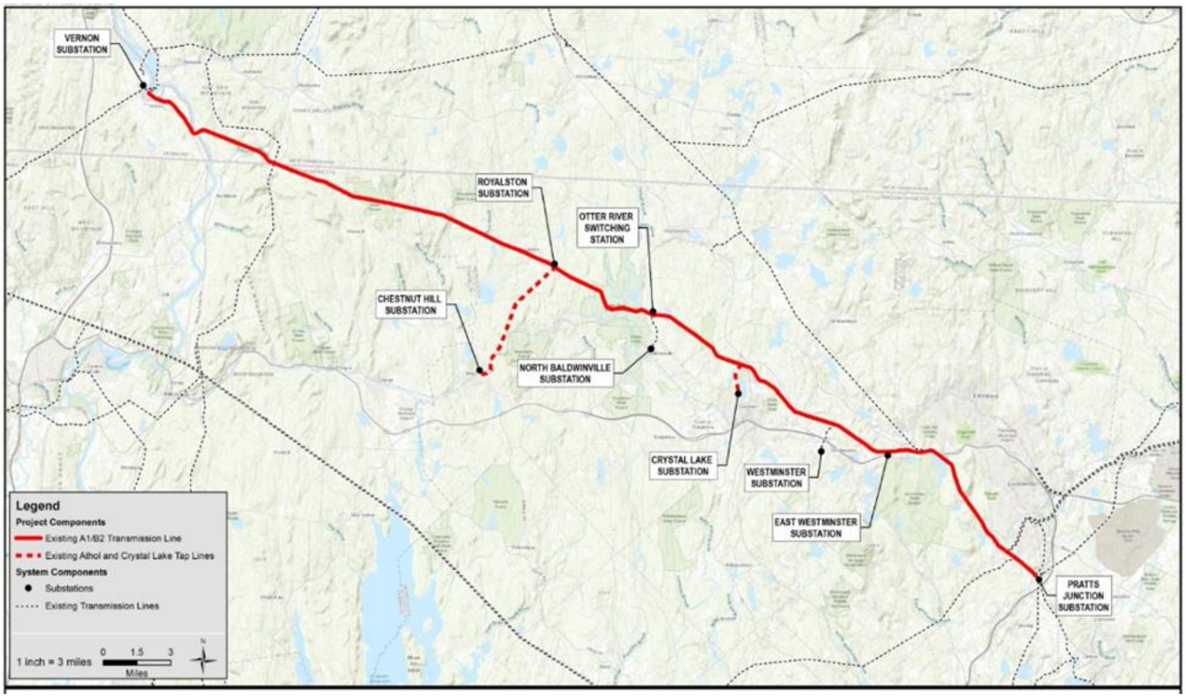
Next Steps

- Feedback on this 2050 Transmission Study presentation may be submitted to pacmatters@iso-ne.com by January 3, 2023
- Solution development work will be ongoing throughout 2023
- Consultant has begun to develop cost estimates for more complex/challenging solution components
- Next update to PAC anticipated in late Q1/early Q2 2023

Questions

A1/B2 Asset Condition Refurbishment Project

Route Selection Process - Supporting Information
Appendix 4-1



<u>Prepared for:</u>
New England Power Company
170 Data Drive
Waltham, MA 02451

BSC Project No. 89620.66

BSC GROUP
BUILD | SUPPORT | CONNECT

Appendix 4-1

Table A: Electric Transmission Line Corridors

ROW	Operating Company	Approximate Location
ROW 1	NEP I135N/J136N	This is an estimated 130-to-175-foot-wide transmission ROW that runs approximately 33 miles NW/SE through the Flag Pond Substation near the eastern corner of the Study Area. The line passes through the towns of Leominster and Ashburnham. For most of its length, this ROW contains 115 kV overhead transmission lines (I135N/J1136N). A portion of this ROW also contains 345 kV Eversource overhead transmission line (367) in addition to the 115 kV lines. NEP controls majority of this ROW in fee or easement in Massachusetts.
ROW 2	Eversource 379	This is an estimated 100-to-275-foot-wide ROW that runs approximately 20 miles E/W through the northern corner of the Study Area in New Hampshire. For most of its length, this ROW contains 345 kV overhead transmission line (379). A portion of the ROW contains 115 kV NEP overhead transmission line (A152) in addition to the 345 kV lines. Eversource controls the majority of this ROW in fee or easement.
ROW 3	NEP E205E	This is an estimated 100-to-275-foot-wide transmission ROW that runs approximately 59 miles SW/W through the eastern corner of the Study Area. The line passes through the towns of Princeton, Barre, New Salem, Wendell, Erving, and Colrain. For most of its length, the ROW contains 230 kV overhead transmission line (E205E). A portion of the ROW contains 115 kV NEP overhead transmission lines (A127/B128) in addition to the 230 kV lines. NEP controls this ROW in fee or easement.
ROW 4	NEP D4	This is an estimated 75-to-350-foot-wide transmission ROW that runs approximately 13 miles SW through the north-western corner of the Study Area. The line passes through the towns of Colrain and Leyden, Massachusetts and Vernon, Vermont. The ROW contains one 69 kV overhead transmission line (D4). NEP controls this ROW in fee or easement.
ROW 5	Eversource 381	This is an estimated 115-to-315-foot-wide transmission ROW that runs approximately 19 miles N/S through the north-western corner of the Study Area. The line passes through the towns of Hinsdale and Winchester, New Hampshire. For most of its length, the ROW contains 345 kV overhead transmission line (381). A portion of the ROW contains 115 kV NEP (N186) and 345 kV Eversource (379) overhead transmission lines in addition to the 345 kV line. Eversource controls this ROW in fee or easement in Massachusetts.
ROW 6	Eversource 312	This is an estimated 125-to-150-foot-wide transmission ROW that runs approximately 1.4 miles N/S towards south-western corner of the Study Area. The line passes through the town of Montague and Wendell. The ROW contains 345 kV overhead transmission line (312). Eversource controls this ROW in fee or easement.
ROW 7	NEP G33	This is an estimated 115-to-315-foot-wide transmission ROW that runs approximately 2.5 miles N/S through the north-western corner of Study Area in New Hampshire and Vermont. The line passes through the towns of Hinsdale and Winchester, New Hampshire and Vernon, Vermont. The ROW contains one 69 kV overhead transmission line (G33). NEP controls this ROW in fee or easement in New Hampshire and Vermont.
ROW 8	NEP K137W/ L138W	This is an estimated 75-to-250-foot-wide transmission ROW that runs approximately 7 miles NE/SW through the eastern corner of the Study Area. The line passes through the towns of Lancaster and Shirley. For most of its length, this ROW contains 115 kV overhead transmission line (K137W/L138W). A portion of the ROW contains 345 kV Eversource overhead transmission lines (314 & 343) in addition to the 115 kV lines. NEP and Eversource control this ROW in fee or easement.

ROW 9	NEP U21S/V22S	This is an estimated 75-to-130-foot-wide transmission ROW that runs approximately 18 miles NE/SW through the eastern corner of the Study Area. The line passes through the town of Leominster. The ROW contains one 69 kV overhead transmission line (U21S/V22S). NEP controls this ROW in fee or easement.
ROW 10	NEP J136S	This is an estimated 130-to-185-foot-wide transmission ROW that runs approximately 3 miles N/S through the eastern corner of the Study Area. The ROW contains one 115 kV overhead transmission line (J136S). The line passes through the town of Leominster. NEP controls this ROW in fee or easement.

Appendix 4-1

Table B: Railroad Corridors

Railroad/Operating Company	Approximate Location
MassDOT/Connecticut River Line – Amtrak/Pan Am Railways, Inc ("PAR")	The Connecticut River Line runs approximately 15 miles north-south through the northwestern corner of the Study Area. The railway is typically 50-feet wide and runs through undeveloped, agricultural, and moderately-developed areas of north-central Massachusetts. Some of the towns which intersect this railroad within the Study Area include Northfield and Bernardston. The Connecticut River Line intersects the Central Vermont Railroad and Patriot Corridor.
Boston and Maine Railroad/Patriot Corridor/ Ware River Branch/ Pan Am Southern ("PAS")	The Patriot Corridor runs approximately 45 miles east-west through the north-central half of the Study Area. Portions of the corridor are located in the vicinity of the Wendell Depot Substation, Chestnut Hill Substation, North Baldwinville Substation, Ashburnham Substation, Flagg Pond Substation, and Protech Street Substation. The railway is typically 40-150 feet wide. Some of the towns which intersect this railroad within the Study Area include Montague, Erving, Orange, Athol, Phillipston, Royalston, Templeton, Gardner, Ashburnham, Westminster, Leominster, and Fitchburg.
Central Vermont Railway/New England Central Railroad Genesee and Wyoming ("G&W")	The Central Vermont (aka VT & MA) Railway runs approximately 14 miles north-south through the northwestern portion of the Study Area. In the Study Area, the railway is typically 50-60 feet wide and mostly travels through agricultural and low-density residential areas of southern Vermont and north-central Massachusetts. Some of the towns which intersect this railroad within the Study Area include Vernon, Vermont, and Northfield, Montague, and Erving.
Providence and Worcester Railroad ("P&W")/ G&W - Gardner Branch P&W/PAR	The Gardner Branch runs 25 miles generally north-south through the southeastern portion of the Study Area. The Railway is typically 80-feet wide when it does not share a ROW, and mostly travels through residential areas and vacant forested land, as well as commercial areas. This line is used for freight operations and is owned by the Providence and Worcester Railroad. The Gardner Branch intersects the municipalities of Gardner, Hubbardston, and Princeton.
Boston and Maine Railroad - MBTA Fitchburg	The Fitchburg Line runs east-west through the Study Area in the vicinity of the Pratts Junction Substation No. 225 in Sterling, Massachusetts. In the Study Area, the Fitchburg Line intersects the municipalities of Fitchburg and Leominster.
CSX - Fitchburg Secondary	The CSX Fitchburg Subdivision runs north-south through the Study Area in the vicinity of the Pratts Junction Substation No.225 in Sterling. In the Study Area the CSX Fitchburg secondary line connects to the Patriot Corridor.
Local Lines	Several local railroad lines are located in the northeast corner of the Study Area in the area of Winchendon.

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Table C: Highway and Major Roadway Corridors

Highway and Roadway	Description
Interstate Route 190 (I”-190”)	I-190 is located in the eastern portion of the Study Area and runs north-south through the towns of Lancaster and Leominster.
Interstate Route 91 (“I-91”)	I-91 is located in the western portion of the Study Area and runs north-south through the towns of Bernardston and Greenfield and into Vermont.
State Route 10	Route 10 is located in the western portion of the Study Area and runs east-west through the towns of Northfield and Gill and into New Hampshire.
State Route 101	Route 101 is located in the south portion of the Study Area and runs east-west through the towns of Philipston, Templeton, Gardner, and Ashburnham.
State Route 112	Route 112 is located in the south-east portion of the Study Area and runs north-south through the town of Colrain and into Vermont.
State Route 12	Route 12 is located in the south-east portion of the Study Area and runs north-south through the towns of Leominster, Fitchburg, Winchendon, and Ashburnham.
State Route 122	Route 122 is located in the southern portion of the Study Area and runs north-south through the towns of Barre, Petersham, Orange, Fitchburg, Winchendon, and Ashburnham.
State Route 13	Route 13 is located in the south-east portion of the Study Area and runs north-south through the town of Leominster.
State Route 140	Route 140 is located in the central portion of the Study Area and runs north-south through the towns of Leominster, Westminster, Gardner, and Winchendon.
State Route 142	Route 142 is located in the central portion of the Study Area and runs north-south through the towns of Bernardston, Gill, and Northfield (west of Connecticut River) , and into Vermont.
State Route 2	Route 2 is a state highway in Massachusetts that runs east-west through the Study Area, but well to the north of the Pratts Junction Substation.
State Route 2A	Route 2A is a state highway in Massachusetts that weaves around its parent Route 2A and generally runs east-west through the Study Area, but well to the north of the Pratts Junction Substation.
State Route 31	Route 31 is located in the south-east portion of the Study Area and runs north-south through the towns of Princeton and Leominster.
State Route 32	Route 32 is located in the central portion of the Study Area and runs north-south through the towns of Petersham, Athol, Royalston before crossing into New Hampshire.
State Route 62	Route 62 is located in the south portion of the Study Area and runs east-west through the towns of Barre and Princeton.
State Route 63	Route 63 is located in the south-west portion of the Study Area and runs east-west through the towns of Gill and Northfield, and into Vermont.
State Route 68	Route 68 is located in the central portion of the Study Area and runs north-south through the towns of Hubbardston, Gardner, and Royalston.
State Route 70	Route 70 is located in the south-east portion of the Study Area and runs north-south through the town of Leominster.
State Route 78	Route 78 is located in the south-west portion of the Study Area and runs north-south through the towns of Orange and Warwick.
US Highway Route 202	Route 202 is a state highway in Massachusetts located in the south portion of the Study Area. Route 202 runs north-south through the towns of Athol, Baldwinville, and Winchendon and into New Hampshire.
US Highway Route 5	Route 5 runs is a state highway located in the south-west portion of the Study Area and runs north-south through the town of Bernardston and into Vermont.

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Table D: Electric Transmission Corridors Eliminated from Further Consideration

Route	Explanation for elimination
ROW 1	• ROW does not maintain system function and operation, as there is no practical connection to the intermediate substations along the Existing Lines. ROW 1, in combination with ROWs 2 and 5, extends north-west from Flag Pond Substation, resulting in a longer route to the Vernon Substation.
ROW 2	• ROW does not maintain system function and operation, as there is no practical connection to the intermediate substations along the Existing Lines. ROW 2, in combination with ROWs 1 and 5, extends north-west from Flag Pond Substation, resulting in a longer route to the Vernon Substation.
ROW 3	• ROW does not maintain system function and operation, as there is no practical connection to the intermediate substations along the Existing Lines. ROW 3, in combination with ROW 4, extends south-west from Pratts Junction Substation, and results in a longer route to the Vernon Substation.
ROW 4	• ROW does not maintain system function and operation, as there is no practical connection to the intermediate substations along the Existing Lines. ROW 4, in combination with ROW 3, extends south-west from Pratts Junction Substation, and results in a longer route to the Vernon Substation.
ROW 5	• ROW does not maintain system function and operation, as there is no practical connection to the intermediate substations along the Existing Lines. • In addition, Eversource controls this ROW in fee or easement. Working within other utility corridors can result in access restrictions, working space constraints, safety concerns, traffic disruptions, and restrictive work hours.
ROW 6	• ROW does not maintain system function and operation, as there is no practical connection to the intermediate substations along the Existing Lines. • In addition, Eversource controls this ROW in fee or easement. Working within other utility corridors can result in access restrictions, working space constraints, safety concerns, traffic disruptions, and restrictive work hours.
ROW 7	• ROW does not provide alternative routing options in Massachusetts. ROW 7 passes through densely developed areas of Hinsdale, New Hampshire. This can result in access restrictions, workspace constraints, safety concerns, traffic disruptions, and restrictive work hours.
ROW 8	• ROW 8 offers alternative route segments that are over twice as long as the Project Route.
ROW 9	• ROW 9 has a higher urban density than the Project Route in this portion of the Study Area. • ROW 9 traverses through railroads and major highways, as well as landmarks such as North Nashua River, an Area of Critical Environmental Concern (ACEC), Class B posing high environmental impact.
ROW 10	• Combination with ROW 9 or 10, potential route options analyzed pass through areas with varying degrees of residential land uses (high, medium, low, and very low density and multi-family residential).

Table E: Railroad Corridors Eliminated from Further Consideration

Route	Description	Easement (feet)	Explanation for elimination
MassDOT/Connecticut River Line – Amtrak/PAR	Railroad	50	• This corridor runs north-south through the towns of Northfield and Bernardston, northwestern corner of the Study Area. This corridor does not provide access to an intermediate substation. • Easement rights would be required from rail owners to collocate facilities along rail corridor. Land acquisition and construction restrictions on working near active rail line would increase costs. • Restrictions on working near an active rail line would impact maintenance costs and emergency response.
Portion of the Boston and Maine Railroad/Patriot Corridor/ PAS	Railroad	40-150	• Portion of this corridor that runs east-west through the towns of Orange in the southwest portion of the Study Area does not provide access to the intermediate substation along the Existing Lines. • Easement rights would be required from rail owners to collocate facilities along rail corridor. • Restrictions on working near an active rail line would impact maintenance costs and emergency response. • Land acquisition and construction restrictions on working near active rail line would increase costs. • This corridor passes through densely developed residential and commercial areas with many crossroads and driveways in Fitchburg, Gardner, Baldwinville, Athol, and Orange which might increase potential to contribute to visual and noise impacts. • This corridor passes through 13 EJ areas, as opposed to the four intersected by the Project Route, as well as rare species habitat, wetlands and streams, major waterbody crossings and open space recreational areas. This would result in additional social/environmental impacts as compared to the Project Route.
Central Vermont Railway/New England Central Railroad	Railroad	50-180	• This corridor runs north-south through the towns of Northfield in the northwestern portion of the Study Area. This corridor does not provide access to an intermediate substation. • Easement rights would be required from rail owners to collocate facilities along rail ROW. • Land acquisition and construction restrictions on working near active rail line would increase costs. • Restrictions on working near an active rail line would impact maintenance costs and emergency response.
Portion of the P&W/ G&W - Gardner Branch P&W/PAR	Railroad	75-85	• Easement rights would be required from rail owners to collocate facilities along rail corridor. • Restrictions on working near an active rail line would impact maintenance costs and emergency response. • Land acquisition and construction restrictions on working near active rail line would increase costs.

Boston and Maine Railroad - MBTA Fitchburg Line	Railroad	60-250	• This corridor runs east-west through the towns of Fitchburg, Massachusetts in the eastern portion of the Study Area. This corridor does not provide access to an intermediate substation. • Easement rights would be required from rail owners to collocate facilities along rail corridor. • Land acquisition and construction restrictions on working near active rail line would increase costs. • Restrictions on working near an active rail line would impact maintenance costs and emergency response. • This corridor passes through densely developed residential and commercial areas with many crossroads and driveways which might increase potential to contribute to visual and noise impacts. • MBTA Fitchburg passes through 10 EJ communities, as opposed to the four intersected by the Project Route. This would result in additional social/environmental impacts.
CSX - Fitchburg Secondary	Railroad	30 - 250	• This corridor runs north-south through the towns of Leominster in the eastern portion of the Study Area. This corridor does not provide access to an intermediate substation. • Easement rights would be required from rail owners to collocate facilities along rail corridor. • Land acquisition and construction restrictions on working near active rail line would increase costs. • Restrictions on working near an active rail line would impact maintenance costs and emergency response.
Local Lines	Railroad	55 - 315	• This corridor runs east-west through the towns of Winchendon in the northern portion of the Study Area. This corridor does not provide access to an intermediate substation. • Easement rights would be required from rail owners to collocate facilities along rail corridor. • Land acquisition and construction restrictions on working near active rail line would increase costs. • Restrictions on working near an active rail line would impact maintenance costs and emergency response.

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Table F: Highway and Major Roadway Corridors Eliminated from Further Consideration

Route	Description	Easement (feet)	Explanation for elimination
I-190	Highway	50-230	• I-190 runs north-south through the towns of Lancaster and Leominster in the eastern portion of the Study Area. This corridor does not provide access to an intermediate substation. • Rights/Agreements would be required from the Massachusetts Department of Transportation ("MassDOT") to occupy the I1-90 corridor, which are not likely to be acquired due to the availability of other viable alternatives. • Unlikely to receive permission to locate in/along Interstate Route corridor, given the availability of the existing A1/B2 and Tap Line corridors. • Significant construction and improvement efforts would be required to create the general accessibility necessary for construction and future maintenance of the relocated lines.
I-91	Highway	120 - 350	• I-91 runs north-south through the towns of Lancaster and Leominster in the western portion of the Study Area. This corridor does not provide access to an intermediate substation. • Rights/Agreements would be required from the MassDOT to occupy the I-91 corridor, which are not likely to be acquired due to the availability of other viable alternatives. • Unlikely to receive permission to locate in/along Interstate Route corridor, given the availability of the existing A1/B2 and Tap Line corridors. • Significant construction and improvement efforts would be required to create the general accessibility necessary for construction and future maintenance of the relocated lines.
Portion of State Route 2/ 2A (west of the Chestnut Hill Substation)	Roadway	150-545	• Rights/Agreements would be required from MassDOT to occupy the US State Route 2/2A corridor, which are not likely to be acquired due to the availability of other viable alternatives. • Significant construction and improvement efforts would be required to create the general accessibility necessary for construction and future maintenance of the relocated lines. • Route 2 traverses through several DCR lands. Article 97 legislative approval would be required for installation of a new transmission corridor within Massachusetts DCR roads & trails. Additionally, working in these areas will result in new environmental impacts to open spaces. • This corridor passes through 25 EJ communities, as opposed to the four EJ communities intersected by the Project Route. This would result in additional social/environmental impacts as compared to the Project Route. • Route 2 passes through densely developed residential and commercial areas with many crossroads and driveways Leominster and Gardner which might increase potential to contribute to visual and noise impacts.

			• There are numerous historical and archaeological resources along the Route 2 corridor. Working within these resource areas might result in additional costs associated with redesign and/or required avoidance and protection efforts.
US Highway Route 5	Highway	50-150	• Rights/Agreements would be required from the MassDOT to occupy the Route 5 corridor, which are not likely to be acquired due to the availability of other viable alternatives. • Significant construction and improvement efforts would be required to create the general accessibility necessary for construction and future maintenance of the relocated lines. • Additional easement rights and/or land acquisition would be necessary along the ROW.
State Route 31	Roadway	40-95	• Significant construction and improvement efforts would be required to create the general accessibility necessary for construction and future maintenance of the relocated lines. • Additional easement rights and/or land acquisition would be necessary along the ROW. • Rights/Agreements would be required from MassDOT to occupy the Route 31 corridor, which are not likely to be acquired due to the availability of other viable alternatives. • Route 31 passes through densely developed residential and commercial areas with many crossroads and driveways in West Fitchburg which might increase potential to contribute to visual and noise impacts. • The width of Route 31 is approximately 40 to 95- feet, which is insufficient to accommodate new 115 kV-capable lines.
All other Major Roadways running perpendicular to the A1/B2 and Tap Line ROWs and/or are far removed from the Existing Lines.			

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Table G: Natural Gas Pipeline Corridor Eliminated from Further Consideration

Corridor	Explanation for elimination
Tennessee Gas Pipeline (TGP)	• ROW does not maintain system function and operation, as there is no practical connection to the intermediate substations along the Existing Lines. • Collocation with natural gas pipeline corridor can present safety concerns during construction and maintenance of a new transmission line, and these routes are generally avoided if a more feasible route is available.

PURPOSE/OBJECTIVE:
This document provides National Grid personnel, consultants and contractors with Best Management Practices (BMPs) for conducting work on electric and natural gas transmission and distribution rights-of-ways (ROWs) and substations in New England.

WHO:
These BMPs are to be followed by all personnel conducting work on Company electric and gas ROWs and substations in New England. These BMPs do not apply to Company employees and contractors performing routine vegetation management activities that are not a part of construction or re-construction projects. Employees and contractors maintaining vegetation on Company ROWs and substations must follow the National Grid ROW Vegetation and Substation Vegetation Management Plans.

DEFINITIONS:

Refer to **Glossary** in **Appendix 1** and **Acronyms** in **Appendix 2**.

WHAT TO DO:

1.0 Project Planning

Prior to the start of any project (proposed new facilities or maintenance of existing facilities), the Project Engineer or other project planner shall determine whether any environmental permits or approvals are required, per the state-specific EG-301 environmental checklists. Any questions regarding which activities may be conducted in regulated areas or within environmentally sensitive areas shall be referred to the National Grid Environmental Scientist or Project Environmental Consultant.

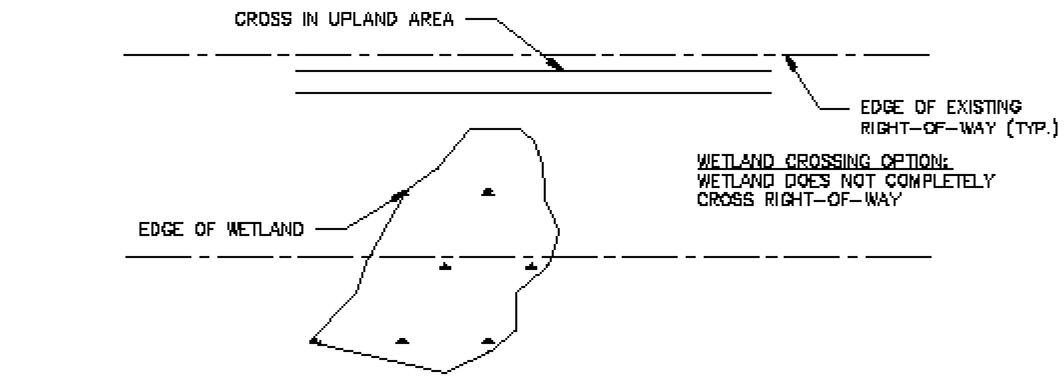
All new construction and maintenance projects shall follow clear and enforceable environmental performance standards, which is the purpose for which these BMPs have been compiled.

1.1 Avoidance and Minimization

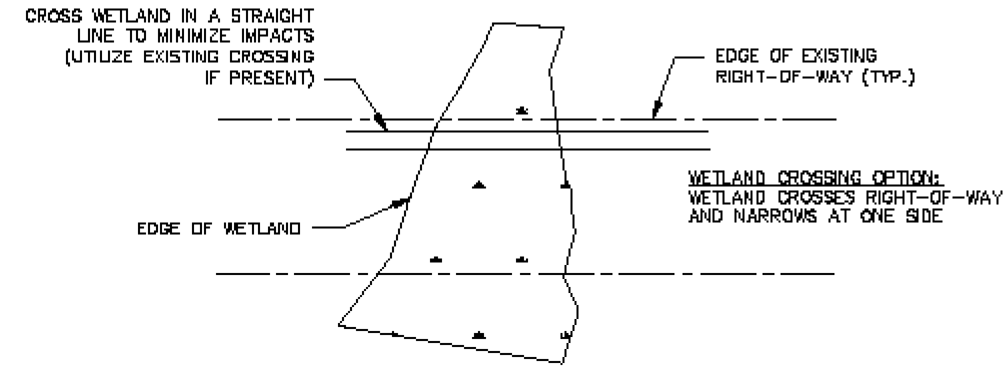
Measures shall always be taken to avoid impacts to wetlands, waterways, rare species habitats, known below and above ground historical/archeological resources and other environmentally sensitive areas. If avoidance is not possible, then measures shall be taken to minimize the extent of impacts. Alternate access routes or staging areas shall always be considered. Below is a list of methods that shall be considered where impacts are unavoidable:

- Use existing ROW access where available. Keep to approved routes and roads without deviating from them or making them wider.
- Off-ROW access shall never be assumed and shall be coordinated through National Grid Real Estate before being implemented.
- Where no existing ROW access is present, avoid wetlands and if a wetland crossing is necessary, cross wetlands at the most narrow point possible or at the location of a previously used crossing (if evident). Figure 1 below illustrates this minimization technique.

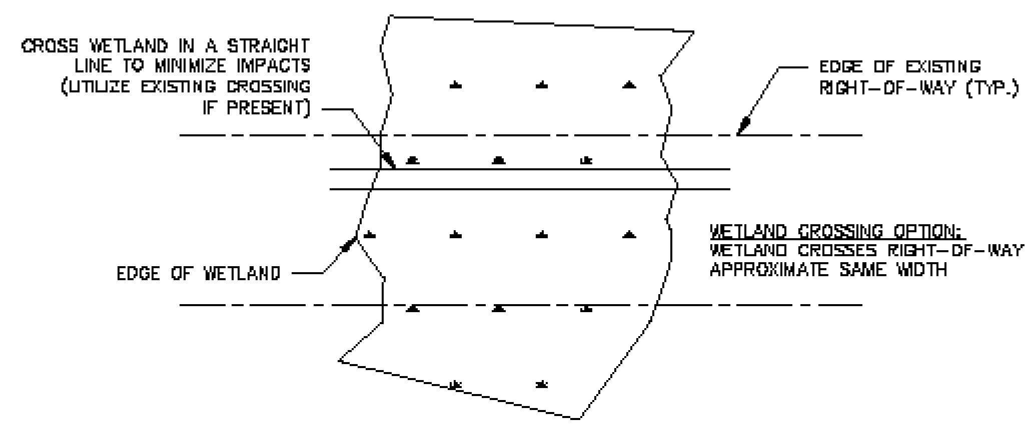
- Avoid and minimize stream crossings.
- Minimize the width of typical access roads through wetlands to a maximum width of 16 feet.
- Conduct work manually (without using motorized equipment) in wetlands, wherever possible.
- Use construction mats in wetlands to minimize soil disturbance and rutting when crossing or working within wetlands. When not using mats for access, standard vehicles shall not be allowed to drive across wetlands without the prior approval of the National Grid Environmental Scientist. Use of a low ground pressure (LGP) vehicle may be a feasible alternative to mats provided that such LGP vehicle use has been reviewed and approved by the National Grid Environmental Scientist. See Section 7.0.
- Coordinate the timing of work to cause the least impacts during the regulatory low-flow period under normal conditions, when water/ground is frozen, after the spring songbird nesting season, and, outside of the anticipated amphibian migration window (mid-February to mid-June). Refer to the United States Army Corps of Engineers (USACE) state-specific General Permit for the definition of the low-flow period in each state at: http://www.nae.usace.army.mil/Missions/Regulatory/State-General-Permits/. A summary table is provided in Section 7.0.
- Seek alternative routes or work methods to minimize impact.



WETLAND AVOIDANCE
FIGURE 1a – AVOIDANCE



WETLAND AVOIDANCE
FIGURE 1b – MINIMIZATION
(CROSSING AT NARROWEST LOCATION)



WETLAND AVOIDANCE
FIGURE 1c – MINIMIZATION
(CROSSING UNIFORM WIDTH IN A STRAIGHT LINE)

1.2 Historically Significant Areas

Areas that have been identified as historically and/or culturally significant shall be avoided in accordance with site-specific avoidance plans, as applicable. Refer to the project-specific Environmental Field Issue (EFI) for any applicable avoidance plans or consult with the National Grid Environmental Scientist. Demarcation of these areas to be avoided shall use staked orange snow fencing or an equivalent physical barrier (not just ribbon flagging) and signage. Refer to Section 14.0 for signage guidance.

1.3 Rare Species Habitat

Work within areas that have been identified as mapped rare species habitat shall follow site-specific requirements, as applicable. In Massachusetts, maintenance activities within mapped habitat (known as Priority Habitat of Rare Species) shall follow the BMPs outlined in the Natural Heritage Endangered Species Program (NHESP)-approved National Grid Operation and Maintenance Plan. Work in mapped rare species habitat may require, at a minimum, turtle training for crews and sweeps of work areas for turtles, botanist identification of rare plant locations and avoidance of these locations, and protection of vernal pools, all prior to the start of work. Demarcation of these areas to be avoided (e.g., rare plant populations, overwintering turtles, nests) shall use staked orange snow fencing or an equivalent physical barrier (not just ribbon flagging) and signage. Refer to Section 14.0 for signage guidance.

Where new substations are being constructed or existing substations are undergoing a rebuild or expansion, and the substations are located in mapped rare turtle habitat, project team members should consider fenceline improvements or measures needed to prevent/eliminate turtle entrance into the substation or allow multiple points for easy egress such that turtles are not trapped within the substation fenceline.

Other requirements may apply in NH, VT and RI. Refer to the project-specific EFI for any applicable measures or consult with the National Grid Environmental Scientist.

1.4 Meetings

Pre-permitting meetings shall take place early in the project development process to determine what permits are triggered by the proposed work and the timeline required for permitting. During these meetings, the team shall develop access plans and BMPs to be used during construction of the project.

Field / Constructability review meetings shall take place on-site to evaluate construction site access and job site set-up, to ensure that the project can proceed as permitted. It is at this point in time where work areas, pulling locations, laydown areas, parking areas, and equipment storage areas are evaluated and located. Off-ROW areas under consideration should be included in this discussion.

Prior to submitting permit plans to regulatory authorities, the construction group (contractor or National Grid) shall review the plans for final sign off.

Pre-construction meetings are typically held prior to the commencement of all work to appoint responsible parties, discuss timing of work, and further consider options to avoid and/or minimize impacts to sensitive areas. These meetings can occur on- or off-site and shall include all the willing and available stakeholders (i.e., utility employees, contractors, consultants, inspectors, and/or monitors, and regulatory personnel). Training of crews and supervisors of the EFI, Stormwater Pollution Prevention Plan (SWPPP), rare species, and other permit requirements shall be conducted at a pre-construction meeting.

Pre-job briefings shall be conducted daily or otherwise routinely scheduled meetings shall be conducted on-site with the work crew throughout the duration of the work. These meetings are a way of keeping everyone up to date, confirming there is consensus on work methods and responsibilities, and ensuring that tasks are being fulfilled with as little impact to the environment as possible.

The Project Environmental Scientist/Monitor and Construction Project Manager shall communicate regularly (e.g. weekly or bi-weekly meetings or phone conversations) to discuss the work completed since last communication (i.e. work locations, wetland impacts, equipment used, and unexpected delays or work conditions). These meetings or calls shall include the expected schedule of construction for the upcoming week, the long term construction plans, and planned methods for working near/in wetlands. Both the Project Environmental Scientist/Monitor and Construction Project Manager shall work together so the Project complies with all environmental permits and regulations. When changes to the Project scope or agreed work plan are proposed they shall be done so with the final approval of the National Grid Environmental Scientist.

1.5 Communication of Project Specific Environmental Requirements

Project specific environmental concerns, to include sensitive resources, permits, approved access and time-of-year or other restrictions, shall be communicated to the project team and be included as part of the Pre-Bid and Pre-Construction Meetings. Project specific requirements shall be communicated to the project manager/construction manager/engineering group using the following guidelines:

<u>Environmental Field Issue</u> – The EFI will be a full document consisting of narrative, project permits, access and matting plans. A table summarizing pertinent (but not all) permit conditions and the responsible party for those conditions shall be included in the EFI. Copies of all permits should be included as attachments. This will be prepared for most projects with multiple permits or large, complex projects (siting board, Section 404, 401 WQC, SWPPP). There shall be EFI training at the pre-construction meeting. The National Grid EFI template is located in **EI-303NE**.

<u>Simplified Environmental Field Issue</u> – The Simplified EFI is a memorandum containing environmental resources present, project permit(s), access and matting plans and a table summarizing relevant permit conditions and responsible party for those conditions. Copies of all permits should be included as attachments. The Simplified EFI will be prepared for most projects with 1 or 2 permits (Order of Conditions, S404 Cat 1). The Simplified EFI should also be provided for projects that have environmental resources present, but the scope of the project does not trigger environmental permitting (e.g., the scope of work qualifies for maintenance exemption(s)). The resources present

shall be discussed at the Pre-Bid and Pre-Construction meetings and any changes in scope will require additional review by the National Grid project team.

E-mail delivery of Permit and any Sediment/Erosion control or BMP plan – For those projects with only one permit (eg., MA Order of Conditions, RI DEM permit, RI CRMC permit, NH Utility Notification) or projects with a sediment & erosion control plan (local town requirement or for exempt maintenance work), a copy of the permit and any applicable plan will be emailed to the Project Manager (and the project team where deemed necessary) to be incorporated into the Construction Field Issue.

STORMS work management system input – For STORMS work, no EFI is prepared unless multiple permits are required for the project (see guidance above). If only a MA Order of Conditions, MA Determination of Applicability, RI DEM permit, RI CRMC permit, RI SESC Approval, or NH Utility Notification is required, then the permit is attached in the Documents tab and conditions noted in Remarks/Comments section. Standard STORMS boilerplate language is located in **EI-303NE**.

1.6 Timing of Work

Regulatory authorities may place seasonal or time-of-year restrictions on project construction elements. These time-of-year restrictions may be state or permit-specific, and shall be adhered to.

Work during frozen conditions. Activities conducted once wetland areas are frozen sufficient to minimize rutting and other impacts to the surrounding environment may be authorized by the National Grid Environmental Scientist. Work during this time also generally reduces disturbance of aquatic and terrestrial wildlife movement by avoiding sensitive breeding and nesting seasons. When not using mats for access, vehicles shall not be allowed to drive across wetlands without the prior approval of the National Grid Environmental Scientist.

Work during the regulatory low-flow period. Conducting work during the low-flow period can reduce impacts to surface water and generally avoids spawning and breeding seasons of aquatic organisms. If the water is above normal seasonal levels, adjustments to work activities and methods are required.

1.7 Alternate Access

1.7.1 Manual Access

In some cases such as for smaller projects, work areas can be accessed manually. This includes access on foot through upland and shallow wetland areas, access by boat through open water or ponded areas, and climbing of structures where possible. Smaller projects, such as repair of individual structures, or parts of structures, that do not categorically require the use of heavy machinery, shall be accessed manually to the greatest extent practicable.

1.7.2 Use of Overhead/Aerial Access

Using helicopters can be expensive and is not always feasible, but it may be appropriate in some situations in order to get workers and equipment to a site that otherwise may be very difficult to access. The use of overhead and/or aerial equipment may be beneficial for work in areas where larger water bodies, deep crevices, or mountainous areas hinder ground access. The landing area for helicopters shall be reviewed for environmentally sensitive resources. Use of helicopters requires Project Manager and Senior Management approval.

2.0 Inspection, Monitoring and Maintenance

All construction practices and controls shall be inspected on a regular basis and in accordance with all applicable permits and local, state, and federal regulations to avoid and correct ANY damage to sensitive areas.

The construction crews shall be responsible for completing daily inspections, and IMMEDIATELY bring any **damage or observed erosion, or failed erosion controls** to the attention of the Person-In-Charge and the National Grid Environmental Scientist. Where applicable and/or as directed by environmental permits issued for the project, the Project Environmental Consultant shall conduct weekly (at a minimum) inspections of the project work areas and shall document their inspection using the Stormwater, Wetlands & Priority Habitat Environmental Compliance Site Inspection / Monitoring Report form found in **Appendix 3** and issue the report within 24 hours. The Person-in-Charge shall work with the National Grid Environmental Scientist and the Project Environmental Consultant to determine when and how the repairs shall be made.

Project-specific Action Logs and Long-Term Restoration Logs are prepared as needed by the National Grid Environmental Scientist or the Project Environmental Consultant to track issues and/or repairs and assign responsible parties.

3.0 Best Management Practices

The BMP sections presented in this EG address access, construction, snow and ice management, structures in wetlands, access road maintenance and repair, clean-up and restoration standards, ROW gates, field refueling and maintenance operations, management of spills/releases, and a summary of key construction BMPs.

Note that BMPs shown on any permit drawings for a specific project may need to be revised and or supplemented during the execution of a project based on unforeseen or unexpected factors such as extreme weather or unknown subsurface conditions. It is the responsibility of the Contractor to work with the National Grid Environmental Scientist and/or the Project Environmental Consultant to identify necessary changes and to ensure that construction-related impacts to wetlands, water bodies and other environmentally sensitive areas are avoided.

Any deviation from the approved BMPs shown in the EFI and/or SWPPP plans shall be communicated immediately to the National Grid Environmental Scientist as it may require additional permitting or could result in a permit violation.

3.1 Wetland Boundary Demarcation

Prior to the start of any activity conducted under an environmental permit, wetland boundaries shall be reviewed. Flagging for wetland boundaries, stream banks and other resource areas shall be refreshed as needed. This may become particularly important when the original flagging was placed in previous seasons and now may have become obscured.

3.2 Sedimentation and Erosion Controls

Appropriate sedimentation and erosion control devices shall be installed at work sites, in accordance with permit conditions and/or regulatory approvals, and as needed to prevent adverse impacts to water resources and adjacent properties.

The overall purpose of such controls is to prevent and control the movement of disturbed soil and sediment from work sites to adjacent, undisturbed areas, and particularly to water resources, public roads and adjacent properties. All proprietary controls shall be installed per manufacturer's recommendations and specifications.

Appropriate sedimentation and erosion control devices include but are not limited to: silt fencing, straw bales, wood chip bags, straw wattles, compost socks, erosion control blankets, mulch, slope interruption practices, flocculent powder/blocks and storm drain/catch basin inlet protection. Such controls shall be installed between the work area and environmentally sensitive areas such as wetlands, streams, drainage courses, roads and adjacent property when work activities shall disturb soils and result in a potential for causing sedimentation and erosion.

In Massachusetts, use of monofilament-encased wattles shall be avoided in mapped Priority Habitat for snakes and amphibians. For projects with work within mapped Priority Habitat for snakes and amphibians, wattles that are encased in a sock, hemp, fiber, or movable jute netting are required to prevent entrapment. Also, "wildlife gaps" should occur every 50 feet, if possible, given wetland permit conditions. This spacing of the wattles allows snakes and amphibians to move across the ROW. Refer to the Amphibian and Reptile BMPs in **Appendix 4**.

Staked straw bales often serve as the demarcation of the limits of work and/or sensitive areas to be avoided. Work shall never be conducted outside the limit of erosion controls without prior approval from the National Grid Environmental Scientist.

Project plans depict proposed erosion controls, however field conditions may warrant additional practices be implemented (e.g., wet conditions, frozen conditions, poorly drained soils, steep slopes, materials used for work pads, transition areas to construction mats, number of trips across work areas, etc.).

Any deviation from the approved erosion controls shown in the EFI and/or SWPPP plans needs to be communicated immediately to the National Grid Environmental Scientist as it may require additional permitting or result in a permit violation.

Appendix 4 provides typical sketches of common sedimentation and erosion controls. If a SWPPP is required for the project, maintenance and inspection of erosion controls shall follow the SWPPP requirements. Sedimentation and erosion controls shall be properly maintained and inspected on a periodic basis, until work sites are properly stabilized and restored. Inspections shall be documented using the Inspection Form "Storm Water, Wetlands & Priority Habitat Environmental Compliance Site Inspection/Monitoring Report" (**Appendix 3**).

The sequence and timing of the installation of sedimentation and erosion control measures is critical to their success. Sedimentation and erosion controls shall be installed prior to commencing construction activities that may result in any soil disturbance or cause otherwise polluted site runoff. Inspection of these devices may be required by the National Grid Environmental Scientist or by regulators prior to the start of work. The installation of water bars and other erosion control measures shall be installed shortly thereafter.

3.3 Concrete Wash Outs

Concrete wash outs shall be used for management of concrete waste. Concrete and concrete washout water shall not be deposited or discharged directly on the ground, in wetlands or waterbodies, or in catch basins or other drainage structures. Where possible, concrete washouts shall be located away from wetlands or other sensitive areas. Consult the National Grid Environmental Scientist on proposed concrete wash out locations prior to their use. Following the completion of concrete pouring operations, the wash outs shall be disposed of off-site with other construction debris. Refer to BMPs in **Appendix 4**.

3.4 Construction Activities in Standing Water

The use of silt curtains or turbidity barriers may be required when working in or adjacent to standing water such as ponds, reservoirs, low flowing rivers/streams, or coastal areas. Silt curtains and turbidity barriers prevent sediment from migrating beyond the immediate work area into the resource areas.

Coffer dams constructed using sheet piling or large sandbags (Trade names such as "the Big Bag" or "DamItDams") may be used to temporarily isolate and contain a work area in standing water.

When working in standing water, an oil absorbent boom, in addition to a silt curtain or other temporary barrier, shall be placed around the work area for spill prevention.

Work in drinking water reservoirs or other waters may require extensive regulatory agency review, even for maintenance work, which could result in additional time required for permitting, review and material procurement prior to the start of work.

3.5 Dewatering

Where excavations require the need for dewatering of groundwater or accumulated stormwater, the water shall be treated before discharge. Appropriate controls include dewatering basins, flocculent blocks, filter bags, filter socks, or weir tanks. Schematics of these BMPs are included in **Appendix 4**. Water trucks or fractionation tanks may be utilized if watertight containers are desired for controlled on-site discharge or for off-site discharge into an approved dewatering area when site restrictions make it difficult to utilize other dewatering methods on-site. Dewatering discharge water shall never be directed into wetlands, streams/rivers, other sensitive resource areas, catch basins, other stormwater devices, or substation Trenwa trenches. Dewatering flow shall be controlled so that it does not cause scouring or erosion through the use of a dewatering basin, filter sock, or equivalent. If it is determined that the chosen controls are not appropriately filtering the fine sediment from the dewatering pumpate then the National Grid Environmental Scientist shall be notified immediately and the controls shall be revised or supplemented.

When establishing a dewatering basin, consideration should be given to the anticipated volume of water and rate of pumping in determining the size of the dewatering basin. Dewatering basins shall be constructed on level ground. Once pumping commences, the basin shall be monitored frequently to assure that the rate of water delivery to the structure is low enough to prevent water from flowing, unfiltered, over the top of the basin walls. The basin shall be monitored throughout the dewatering process because the rate of filtration shall decrease as sediment clogs the filter fabric. If the basin is not appropriately filtering the fine sediment from the dewatering pumpate then the basin may need to be supplemented with a flocculent block. Field conditions shall dictate how often the basin should be inspected.

Distance to sensitive areas, direction of flow (toward or away from protected, or sensitive areas, such as wetlands, ponds, or streams), amount of vegetative ground cover between the basin and nearby sensitive areas, ground conditions (ledge, frozen, etc.), volume of water being pumped, and pump-rate, are some of the factors to be considered when determining an inspection frequency. Clogged filter fabric shall be replaced and accumulated sediment shall be removed as necessary from the basins to maintain efficacy.

Any new dewatering location (not previously reviewed and approved by the National Grid Environmental Scientist during project planning or permitting) shall be reviewed and the discharge location approved by the National Grid Environmental Scientist before use.

Complex projects that require large scale dewatering shall require individual review by the National Grid Environmental Scientist and may trigger additional permitting.

Dewatering in areas of known chemical contamination may require a separate NPDES permit, or other approval, and treatment or containment system. Consult with the National Grid Environmental Scientist.

3.5.1 Overnight Dewatering

Some projects may necessitate 24-hour dewatering for on-site construction activities. Overnight dewatering will be evaluated on a case-by-case basis by the National Grid Environmental Department.

If it is necessary to conduct overnight dewatering on a project, a dewatering plan must be submitted to the Environmental Department for review and approval **5 business days prior to beginning dewatering activities**. Sufficient knowledge of flow, discharge, and re-infiltration rate of water must be obtained and submitted for review. The Environmental Department may require monitored dewatering for a period of time in order to provide this data in support of a request for 24-hour dewatering. The dewatering plan must include at a minimum:

1. Location of dewatering system, system components (basin, frac tank, etc), and materials.
2. Location of discharge and distance from closest wetland.
3. Location of erosion controls. A secondary perimeter of erosion controls will be required around the dewatering system for overnight dewatering.
4. Peak flow, discharge rate and re-infiltration rates.
5. Visual monitoring plan for discharge. Expected duration of dewatering.
6. Emergency provisions if overnight, unattended dewatering is proposed.

3.5.2 Dewatering Clean Up/Restoration

Basins shall be cleaned and removed as soon as dewatering is complete. Sediment removed from the dewatering basin shall be allowed to dry before being disposed of by evenly spreading it over unvegetated upland areas where erosion is not a concern if clean or removing it from the site for proper disposal. Off-site trucking of wet soils is prohibited. The sediment disposal area shall be approved by the National Grid Environmental Scientist or the Project Environmental Consultant prior to use. Stabilization measures shall also need to implemented and approved by the National Grid Environmental Scientist or the Project Environmental Consultant. Soils/sediments shall be dewatered and dried to the point practicable for either on-Site reuse or off-Site transport.

3.6 Check Dams

Check dams are a porous physical barrier installed perpendicular to concentrated storm water flow. They are used to reduce erosion in a swale by reducing runoff energy (velocity), while filtering storm water, thereby aiding in the removal of suspended solids.

Check dams should only be used in small drainage swales that shall not be overtopped by flow once the dams are constructed. These dams should not be placed in streams. Check dams are typically installed in ROWs or on other construction sites prior to the start of soil disturbing work. Per the Rhode Island Soil Erosion and Sediment Control Handbook, no formal design is required for a check dam if the contributing drainage area is 2 acres or less and its intended use is shorter than 6 months; however, the following criteria should be adhered to when specifying check dams.

- The drainage area of the ditch or swale being protected should not exceed 10 acres.
- The maximum height of the check dam should be 2 feet.
- The center of the check dam must be at least 6 inches lower than the outer edges.
- The maximum spacing between the dams should be such that the toe at the upstream dam is at the same elevation as the top of the downstream dam.

Per the NHDES stormwater manual, the use of check dams should be limited to swales with longitudinal slopes that range between 2 to 5 percent that convey drainage from an area less than 1 acre. Existing conditions that exceed these limitations should be assessed in the field and discussed with the National Grid Environmental Scientist to determine the viability of this BMP for the specific application. Check dams are often comprised of stone, straw bales, sand bags, or compost/silt socks. Use of check dams should be coordinated with the National Grid Environmental Scientist to ensure that the material selection, spacing and construction method are appropriate for the site. Check dams composed of biodegradable materials (e.g. straw bales or wattles, wood chip bags) may require periodic replacement for continued proper functioning[1]. Refer to BMPs in **Appendix 4**.

3.7 Water Bars

Water bars should be used on sloping ROWs to divert storm water runoff from unstabilized or active access roads when needed to prevent erosion. Surface disturbance and tire compaction promote gully formation by increasing the concentration and velocity of runoff. Water bars are constructed by forming a ridge or ridge and channel diagonally across the sloping ROW. Each outlet should be stable. The height and side slopes of the ridge and channel are designed to divert water and to allow vehicles to cross. When siting water bars, consideration shall be given to the sensitivity of the area receiving the diverted runoff. For example, runoff should not be directed into a wetland, waterbody, other environmentally sensitive areas, or to private property or public roadways. Refer to BMPs in **Appendix 4**.

3.8 Retaining Walls

In some situations, retaining walls comprised of concrete blocks, gabions, boulders or other comparable materials may be required to stabilize the shoulder of existing access roads and/or supplement required erosion controls. Installation of such measures shall not be allowed as a maintenance activity. Should these controls be considered for a project, it shall be reviewed by the National Grid Environmental Scientist, as design and additional permitting may be required.

3.9 Slope Stabilization

Temporary slope stabilization practices help to keep exposed, erodible soils stabilized while vegetation is becoming established. Acceptable temporary slope stabilization practices may include the use of erosion control blankets, or hydraulic erosion control. Erosion control blankets, often comprised of natural fibers (e.g., jute, straw, coconut, or other degradable materials) are a useful slope stabilization, erosion control and vegetation establishment practice for ditches or steep slopes. Blankets are typically installed after final grading and seeding for temporary or permanent seeding applications. Hydraulic erosion control practices, including Bonded Fiber Matrix or hydroseed with a soil stabilizer (e.g., tackifier and/or mulch) may be an acceptable or desirable alternative form of temporary slope stabilization. For all practices, manufacturer's specifications should be followed for installation depending on slope and other field conditions. Consult the National Grid Environmental Scientist prior to selecting and installing any slope stabilization practices. Refer to BMPs in **Appendix 4**.

[1] Grass growth on a biodegradable type check dam is evidence that the material is decomposing. While this doesn't mean it is no longer functioning, it means it may be in a weakened condition and could potentially fail under high flow velocity. It is acceptable for grass to be growing on a stone check dam.

3.10 Maintenance of Sedimentation and Erosion Controls

Sedimentation and erosion controls shall be maintained in good operational condition during the course of the work. This includes, but is not limited to, replacing straw bales that are no longer in good condition, re-staking straw bales, replacing or re-staking silt fence, and removing accumulated sediment. Remove sediment before it has accumulated to one half the height of any exposed silt fence fabric, straw bales, other filter berm, check dams or water bars. Accumulated sediment shall be removed from sedimentation basins to maintain their efficacy. Manage the removed sediment by evenly spreading it over unvegetated upland areas where erosion is not a concern, by stockpiling and stabilizing, or by disposing of off-site. Stabilization measures shall also need to be implemented and approved by the National Grid Environmental Scientist or the Project Environmental Consultant. Where a SWPPP has been prepared for a specific site, the guidelines documented therein shall govern the management of sediment.

4.0 Right-of-Way (ROW) Access

Whenever possible, access shall be gained along existing access routes or roads within the ROW. However, in some cases there is no existing access. In many cases, temporary access can be utilized. The following practices provide general guidance on accessing a ROW. Check with a National Grid Environmental Scientist to determine if any environmental permitting is required before utilizing a temporary access.

Note that the building of new roads or enlargement of existing roads is **prohibited** unless this activity is allowed by a project-specific permit, and the new roads appear on the Site Plans that were authorized in the regulatory approvals.

4.1 Off-ROW Access

Off-ROW access shall be evaluated for wetlands, rare species, cultural resources and other potential sensitive receptors, as applicable. National Grid Real Estate and Stakeholder Relations shall also be contacted as soon as possible once off-ROW access is determined to be needed.

4.2 Stabilized Construction Entrance/Exit for Access to ROWs from Public or Private Roads

A suitable (minimum 15-foot wide by 50-foot long) construction entrance/exit shall be installed at the intersection of the ROW access road/route with public/private paved roads, or other such locations where equipment could track mud or soil onto paved roads. The construction entrance/exit should be comprised of clean stone installed over a geotextile fabric. Geotextile fabric may be omitted for permanent construction entrances/exits on a case-by-case basis with the approval of the National Grid Environmental Scientist. Refer to BMPs in **Appendix 4**.

Construction entrance areas shall be monitored and maintained to ensure that stone or other material is not deposited onto the roadway, causing a safety concern. Where track-out of sediment has occurred onto a roadway, it shall be swept off the road by the end of that same work day.

If a construction entrance/exit is clogged with sediment and no longer functions, the sediment and stone may require removal and replacement with additional clean stone (clean stone refreshment) to ensure this tracking pad is performing its intended function adequately. Heavier traffic use may require this clean stone refreshment multiple times throughout a project. Reinforcement of these stabilized construction entrance/exits with asphalt binder or asphalt millings is not likely to be considered "maintenance" and may trigger additional permitting requirements[2]. In some cases, heavily used construction entrances/exits may benefit from the installation of a 5-15 foot strip of asphalt binder or asphalt millings closest to the paved roadway to capture any stone that is tracked from the stone apron. Such cases shall be evaluated on an individual basis with the National Grid Environmental Scientist.

Once work is complete, the construction entrance/exit shall either be removed or retained, depending upon future maintenance-related access needs, property ownership, and/or project-specific approvals. If removed, the area shall be graded, seeded (if adequate root and seed stock are absent) and mulched. Proper approvals for leaving access roads in place shall be obtained; contact the National Grid Environmental Scientist and Property Legal.

4.3 Maintenance of Existing Access Roads

In many cases, the existing access road may need to be maintained to allow passage of the heavy equipment required for scheduled maintenance work. Access roads cannot deviate from the approved and permitted access plans. Maintenance of these roads may include adding clean gravel or clean crushed stone to fill depressions and eroded areas. This activity shall be conducted only within the width of the existing access road footprint and does not include widening existing access roads

If gravel begins to migrate onto the existing vegetated road shoulder, this gravel shall be removed during the project and/or after the completion of use of the road to ensure the road fill is not spreading into adjacent resource areas, or resulting in the road becoming much wider than its pre-existing or permitted condition. In some areas of mapped rare species habitat or other sensitive areas where project-specific permit conditions require the prevention of the migration of sediments into adjacent resources, an engineered stabilization system (e.g., GeoWeb or similar) may be suitable to prevent sedimentation while allowing for unrestricted wildlife migration.

In Massachusetts, any proposed widening of access roads in turtle Priority Habitat would require individual consultation with NHESP and, depending on the level of impact proposed, may require a Project Review filing. The limited filling of ruts or potholes is compatible with the National Grid Operation and Maintenance Plan approved by NHESP under the Massachusetts Endangered Species Act, however, severely rutted access roads in turtle Priority Habitat that require extensive linear feet of stone for safe passage will require individual consultation with NHESP.

[2] Depending on the road, use of an asphalt binder or asphalt millings as a construction entrance/exit may trigger state or local permit requirements.

Major reconstruction projects may require multiple permits. In all cases, the fill to be used for existing access roads shall be clean and free of construction debris, trash or woody debris. Use of processed gravel may be approved by the Person-In-Charge and the National Grid Environmental Scientist, on a case-by-case basis. If clean stone is used then addition of more erosion controls may not be necessary.

4.5 Maintenance of Existing Culverts

Damaged culverts may not be repaired or replaced without consulting with the National Grid Environmental Scientist to determine if a permit is required. For functioning culverts, care shall be taken to protect adjacent wetlands and watercourses by installing appropriate sedimentation and erosion controls around the downstream end of the culvert. Culverts shall be repaired/replaced in kind and shall not be changed in size unless approval has been obtained from the National Grid Environmental Scientist. In-kind replacement is replacement using the same material, functional inverts, diameter and length as the existing culvert. Changes to any of these characteristics shall require permitting. Installation of any **new** culvert is not allowed without obtaining all necessary permits first. Refer to BMPs in **Appendix 4**.

If, at the time of anticipated replacement, there is heavy flow through the culvert, the Person-In-Charge shall consult with the National Grid Environmental Scientist, to verify whether the culvert shall be replaced at that time. Water may need to be temporarily diverted during culvert repair/replacement. There typically are seasonal restrictions limiting both the replacement of existing culverts as well as installation of new culverts to the low-flow period. The low-flow period can vary from state to state. If any unexpected conditions are encountered during culvert replacement, the National Grid Environmental Scientist shall be contacted immediately prior to the work being completed for additional consultation.

4.6 Temporary Construction Access over Drainage Ditch or Swale

In some situations, construction access from paved roads onto ROWs may require the crossing of drainage ditches or swales along the road shoulder. In these situations, the installation of construction mats, mat bridges or temporary culverts may facilitate construction access over the ditches or swales. These culverts shall be temporary only, sized for peak flow, and shall be removed after construction is complete. Consult with the National Grid Environmental Scientist prior to installation. In addition, if access over existing culverts may require extending the culvert, consult with the National Grid Environmental Scientist. Refer to BMPs in **Appendix 4**.

4.7 Construction Material along ROW

After preparing a site by clearing and/or installing any necessary erosion and sediment controls and prior to the start of construction, material such as poles, cross-arms, cable, insulators, stone and other engineered backfill materials may be placed along the ROW, as part of the project. The stockpiling of stone and other unconsolidated material on construction mats shall be avoided, if determined necessary due to access and work pad constraints, the material must be placed on a geotextile fabric and be properly contained with a sedimentation barrier such as straw wattle. No construction material shall be placed in wetlands or other sensitive resource areas unless authorized by the National Grid Environmental Scientist or Project Environmental Consultant.

5.0 Winter Conditions

5.1 Snow Management

Refer to **Appendix 6** for the current Snow Disposal Guidelines.

5.2 De-Icing

Where allowed, calcium chloride is preferred as a de-icing agent when applied according to manufacturer's guidelines in upland areas. Sand shall be used on construction mats through wetland areas.

Consult with the National Grid Environmental Scientist on de-icing agents when working in a facility or substation close to resource areas. Many municipalities have specific requirements for de-icing agents allowed within 100 feet of wetland resources and other sensitive areas.

5.3 Snow and Ice Management on Construction Mats

Proper snow removal on construction mats shall avoid the formation of ice. To avoid the formation of ice, snow shall be removed from construction mats before applying sand. Prior to their removal from wetlands, sand shall be collected from the construction mats and disposed of in an upland area. A round street sweeping brush mounted on the front of a truck may be an effective way to remove snow from construction mats. Propane heaters may also be suitable solutions for snow removal and/or de-icing of construction mats.

Once construction mats are removed, wetlands shall be inspected for build up of sand that may have fallen through construction mats. Care shall be taken to inspect wetland crossings as each mat is removed to ensure sand is properly removed and disposed of off-site.

6.0 Construction Mats

The use of construction mats allows for heavy equipment access within wetland areas. The use of construction mats minimizes the need to remove vegetation beneath the access way and helps to reduce the degree of soil disturbance and rutting in soft wetland soils. Construction mats most often used by National Grid are wooden timbers bolted together typically into 4-ft by 16-ft sections, wooden lattice mats, or composite mats. In some cases, construction mats or other mats are used for staging or access in upland areas based on site conditions (e.g., agricultural field access). Refer to BMPs in **Appendix 4**.

Typically construction mats may be installed on top of the existing vegetation, however in some instances cutting large woody vegetation may be required. Check with National Grid Environmental Scientist prior to cutting or clearing vegetation for construction mat placement.

Where an extended period of time has lapsed since wetland delineation and start of construction, and new vegetative growth has concealed wetland flagging or flagging is simply no longer obviously visible, wetland boundaries should be re-flagged where necessary prior to the installation of matting.

Follow the approved plans in the EFI for construction mat installation and do not deviate from the plans. **Any deviation from the approved plans needs to be communicated immediately to the National Grid Environmental Scientist as it may require additional permitting, require stopping the project or result in a permit violation or revocation.**

6.1 Construction Mats and Mowing

Close coordination with the mowing contractor shall be required to ensure that access plans are followed, and construction mats are utilized when necessary. Sometimes mowing contractors may have to work off the leading edge of a construction mat to mow in order to lay the next construction mat and continue further into the wetland. Under no circumstances shall trees or shrubs be allowed to be pulled out of the wetland by the root ball. The root ball of trees and shrubs shall remain intact. Chipping debris and excessive amounts of slash shall not be placed in wetlands or other resource areas. In some instances, it may be beneficial to pile a reasonable amount of slash within a nearby upland area to create habitat for wildlife. This activity shall be approved by the National Grid Environmental Scientist.

6.2 Stream Crossings and Stream Bank Stabilization

Stream crossings shall be bridged with construction mats or other temporary minimally-intrusive measures unless fording is acceptable for the site and is authorized by the National Grid Environmental Scientist. Care shall be taken when installing a construction mat bridge to insure that the stream bed and banks are not damaged during installation and removal and that stream flow is not unduly restricted. Where stream width allows, construction mats shall be installed to span the watercourse in its entirety without stringer placement in the water or any restriction of stream flow. Environmental permits may be required to cross or disturb protected waters, depending upon state-specific regulatory requirements. Refer to BMPs in **Appendix 4**. Immediately following construction mat removal, all stream banks shall be stabilized and restored to prevent sedimentation and erosion.

6.3 Cleaning of Construction Mats

Mats shall be certified clean by the vendor prior to installation. The vendor shall use the certification form provided as **Appendix 5** to document compliance. Clean is defined as being free of plant matter (stems, flowers, roots, etc), soil, or other deleterious materials prior to being brought to the project site. Any equipment or timber mats that have been placed or used within areas containing invasive species within the project site shall be cleaned of plant matter (stems, flowers, roots, etc), soil, or other deleterious materials at the site of the invasive species prior to being moved to other areas on the project site to prevent the spread of invasive species from one area to another[3]. **Mats shall be cleaned prior to being removed at the completion of the project: exceptions to this requirement**

[3] On ROW projects where multiple wetlands may be dominated by the same invasive species, cleaning may not be required for movement along the ROW. Check with the National Grid Environmental scientist for guidance.

may be made on a case-by-case basis. Consult with the National Grid Environmental Scientist prior to discharging or disposing of any waste water or waste material from the cleaning of construction mats.

6.4 Stone Removal for Construction Mat Placement

For situations where the matting contractor determines that stones or boulders must be removed or relocated within wetland areas in order to install safe and level structure work pads or access roads the boulders shall be moved in a manner which does not result in significant soil disturbance (i.e., pushing with a bull dozer is not allowed). The boulders shall not be placed on any existing vegetated areas within wetlands or within vernal pools. When numerous boulders shall be removed from a wetland area, they shall be deposited in an upland area outside of the flagged wetland limits, outside of any cultural resource areas and outside of any RTE species populations. Any boulders that shall be placed within buffers (In MA, the 100-foot buffer zone, and in RI, the 50-foot Perimeter Wetland, 100-foot or 200-foot Riverbank Wetlands) shall be placed to avoid causing soil disturbance and they shall be within an approved limit of work. When there is a significant number of boulders that need to be removed, the National Grid Environmental Scientist shall be consulted for guidance.

6.5 Transition onto Mats

Erosion controls and stone or wood chip ramps shall be installed to promote a smooth transition to and minimize sediment tracking onto construction mats. Geotextile may be added beneath stone or wood chip transitions to facilitate removal, as necessitated by site or permit conditions. Mat transitions shall be removed once construction mats have been removed and during restoration. Refer to BMPs in **Appendix 4**.

6.6 Construction Material on Mats

The stockpiling of stone, drill spoils and other unconsolidated material on construction mats shall be avoided unless determined necessary due to access and work pad constraints. Additional controls, such as watertight mud boxes and geotextile/filter fabric over or between construction mats shall be considered for stockpile management. If material is placed on construction mats and falls through into wetlands, the material must be removed by hand. Saturated soils shall be allowed to dewater prior to off-site transport for sufficient time to ensure that water/sediment is not deposited onto construction mats or public roads during transport. Heavy machinery shall not be left overnight on mats located within floodplain unless approved by the National Grid Environmental Scientist, the machinery is still in use, and removal of the equipment requires the use of additional equipment to move it and would increase vehicle trips in/ou of wetlands. In these situations and when approved by the National Grid Environmental Scientist, the equipment shall be secured against vandalism and secondary containment measures shall be employed where feasible. Mat anchoring shall be evaluated, see below.

6.7 Mat Anchoring

The National Grid Environmental Scientist and Project environmental consultant shall indicate to the project team when mat anchoring may or shall be necessary. The matting contractor will propose the method of mat anchoring, which will be approved by the National Grid Environmental Scientist and the

National Grid Construction Supervisor. The need for anchoring should be noted in the project EFI, on the project access and matting plans, and in the scope of the bid document (if externally sourced).

Anchoring of construction mats should be considered when any of the following conditions are presented at a project work location:

Location	Considerations
Stream crossings Shorelines of Ponds/Lakes Wetlands Floodplains	When located in a mapped flood area (A). When mapped 100-year flood elevations (AE) are greater than 2 ft above existing grades. Where past flash flood events have occurred. Where steep terrain is present or surrounds the project location. When mats will be in place during hurricane season for greater than 2 weeks.
Tidal areas	When located in a Velocity (V or VE) Zone. When mats will be in place during a moon tide cycle. When mats will be in place during hurricane season for greater than 2 weeks.

Examples of mat anchoring are provided below, but the implementation methods for anchoring mats are not limited to these examples. Where anchoring is determined to be necessary, the matting contractor should propose a method suitable based on field conditions and that takes crew safety, slip/trip/fall hazards, size of matting footprint, and other project and site-specific factors into consideration. Refer to BMPs in **Appendix 4**.

Limited sets of mats

- Cable or rope in chain pockets and run linearly, or
- Linear ropes anchored using helical screws, manta ray anchors, or posts.

Larger sets of mats or those without chain pockets

- Chain link fence posts or other posts driven in along mat edge every 3-4 feet and ropes then laced across mats between opposing posts before storm event, or
- Anchor bolts added to mats, then cable is laced between bolts and tied to helical or manta ray anchor.

6.8 Corduroy Roads

Corduroy roads are a wetland crossing method where logs are cut from the immediate area and used as a road bed to prevent rutting from equipment crossing. This technique is designed to be used in areas of wetland crossings where there is no defined channel or stream flow and should never be used in streams. Corduroy logs shall be placed in the narrowest area practicable for crossing with the logs placed perpendicular to the direction of travel across wet area. The use of corduroy logs shall only be in emergencies when approved by the National Grid Environmental Scientist or when they have been specifically permitted as part of a project. Refer to BMPs in **Appendix 4**.

6.9 Construction Mat Removal

Once construction mats are removed, wetlands shall be inspected for build up of sand or other materials that may have fallen through construction mats. Care shall be taken to inspect wetland crossings as each mat is removed to ensure any materials are properly removed and disposed of off-site.

6.10 Utility Air Bridging

In ROWs where other utility facilities (including but not limited to gas, oil, fiber optic, electric, water, and sewer) are co-located within the transmission ROW, bridging may be required to cross those facilities. The project team shall coordinate with the respective utility company prior to determining if bridging or permanent crossings are required.

7.0 LGP Equipment Use

Only when approved by the National Grid Environmental Scientist on a case-by-case basis shall equipment with a LGP **psi that meets the state-specific USACE General Permit requirement when loaded** be allowed to access through wetlands. Refer to the state-specific General Permit for the definition of LGP in each state at: http://www.nae.usace.army.mil/Missions/Regulatory/State-General-Permits/, or to the summary table provided below. The National Grid Environmental Scientist's approval of the use of LGP equipment through wetlands depends on several criteria including:

- Time of year. LGP equipment use may be allowed if weather and field conditions at the time of construction are suitable to eliminate/minimize the concern of rutting or other impacts. Frozen, frozen snow pack, low flow, drought conditions, or unsaturated surface soil conditions are typically acceptable conditions. Spring and fall construction, due to the typical higher precipitation, are not suitable times of year for LGP equipment use.
- Number of trips. Multiple trips through a wetland have shown to increase the potential for damage and require matting. LGP equipment use shall likely only be approved if trips are limited to one trip in and one trip out.
- Type of wetland system. Some wetlands have harder soils/substrate, and may be passable without causing significant damage. Some of the wetlands along National Grid ROWs have existing hard bottom roads that have been vegetated over time and may be traversed with LGP equipment without construction mats.
- Emergencies. LGP equipment use may be allowed during emergency or storm conditions for outage restoration.
- State-specific USACE General Permit Performance Standards. The standard is for no impact to the wetland, which may be obtained by using LGP equipment **when loaded**). "*Where construction requires heavy equipment operation in wetlands, the equipment shall either have low ground*

pressure (as specified in the USACE GP), or shall not be located directly on wetland soils and vegetation; it shall be placed on construction mats that are adequate to support the equipment in such a way as to minimize disturbance of wetland soil and vegetation."

- Local bylaws. Municipal wetland bylaws, where applicable, shall be reviewed for prohibitive conditions or applicable performance standards.

LGP equipment is prohibited in the following resources areas:

- Stream crossings
- State listed-species habitat
- Outstanding Resource Waters (ORWs)
- Vernal pools
- Archaeological sensitive areas

Where LGP equipment use is desired in lieu of construction mats, the construction supervisor should identify these areas on marked-up access plans. A site visit with the Project Environmental Monitor should be scheduled to assess if the proposed locations are potential candidates. The Project Environmental Monitor will document potentially suitable locations and dismiss others as unsuitable.

ACOE New England District General Permit Requirements

State	Restrictions	Maximum PSI (when loaded) for Use without Mats	Reference
MA	*One of the following must apply:* Equipment operated within wetlands shall: a) Have low ground pressure; b) Be placed on timber mats that are adequate to support the equipment in such a way as to minimize disturbance of wetland soil and vegetation; or c) Equipment must be operated on adequately dry or frozen conditions such that shear pressure does not cause subsidence of the wetlands immediately beneath equipment and upheaval of adjacent wetlands.	3 psi	MA General Permit, General Condition 13
NH	*One of the following must apply:* Equipment operated within wetlands shall: a) Have low ground pressure; b) Be placed on timber mats that are adequate to support the equipment in such a way as to minimize disturbance of wetland soil and vegetation; or c) Be operated on frozen wetlands.	4 psi	NH General Permit, General Condition 17
VT	*One of the following must apply:* Equipment operated within wetlands shall: a) Have low ground pressure; b) Be placed on timber mats that are adequate to support the equipment in such a way as to minimize disturbance of wetland soil and vegetation; or c) Be operated on frozen wetlands such that shear pressure does not cause subsidence of the wetlands immediately beneath equipment and upheaval of adjacent wetlands. Note: Written authorization from the Corps required to waive the use of mats during frozen or dry conditions.	3 psi	Vermont General Permit, General Condition 14
RI	*One of the following must apply:* Equipment operated within wetlands shall: a) Have low ground pressure; b) Be placed on timber mats that are adequate to support the equipment in such a way as to minimize disturbance of wetland soil and vegetation; or c) Be operated on frozen wetlands such that shear pressure does not cause subsidence of the wetlands immediately beneath equipment and upheaval of adjacent wetlands.	6 psi	Rhode Island General Permit, General Condition 15

State	Restrictions	Maximum PSI (when loaded) for Use without Mats	Reference
	Note: Written authorization from the Corps required to waive the use of mats during frozen or dry conditions.		

Due to the fact that ground conditions may change between the time of the evaluation and construction, LGP equipment approval is required **at the time of construction for each wetland crossing** and shall be dependent upon the above conditions. In addition, LGP equipment use and approval shall be assessed by the National Grid Environmental Scientist or Project Environmental Monitor during construction on a continuing basis

Once a location is approved for the use of LGP equipment:

- The Construction Supervisor must check-in with the Project Environmental Monitor at least two weeks before construction begins to ensure conditions remain suitable for LGP equipment use, and weather conditions are favorable.
- The Project Environmental Monitor must observe the equipment when in use.
- LGP equipment use shall cease immediately if field conditions are found to be unsuitable (i.e. soil rutting greater than six inches or the destruction of vegetation root systems beyond the capacity of natural revegetation).
- **If wetlands damage occurs, the use of the LGP equipment shall be suspended, and the wetlands be restored.**
- Any LGP equipment used within areas containing invasive species within the project site shall be cleaned of plant matter (stems, flowers, roots, etc), soil, or other deleterious materials at the site of the invasive species prior to being moved to other areas on the project site to prevent the spread of invasive species from one area to another.

8.0 Soil Disturbing Activities

8.1 Dust Control

Cutting activities shall be conducted to minimize the impacts of dust on the surrounding areas. Dust suppression is an important consideration. Water or other National Grid approved equivalent in accordance with the manufacturer's guidelines may be used for dust control along ROWs in upland areas. During application of water for dust control, care shall be taken to ensure that water does not create run-off or erosion issues. Refer to BMPs in **Appendix 4.**

8.2 Clearing

Clearing is not allowed without specific permission as it constitutes soil disturbance under several regulatory programs and may trigger permitting by increasing the project's footprint of disturbance. If clearing is required for a project, the limit of clearing shall be established with flagging or construction fencing and/or erosion controls. Clearing shall be done in accordance with project specific permits. Following the completion of clearing, the limits of work shall be re-established. Refer to BMPs in **Appendix 4**.

8.3 Grubbing

Grubbing is not allowed without specific permission as it constitutes soil disturbance under several regulatory programs and likely triggers permitting by increasing the project's footprint of disturbance. If grubbing is required for a project, the limit of grubbing shall be re-established after clearing has been completed. The area of grubbing shall be identified with flagging or construction fencing and/or erosion controls. Grubbing shall be conducted in accordance with project-specific permits.

8.4 Blasting, Noise and Vibration Control

If blasting is anticipated, the project team, including the National Grid Environmental Scientist, shall be consulted. If possible, plan work in residential areas to avoid noisy activities at night, weekends or during evenings. Emergency work in residential areas should be carried out in such a way as to keep noise to a minimum at night and weekends. Equipment should be maintained as per the manufacturer's guidance to minimize noise and vibration.

Work plans must consider local noise ordinances and provide specific controls to ensure noise levels are maintained within specified limitations.

8.5 Site Grading

The work site shall not be graded other than in accordance with project permits. Any proposed grading shall be reviewed by the National Grid Environmental Scientist for wetlands, rare species habitat, areas of cultural and historical significance, and other environmentally sensitive areas prior to start of work. In some cases, additional testing for cultural or historical resources may be triggered by proposed grading; alternatives to grading may be sought due to protracted time frame of obtaining the permit associated with testing and performing the testing. Grading outside of a regulated area shall be kept to the minimum extent necessary for safe and efficient operations and shall comply with the project permit plans.

Grading shall be performed in a manner which does not increase the erosion potential at the Site (e.g., terraces or slope interruptions shall be utilized). Graded sites shall be promptly stabilized by applying a National Grid approved seed mix (if adequate root and seed stock are absent), and mulching with hay, straw or cellulose (use straw or cellulose hydromulch where the potential introduction of invasive plant species is of concern) to reduce erosion and visual impact, as soon as possible following completion of work at the site. Grading within a regulated area shall be subject to the review and approval of the National Grid Environmental Scientist.

In some municipalities, site grading activities require the prior approval of the Town Engineer, Building and Zoning Official, or Public Works Director. Local ordinances or bylaws should be reviewed for applicable restrictions and permitting thresholds

8.6 Grounding Wells

The installation of grounding wells shall require erosion controls and proper soil management. Due to the typical depth required for grounding wells (typically 50 to 200 feet or more), erosion controls shall be installed around the proposed well location when working in buffer zone, in proximity to sensitive resources or near slopes. Also, dewatering basins may be required for the proper management of groundwater. The National Grid Environmental Scientist shall be consulted for the disposal of any excess soil.

8.7 Counterpoise and Cathodic Protection

The installation of counterpoise or cathodic protection shall require erosion controls and proper soil management. The National Grid Environmental Scientist shall be consulted for the disposal of any excess soil.

8.8 Work Pads

When work pads are being constructed, only clean material shall be used in their construction. Work pads shall only be constructed in areas approved by the National Grid Environmental Scientist and shown on the approved permit access plans.

8.9 Site Staging and Parking

During the project planning and permitting process, locations shall be identified for designated crew parking areas, material storage, and staging areas. Where possible, these areas should be located outside of buffer zones, watershed protection areas, and other environmentally sensitive areas. Any proposed locations shall be evaluated for all sensitive receptors and for new projects requiring permitting, shall be incorporated onto permitting and access plans.

8.10 Soil Stockpiling

Soil stockpiles shall be located in upland areas and, if in close proximity to wetlands and wetland buffers, shall be enclosed by staked straw bales or another erosion control barrier. The stockpiling of stone, drill spoils and other unconsolidated material on construction mats shall be avoided unless determined necessary due to access and work pad constraints. Additional controls, such as watertight mud boxes and geotextile/filter fabric over or between construction mats shall be considered for stockpile management. If material is placed on construction mats and falls through into wetlands, the material must be removed by hand. Saturated soils shall be allowed to dewater prior to off-site transport for sufficient time to ensure that water/sediment is not deposited onto construction mats or public roads during transport.

8.11 Top Soil/High Organic Content Soil

When the work site requires excavation and grading, the top soil shall be stockpiled separately from the material excavated. This top soil shall be spread as a top dressing over the disturbed area during restoration of the site.

In some instances where work is occurring within wetlands, high organic content soil may be displaced. Such high organic content soil shall be segregated from other excavated materials and stockpiled for use in wetland restoration areas. Care shall be taken to minimize the handling of high organic content soil. Preferably, the soil shall be stockpiled in one location until it is moved to the restoration area.

9.0 Stone Wall Dismantling and Re-building

Removal or alteration of stonewalls shall be avoided, whenever possible. As appropriate, some stonewalls removed or breached by construction activities shall be repaired or rebuilt. Rebuilt stone walls shall be placed on the same alignment that existed prior to temporary removal, to the extent that it shall not interfere with operations. The removal and rebuilding of stone walls requires approval from the National Grid Environmental Scientist and Property Legal, and may require several weeks lead time for coordination. Note that not all states allow this technique and that dismantling may not be allowed at all due to quality or significance of the wall. Once a stone wall has been identified as requiring dismantling, the following procedures shall be followed:

- Identify stone wall that is required to be temporarily dismantled and notify project team that a site visit is warranted to review the stone wall.
- The National Grid Environmental Scientist, with support from Property Legal and/or cultural/historical consultant, shall determine if permitting or additional permissions are required prior to dismantling stone wall.
- Once permit or permissions have been received, full documentation of wall dimensions (measurements and photographs) shall be submitted to the National Grid Environmental Scientist. Documentation of the wall dimensions shall be marked onto a copy of the applicable EFI access plan (or equivalent plan) with a useful reference for future locating such as GPS coordinates and/or measurement from a permanent reference point (closest structure location or closest cross street, etc.). The wall shall be photographed from all sides with a written description of the photograph (i.e. southern side of wall looking north). In addition, documentation of the length of wall to be dismantled shall be recorded. Take special care to note if granite property bounds (or other marker) are located within the wall so additional survey can be accomplished prior to dismantling in cases where the stone wall represents a property boundary. Site visits by project team (which shall include the National Grid Environmental Scientist) are a mandatory requirement prior to dismantling.
- No dismantling shall take place until documentation has been submitted to the National Grid Environmental Scientist and approved as sufficient documentation.
- Stones from the wall shall be removed from the work area and temporarily stored in nearby location, away from wetlands; buffer zones; rare species habitat and other historical/archeological concerns.
- Avoid dismantling via the “bulldozer” method when possible as this method makes it nearly impossible to rebuild the wall in the same alignment due to its uncontrolled nature. Dismantling shall be conducted either by hand, with stones stacked as they are removed, or on less “sensitive” walls to use an excavator with a thumb to grab each stone and build a stockpile. Significant ground disturbance below the wall shall be avoided.

- Once construction and access in the area has been completed, the wall shall be rebuilt to pre-dismantled conditions or better. If rebuilding a stone wall can not be placed on the same alignment that existed prior to temporary removal, approval from the National Grid Environmental Scientist and Property Legal is required. **Note that if the wall represents a legal property boundary or is historically or culturally significant (or was previously determined to be in a very high quality condition), a professional stone masonry company may be required to document wall alignment, and conduct the dismantling and rebuilding.**

10.0 Avian Nest Removal

Avian nest removal shall be done in accordance with EG-304. Consult the National Grid Environmental Scientist prior to removing any nests. There are seasonal restrictions of the removal of avian nests and federal or state permits may be necessary prior to removal.

11.0 Drilling Fluids and Additives

When installing subsurface structures, there may be a need to utilize drilling aids such as slurries, borehole sealants, and other additives. All necessary steps shall be taken by National Grid personnel and contractors to prevent potential adverse effects on drinking water aquifers, groundwater quality, and wetlands when utilizing drilling aids. Efforts should be made to utilize natural bentonite clay-type materials, in place of polymer-based drilling aids. Regardless of the specific product type, the following requirements shall be met:

- Drilling aids must be NSF certified and manufactured to NSF-ANSI 60 standards. https://www.nsf.org/newsroom_pdf/NSF-ANSI_60_watemarked.pdf
- Product use must be in accordance with manufacturer's specifications and instructions.
- National Grid personnel or their contractor shall provide all the necessary information regarding the proposed product to be used to National Grid's Environmental Sustainability, Compliance and Licensing & Permitting Department as early as possible in the project planning phase. If the work is being performed by a contractor, this information must be included as part of their initial bid package.
- If polymer-based products are proposed for use, product information shall be included in all related environmental regulatory filings and frac-out plans, if possible.
- A qualified individual shall be designated who will confirm/verify and document the specific use of a drilling aid at each location. This will include add-mix ratios, surface area treated, volume of water within excavation, volumes/weight of additives used, and any other measurements specified by the manufacturer. No mixing will be allowed in the drilled shaft excavation.
- The Contractor or National Grid crew performing the work is responsible for neutralizing all drilling products, as applicable, in accordance with the manufacturer's specifications. This shall be performed following removal from the excavation and while held in holding tanks. A

qualified person shall be designated by the Contractor who will confirm/verify and document the appropriate neutralization activity at each location, as necessary.

- Waste drilling aids (neutralized or not) or soils that may have come into contact with drilling aids will not be disposed of on National Grid properties, discharged to any ground surface or subsurface, waterbodies, wetlands or placed on 3rd party properties.
- All product use must be completed in strict adherence with the management, storage, mixing, transporting, disposing and any other requirements of state and federal regulatory approvals and permits, as applicable.
- Relevant documentation shall be maintained by the Contractor or National Grid crew performing the work, and shall include volume of material treated and disposed and the location/facility at which it was disposed.
- National Grid will not be identified as the disposal generator for any polymer based slurry waste or additives generated by Contractor activities.
- The Contractor or National Grid crew performing the work assumes full responsibility for the safe storage of all polymers and additives during use and also assumes full responsibility for improper use and application of said polymers and additives that are deemed to have contravened aquifer and/or groundwater quality.
- National Grid reserves the right to refuse and terminate the use of any specific drilling aid at any time.

Regardless of the type of drilling aid utilized, the Contractor or National Grid crew performing the work is responsible for properly treating, containerizing, testing, transporting and disposing of any/all fluids and solids generated during their activities. All wastes must be disposed of in accordance with federal and state regulations. Relevant documentation shall be maintained and shall include volume of material treated and disposed and the location/facility at which it was disposed.

12.0 Water Withdrawal for Geotechnical Investigations

The use of water during geotechnical drilling operations may be required, and is most common during the “drive and wash” drilling technique, where 4- or 6-inch diameter casing is driven into the ground, and the soil inside the casing is washed out using a pump and hollow rods. Soil samples are generally collected at periodic intervals using a split spoon sampler (e.g., every 5 vertical feet).

The National Grid Environmental Scientist and/or Project Environmental Monitor may approve withdrawals from wetlands and waterways on a case-by-case basis should the geotechnical team advise no other options are available. Generally, the amount of water required for withdrawal is between 100 and 200 gallons, and the water is then recycled continuously in the drilling process. Certain scenarios may require additional water usage if water is lost down the boring (e.g., lost due to bedrock fractures during rock coring). The following general guidance should be adhered to when determining whether water withdrawals may be allowed during geotechnical investigations on the ROW. Approval from the National Grid Environmental Scientist and/or Project Environmental Monitor is required prior to initiating water withdrawals during geotechnical investigations.

- Withdrawals from perennial streams, ponds, lakes and large wetlands systems are preferred over small isolated wetlands to ensure the water level, water table, and hydroperiod are not affected. Prior to start of work, the Contractor shall identify which water source they prefer to withdraw from. The National Grid Environmental Scientist and/or the Project Environmental Monitor will confirm whether these sources are appropriate.
- Care should be taken to avoid alteration of wetlands or the beds and banks of surface waters. Examples of alterations include, but are not limited to, the following:

  (a) the changing of pre-existing drainage characteristics, flushing characteristics, salinity distribution, sedimentation patterns, flow patterns and flood retention areas;

  (b) the lowering of the water level or water table;

  (c) the destruction of vegetation; and

  (d) the changing of water temperature, biochemical oxygen demand (BOD), and other physical, biological or chemical characteristics of receiving waters.
- Wetlands and waterways providing habitat for rare species should be avoided unless all other options are exhausted. Under no circumstances should water be withdrawn from a Vernal Pool.
- Withdrawal pipes or stingers should be elevated off the bottom of wetlands and streams during the duration of pumping. Additionally, fabric or screening should be covering the withdrawal pipes to eliminate inadvertent harm to wildlife.
- Withdrawals should be performed in a manner that does not damage vegetation, disturb sediment, or result in the release of temporary or permanent fill material (e.g., sediment, spoils, or turbid water) into the wetland/waterway. Additional detail from geotechnical experts may be required to solidify BMP recommendations.
- Any water used for geotechnical drilling operations (including water withdrawn from surface water, brought on-site, or from other sources) shall be discharged into the open borehole or to an upland area such that the water infiltrates to the ground and is not discharged to a wetland or surface water resource area. Consultation with the National Grid Environmental Scientist and/or the Project Environmental Monitor is required if this is not feasible. At no time should water withdrawals result in a temporary or permanent fill/discharge of material (e.g. sediment, spoils, or turbid water) into the wetland or waterway.
- If water sourcing options is not determined prior to mobilization, necessary water shall be brought in by tank truck. Should withdrawal from surface water sources become necessary during soil boring work, the National Grid Environmental Scientist and/or the Project Environmental Monitor shall be notified prior to beginning withdrawal. If initial withdrawal from surface water is approved by the National Grid Environmental Scientist and/or the Project Environmental Monitor, the driller may withdraw from the surface water, as long as the above criteria are met.
- If excessive water withdrawal is necessary, the National Grid Environmental Scientist and/or the Project Environmental Monitor shall be consulted to determine whether the water source is appropriate for withdrawal.
- In New Hampshire, withdrawals made from state-owned property require written permission from

the agency with primary responsibility for monitoring and/or maintaining the site.

13.0 Gates

When not in use, gates shall be locked with a company-approved lock or double locked with the property owner's lock. New gates may be installed during a project, however, installation of a gate requires permission from the property owner, and may require environmental permitting. Consult with National Grid Real Estate and the National Grid Environmental Scientist prior to installing a new gate, as well as with the appropriate engineering department for the current company gate specifications. Refer to BMPs in **Appendix 4**. Installation of ROW access restrictions (e.g., stone, bollards, other) at road crossings also require consultation with the National Grid Environmental Scientist and Property Legal.

14.0 Signage

Specific signage may be required by permits or be specified in the EFI to limit access in certain sensitive areas. Signs shall be used to clarify allowed access and sensitive areas, such as:

- "No snow stockpiling beyond this point";
- "Approved access (to structures A-F)";
- "Do not cross this area until construction mats are in place";
- "No vehicle crossing";
- "Areas to avoid"; and
- "Environmentally Sensitive Area – Keep Out."

Signs shall be used in conjunction with snow fencing or other physical barriers as demarcation for sensitive areas (e.g., rare species areas, sensitive archeological locations, etc.) that need to be protected and avoided by construction activities. In addition, permit signs required by the regulatory agencies shall be present (i.e. MADEP, RIDEM, EPA (SWPPP), ACOE, etc) at construction sites and/or ROW access points. Construction signage shall be installed and maintained by the contractor performing the work during the project. Absence of signage does not eliminate the need to comply with access plans, permit conditions, and other regulatory requirements. Refer to BMPs in **Appendix 4**.

15.0 Refueling and Maintenance Operations

15.1 Spill Prevention and Response Plan

Spill controls shall be provided on every field vehicle. Bulk storage of fuels (55 gallons or greater) shall be approved by the National Grid Environmental Scientist prior to being brought on site. The need for a field spill plan shall be evaluated specific to the project for regulatory requirements under SPCC regulations or local ordinances. A field spill plan would include information on fuels and oils being used, approximate amounts in each container or type of equipment, location, fueling location, secondary containment, response and notification procedures, including contact phone numbers, etc. All personnel shall be briefed on spill prevention and response prior to the commencement of construction. The state-specific EI-501 and EG-502 shall be followed in the event of a spill.

Typical construction activities do not require the use or storage of large quantities of oil or hazardous materials (i.e., greater than 55 gallons). However, oil and/or hazardous materials (OHM) may be required in limited quantities to support construction or vehicle operations. Best practices shall be followed in the use and storage of OHM which include but are not limited to: storage and refueling greater than 100 feet from resource areas; maintenance of spill response equipment at work locations sufficient to handle incidental releases from operating equipment; general training for on-site personnel for spill clean up response for incidental releases of OHM; and contracting with an on-call spill response contractor that is capable of managing incidental and significant releases of OHM. There may situations that additional precautions shall be required for the storage or use of OHM (i.e., within wellhead protection areas, GA/GAA areas, Zone IIs). Storage of OHM shall be done in accordance with any applicable regulatory requirements.

15.2 Field Refueling

Small equipment such as pumps and generators shall be placed in small swimming pools or on absorbent blankets/pads, to contain any accidental fuel spills. Small swimming pools with absorbent blankets/pads, and/or other secondary containment, shall be used for refueling of fixed equipment in wetlands and should be maintained to prevent accumulation of precipitation.

15.3 Grease, Oil, and Filter Changes

Routine vehicle maintenance shall not be conducted on project sites.

15.4 Other Field Maintenance Operations

When other vehicle or equipment maintenance operations (such as emergency repairs) occur, company personnel or contractors at field locations shall bring vehicles or equipment to an access location a minimum of 100 feet away from environmentally sensitive areas (e.g., wetlands or drinking water sources). A paved area, such as a parking lot or roadway, is a preferred field maintenance location to minimize the possibility of spills or releases to the environment.

Crews shall take all usual and reasonable environmental precautions during repair or maintenance operations. Occasionally, it is infeasible to move the affected vehicle or equipment from an environmentally sensitive area to a suitable access area. When this situation occurs, precautions shall be taken to prevent oil or hazardous material release to the environment. These precautions include (but are not limited to) deployment of portable basins or similar secondary containment devices, use of ground covers, such as plastic tarpaulins, and precautionary placement of floating booms on nearby surface water bodies.

15.5 Tools and Equipment

Cleaning of tools and equipment shall be conducted away from environmentally sensitive areas (such as wetlands, buffer zones or drinking water sources) to the maximum extent possible. A paved area such as a parking lot or roadway is preferred, to minimize the possibility of spill or release to the environment. Crews shall wipe up all minor drips or spills of grease and oil at field locations.

16.0 Stabilization Deadlines for Projects Subject to EPA Construction General Permit

16.1 Deadlines to Initiate Stabilization Activities (Permanent and Temporary)

Soil stabilization measures shall be implemented immediately whenever earth-disturbing activities have permanently or temporarily ceased on any portion of the project. The following are some examples of activities that constitute initiation of stabilization:

- Preparing the soil for vegetative or non-vegetative stabilization;
- Applying mulch or other non-vegetative product to the exposed area;
- Seeding or planting the exposed area;
- Finalizing the arrangements to have stabilization product fully installed in compliance with the deadlines to complete stabilization in Section 15.2 below.

16.2 Deadlines to Complete Stabilization Activities (Permanent and Temporary)

As soon as practicable, but no later than 14 calendar days or 7 calendar days (for areas discharging to a sensitive water) after the initiation of soil stabilization measures commence the following should be completed:

- For vegetative stabilization, all activities necessary to initially seed or plant the area to be stabilized; and
- For non-vegetative stabilization, the installation or application of all such non-vegetative measures.

16.3 Vegetative Stabilization (all except for arid, semi-arid, or on agricultural lands)

- Provide established uniform vegetation (e.g., evenly distributed without large bare areas), which provides 70% or more of the density of coverage that was provided by vegetation prior to commencing earth-disturbing activities. Avoid the use of invasive species as cover.
- For final stabilization, vegetative cover must be perennial; and
- Immediately after seeding or planting a disturbed area to be vegetatively stabilized, a non-vegetative erosion control must be implemented to the area while the vegetation is becoming established. Examples include; mulch and rolled erosion control products.

16.4 Vegetative Stabilization (Agricultural Lands)

- Disturbed areas on land used for agricultural purposes that are restored to their pre-construction agricultural use are not subject to vegetative stabilization standards.

16.5 Non-Vegetative Stabilization

If using non-vegetative controls to stabilize exposed portions of your site, or if you are using such controls to temporarily protect areas that are being vegetatively stabilized, you must provide effective non-vegetative cover to stabilize any such exposed portions of the site. Examples of non-vegetative stabilization techniques include, but are not limited to, rip-rap, gabions, and geotextiles.

17.0 Clean-up and Restoration Standards

The following steps shall be taken once construction has been completed at each location along the ROW or within the project site. The following are minimum guidelines for clean-up and stabilization standards. Please refer to permit conditions for project-specific related standards. Refer to the EFI for applicable permit requirements and to determine if the site needs to be reviewed and approved by the permitting authorities prior to removal of erosion controls.

17.1 Removal of Sedimentation and Erosion Controls

After all work has been satisfactorily completed and vegetation has been re-established to a minimum of 75% cover, and upon approval by the National Grid Environmental Scientist, all non-biodegradable materials (e.g., siltation fencing, straw bale strings, stakes, straw wattle mesh casing, etc.) shall be disposed of properly off-site.

Dependent on permit requirements, sedimentation and erosion controls may not be allowed to be removed until after inspection and approval by one or more permitting authority. In most cases, removed straw bales may be used to mulch disturbed areas. Remaining straw bales that do not block the flow of water may be left in place unless they are required to be removed pursuant to permit conditions. Straw bales that block the flow of water shall be removed.

Prior to project construction being completed, the project team will develop post-construction inspection intervals to ensure timely removal of temporary BMPs. BMPs will be removed when the area is stabilized, which typically occurs when the area has either naturally stabilized (75% cover), or seed and mulch that was installed has achieved 75% cover.

17.2 In-Situ Restoration

Unless otherwise specified in permits or prescribed by the National Grid Environmental Scientist or the Project Environmental Consultant, all disturbed areas, including stream banks, wetlands and access routes, shall be restored following the completion of work. When the work is completed and construction mats have been removed, the National Grid Environmental Scientist or Project Environmental Consultant shall conduct an inspection. Wetlands shall be inspected for build up of sand or other materials that may have fallen through construction mats. Care shall be taken to inspect wetland crossings carefully after construction mat removal to ensure any materials are properly removed and disposed of off-site.

<u>Restoration of Soil Compaction</u>. If rutting or soil compaction following construction mat removal is observed, the area shall be returned to pre-existing conditions, and comparable to the surrounding area, by light hand raking or by back-blading with machinery. Restoration shall be overseen by the Project Environmental Consultant or National Grid Environmental Scientist. Deep ruts (>12”) shall be filled in using available, loose soil from the work area.

Seeding and Mulching. If adequate root and seed stock are absent and have been stripped from the area, graded sites shall be promptly stabilized by applying an approved seed mix and mulching with straw to reduce erosion and visual impact. Seeding and mulching shall be completed as soon as possible following completion of work at the site. For some wetland areas, natural re-vegetation may be more appropriate than seeding disturbed sites. Wetland areas where adequate root and seed stock are absent will be seeded using an approved wetland native seed mix. For some wetland areas, natural re-vegetation may be more appropriate than seeding disturbed sites. Refer to BMPs in **Appendix 4** for seed mix tables and mulch ratio tables.

If needed, the import of quality topsoil onto the ROW will be required. Topsoil should be tested, and approved by the Project Environmental Consultant or National Grid Environmental Scientist to determine its suitability for site conditions. Fertilizers will be approved on a case-by-case basis.

For upland areas, the disturbed vegetation and soil shall be restored and stabilized[4] by regrading the area to pre-existing conditions, if needed, seeding (if adequate root and seed stock are absent) and mulching the exposed soil, and removing strings and stakes from straw bales and using broken up straw bales for the mulch. Siltation fencing, strings and stakes shall be removed for disposal as ordinary waste. Refer to BMPs in **Appendix 4** for seed mix tables and mulch ratio tables.

For sites with excess boulders, additional boulders could be used at proposed and existing gate locations to use on either side of the gates as a deterrent for unauthorized vehicle access or be placed along the edges of work pads where steep slopes are present for safety purposes. The final placement of boulders should be reviewed prior to installation with Real Estate and the National Grid Environmental Scientist or Project Environmental Consultant.

Unless otherwise specified in Project-specific permit conditions, the National Grid Environmental Scientist or Project Environmental Consultant shall develop an inspection frequency to monitor restored areas for stabilization, germination and successful revegetation.

17.3 Invasive Species

All equipment shall be certified clean[5] utilizing the attached form (**Appendix 5**) or equivalent as approved by the vendor prior to mobilization to the work site. The vendor shall use the certification from provided as **Appendix 5** to document compliance with invasive species management BMPs. Clean is defined as being free of plant matter (stems, flowers, roots, etc), soil, or other deleterious materials prior to being brought to the project site. Any equipment that has been placed or used within areas containing invasive species within the project site shall be cleaned of plant matter (stems, flowers, roots, etc), soil, or other deleterious materials at the site of the invasive species prior to being moved to other areas on the project

[4] For projects subject to the 2012 CGP, stabilization is required within 14 days, or within 7 days for sensitive areas.

[5] The **Appendix 5** certification form (or equivalent as approved by National Grid Environmental Scientist) shall be used to document the clean certification

site to prevent the spread of invasive species from one area to another[6]. **Equipment shall be cleaned prior to being removed at the completion of the project: exceptions to this requirement shall be determined on a case-by-case basis.** Consult with the National Grid Environmental Scientist prior to discharging or disposing of any waste water or waste material from the cleaning of equipment.

17.4 Cleaning of Equipment

At the completion of the project, equipment shall be cleaned prior to being de-mobilized to prevent tracking of material onto roads and causing safety issues. Consult with the National Grid Environmental Scientist prior to discharging or disposing of any waste water or waste material from the cleaning of equipment.

17.5 Access Roads

Constructed gravel roads shall be left in place following project completion unless permit conditions require their removal. Refer to the specific permit conditions for these provisions. If the road is to be removed, the crushed stone and geotextile fabric shall be removed from the work site. Seeding and/or mulching of gravel roads is generally not required, unless necessary to prevent erosion. Pre-existing sandy soils within mapped rare turtle habitat shall not be seeded unless directed by the National Grid Environmental Scientist so as to not alter nesting habitat.

17.6 Stone Work Pads

Unless permit conditions or property owner's require the removal of constructed stone work pads following project completion, constructed work pads shall be left in place. Refer to the specific permit conditions for these provisions.

17.7 Construction Materials on ROWs

As soon as the structure work has been completed, all used parts and trash are to be picked up and removed from the project site. Retired poles shall be removed in accordance with National Grid Engineering Standard SP.06.01.301. In some cases, the used material from structure work may be temporarily stored at the work area by placing it out of the wetlands or other sensitive resource area until work in the adjacent areas has been completed. However, treated wood poles shall never be stored in standing water or in wetlands. If the project is cancelled, all material shall be removed from the project site. Excess material brought to the project site shall be removed upon project completion. Consult with the National Grid Environmental Scientist on whether the work site shall be restored in addition to the measures outlined above

17.8 Improved Areas

Yards, lawns, agricultural areas, and other improved areas shall be returned to a condition at least equal to that which existed at the start of the project. Off-ROW access shall never be assumed and shall be coordinated through Real Estate before being implemented. Depending on the access point, construction matting or other BMPs may be required to prevent ruts, lawn damage, or other property damage.

[6] On ROW projects where multiple wetlands may be dominated by the same invasive species, cleaning may not be required for movement along the ROW. Check with the National Grid Environmental Scientist for guidance.

Restoration following the completion of work and any use of improved areas shall be conducted in accordance with the measures outlined above.

17.9 Property Damage

All damage to property occurring as a result of a project shall be immediately repaired or replaced. In some locations, it may be desirable to document pre-existing damage prior to work commencing in that area in order to demonstrate afterwards that the damage did not result from the project. Work crews, the Project Environmental Consultant or the National Grid Environmental Scientist shall document repairs that were performed in response to damage from unauthorized vehicle use.

17.10 Overall Work Site

Upon satisfactory completion of work, the construction personnel shall remove all work-related trailers, buildings, rubbish, waste soil, temporary structures, and unused materials belonging to them or used under their direction during construction, or waste materials from previous construction and maintenance operations. All areas shall be left clean, without any litter or equipment (wire, pole butts, anchors, insulators, cross-arms, cardboard, coffee cups, water bottles, etc.) and restored to a stable condition and as near as possible to its original condition, where feasible. Debris and spent equipment shall be returned to the operating facility or contractor staging area for disposal or recycling (cardboard) as appropriate in accordance with EI-111.

17.11 Material Storage/Staging and Parking Areas

Upon completion of all work, all material storage yards, staging areas, and parking areas shall be completely cleared of all waste and debris. Unless otherwise directed or unless other arrangements have been made with an off ROW or off-property owner, material storage yards and staging areas shall be returned to the condition that existed prior to the installation of the material storage yard or staging area. Regardless of arrangements made with a landowner, all areas shall be restored to their pre-construction condition or better. Also any temporary structures erected by the construction personnel, including fences, shall be removed by the construction personnel and the area restored as near as possible to its original condition, including seeding and mulching as needed.

18.0 Notification of Emergency Work

Because it is sometimes difficult to identify wetlands and other sensitive environmental areas, the National Grid Environmental Scientist shall be notified within 24 hours or by the next working day whenever emergency off-road repair work takes place. Although the routine maintenance and emergency repair work is generally allowed, due to site conditions or the scope of the project, notification to the regulating agencies may be required.

19.0 Appendices

APPENDIX 1: Glossary
APPENDIX 2: Acronyms

APPENDIX 3:	Storm Water, Wetlands & Priority Habitat Environmental Compliance Site Inspection / Monitoring Report Form
APPENDIX 4:	BMP Drawings and Guidelines
APPENDIX 5:	Certification Sheet for Invasive Species Control
APPENDIX 6:	Snow Disposal Guidelines

Appendix 1 – Glossary

Access Road – An existing, periodically maintained road often consisting of gravel and/or exposed soils or vegetated with grasses but devoid of woody vegetation, that is visible on aerial photography and shown on ROW T-sheets. May include newly permitted permanent roads (i.e., roads to be constructed in accordance with a project-specific permit).

Access Route - A pathway previously used or proposed to be used by crews for access along the ROW. Routes may be shown on ROW T-sheets or previous project access plans but are not improved as maintained gravel/exposed soil roads. Access routes may be mown and can consist of trails utilized by recreational vehicles.

Action Logs – Project-specific log used to document action items required for permit compliance. The log identifies timeframes for completion and responsible parties. The log is typically updated by the Project Environmental Consultant or the National Grid Environment Scientist and circulated to the project team on a weekly, or more frequent, basis.

Bank – The transitional slope immediately adjacent to the edge of a surface water body, the upper limit of which is usually defined by a break in slope, or, for a wetland, where a line delineated in accordance with applicable state and federal regulations that indicates a change from wetland to upland.

BMP – Best Management Practice. Individual engineered constructions or operating procedures intended to minimize and mitigate soil disturbance, erosion, sedimentation, turbid discharges, and/or impacts to sensitive receptors.

Clean - Free of plant matter (stems, flowers, roots, etc), soil, or other deleterious materials prior to being brought to the project site.

Clean Gravel – Gravel is a type of coarse-grained soil that consists of small stones and other mineral particles. Clean Gravel shall meet the requirements in accordance with National Grid Standard Construction Specification for Electric Stations (Engineering Standard SP.08.00.001) Clean Gravel will not have fine materials that could lead to a turbid discharge.

Clean Stone (Crushed Stone) – Clean Stone (Crushed Stone) shall meet the requirements in accordance with National Grid Standard Construction Specification for Electric Stations (Engineering Standard SP.08.00.001). Clean Stone will not have fine materials that could lead to a turbid discharge.

Clearing – The cutting of trees and large bushes by hand and/or mechanical means.

Compost Socks – Tubular devices comprised of non-degradable, photodegradable, or biodegradable mesh tubing containing organic compost matrix. Compost socks are effective for intercepting site runoff, trapping sediment, and treating for soluble pollutants by filtering stormwater runoff. . Compost socks are a useful sedimentation control device along construction site perimeters, as check dams in drainage channels, as a slope interruption practice on long and/or steep slopes, and around drain or street curb inlets.

Construction Mats **- C**onstruction, swamp, and timber mats ("construction mats") are generic terms used to describe structures that distribute equipment weight to minimize disturbance to wetland soil and vegetation while facilitating passage and providing work platforms for workers and equipment. They are comprised of sheets or mats made from a variety of materials in various sizes.

Corduroy Road – Corduroy roads are cut trees and/or saplings with the crowns and branches removed, and the trunks lined up next to one another.

Dewatering Basin – An established containment area for saturated materials and pumped discharges. This measure is used for the purpose of de-watering soils prior to transport off site or for use in another location on site, and for allowing suspended sediment to settle out of pumped discharges.

Detention/Retention Basin – A detention/retention basin is designed for the purpose of detaining or retaining water. A dewatering basin is a form of detention basin

Dewatering – Use of a system of pumps, pipes and temporary holding dams to drain or divert waterways or wetlands, or lower the groundwater table before and during excavation activities.

Drainage Ditch or Swale – A clearly noticeable channel that is typically dry, except after precipitation events. Intermittent and perennial streams and rivers are not included in this definition.

Dredge – To dig, excavate, or otherwise disturb the contour or integrity of sediments in the bank or bed of a wetland, a surface water body, or other area within the regulating bodies' jurisdiction.

Dredge Spoils – Material removed as the result of dredging.

Embankment – A protective bank constructed of mounded earth or fill materials located between a roadway (or rail bed) and a seasonal stream or other wetland.

Environmental Field Issue – Document that contains copies of all project-specific environmental permits and summarizes all environmental permit conditions. The EFI is prepared by the Project Environmental Consultant or the National Grid Environment Scientist and copies are provided to the Project Manager, Construction Supervisor(s), and other team members as appropriate.

Environmental Monitoring Records – Examples of checklists and/or monitoring reports suggested for use by the Company Environmental Engineer to document conformance of the project with this Environmental Guidance and or project specific permit/license conditions.

Environmental Scientist – Formerly Environmental Engineer. The National Grid Environmental Department representative for the project or the territory where the work is located. For a map of Environmental Department staff territories, refer to the Environmental page of the National Grid infonet.

Environmentally Sensitive Areas – Examples of environmentally sensitive areas that may be found on National Grid properties are rivers, streams, ponds, lakes, wetlands, bogs, swamps, salt marshes, rare species habitat, wellhead protection areas, cultural sites, parks, preserves, schools and as otherwise defined by Federal, State or local regulations. Refer to EG-301.

Erosion Controls – The utilization of methods to prevent soil detachment and minimize displacement or washing down slopes by rainfall or run-off. Common practices include, but are not limited to:

(a) Temporary and Permanent Seeding.

(b) Mulching, Soil Binders, Tackifiers.

(c) Erosion Control Blankets.

(d) Hydraulic Erosion Control.

Excavate/Excavation – To dig, remove, or form a cavity or a hole in an area within the department's jurisdiction.

Fill (n.) – Any rock, soil, gravel, sand or other such material that has been deposited or caused to be deposited by human activity.

Fill (v.) – To place or deposit materials in or on a wetland, surface water body, bank or otherwise in or on an area within the jurisdiction of the department.

Flats – Relatively level landforms composed of unconsolidated mineral and organic sediments usually mud or sand, that are alternately flooded and exposed by the tides and that usually are continuous with the shore.

Frozen Condition – Field conditions when the upper portion of the ground surface freezes or when areas of standing water freeze solid such that vehicle passage over these areas is supported without any resulting soil disturbance. The frozen conditions must have been affected by severe cold (maximum daily temperatures less than 32 degrees F) for a continuous 2-week period.

GAA – Rhode Island groundwater classification, groundwater resources that are known, or presumed to be suitable for drinking water use without treatment, and are located in one of the three areas described below.

a) The state's major stratified drift aquifers that are capable of serving as a significant source for a public water supply ("groundwater reservoirs") and the critical portion of their recharge area as delineated by DEM;

b) The wellhead protection area for each public water system community water supply well. Community water supply wells are those that serve resident populations and have at least 15 service connections or serve at least 25 individuals, e. g. municipal wells and wells serving nursing homes, condominiums, mobile home parks, etc.; and

c) Groundwater dependent areas that are physically isolated from reasonable alternative water supplies and where existing groundwater warrants the highest level of protection. At present only Block Island has been designated as meeting this criterion.

GA – Rhode Island groundwater classification, groundwater resources that are known, or presumed to be suitable for drinking water use without treatment. However, groundwater classified by GA does not fall within any of the three priority areas described under the GAA classification.

Grade/Grading – The movement of soil and fill material to change the elevation of the land. The term refers to the combined actions of excavating and filling to change elevation or shape.

Grubbing – The removal of stumps/roots by mechanical means during site preparation activities.

Immediately - As soon as practicable, but no later than the end of the next work day, following the day when the earth-disturbing activities have temporarily or permanently ceased.

In-kind Replacement - Replacement using the same material, functional inverts, diameter and length as the existing item. In-kind replacement includes the substitution of a structure with a similar structure in approximately the same location as is practicable, and is approximately the same in design. The design may be altered to meet applicable utility standards, and may include alternate materials designed to prolong the life of that service.

Intermittent Stream – A stream that flows for sufficient time to develop and maintain a defined channel, but which might not flow during dry portions of the year.

In the Dry – Work done either during periods of low water or behind temporary diversions, such as Earth Dike / Drainage Swale and Lined Ditches designed and installed in accordance with best management practices.

Limit of Work/Disturbance – The approved project limits within regulated areas. All project related activities in regulated areas must be conducted within the approved limit of work/disturbance. The limit of work/disturbance shall be depicted on the approved permit site plans and in the EFI plans. Where it is warranted National Grid may require that these limits be identified in the field by flagging, construction fencing, and/or perimeter erosion controls.

Long-Term Restoration Logs - Project-specific log used to document restoration required following the completion of construction or as areas of the project have been completed (i.e., segments of ROW for a multi-mile project). The log is typically updated by the Project Environmental Consultant or the National Grid Environment Scientist and circulated to the project team on a weekly basis.

Low Flow Conditions – Low water flow that generally occurs during the summer, as a result of decreased precipitation and the removal of water by increased evaporation and evapotranspiration by vegetation. Work done under low-flow conditions minimizes the potential for environmental damage. The USACE defines the calendar dates for low flow conditions in its New England state-specific Programmatic General Permits.

Low Ground Pressure – Equipment that meets the USACE GP state-specific defined Pounds per Square Inch (PSI) ground pressure when loaded. Use of LGP equipment ***requires approval*** from the National Grid Environmental Scientist.

Marsh – A wetland:

a) That is distinguished by the absence of trees and shrubs;

b) Dominated by soft-stemmed herbaceous plants such as grasses, reeds, and sedges; and

c) Where the water table is at or above the surface throughout the year, but can fluctuate seasonally.

Methods – Are the construction practices and procedures that take place through choosing the proper equipment, trucks and labor to execute the earth moving activities based on the existing conditions and implementing creative and sensitive scheduling for the daily activities.

NHESP - Natural Heritage Endangered Species Program; a department within the Massachusetts Division of Fisheries and Wildlife that is responsible for protecting the 176 species of vertebrate and invertebrate animals and 259 species of native plants that are officially listed as Endangered, Threatened or of Special Concern in Massachusetts.

Perennial – A stream that contains water at all times except during extreme drought.

Permanently Ceased – Is applicable to earth disturbance activities when clearing and excavation within any area of the Project that will not include permanent structures has been completed.

Person-in-Charge – A National Grid Project Engineer, Manager, Supervisor, Field Construction Coordinator or equivalent Contractor personnel assigned to oversee and coordinate work activities.

Processed Gravel – Processed Gravel shall meet the requirements in accordance with National Grid Standard Construction Specification for Electric Stations (Engineering Standard SP.08.00.001). Processed Gravel will not have fine materials that could lead to a turbid discharge. Gravel consisting of inert material that is hard, durable stone and is free from loam and clay, surface coatings and deleterious materials.

Regulating Body – Federal, State, or local authority that has jurisdiction over resource areas that may be impacted by company operations

Regulated Wetland Area – Those areas that are subject to federal, state or local wetland regulation, including certain buffer or adjacent areas.

Repair – The restoring of an existing legal structure by partial replacement of work, or broken, or unsound parts (Env-Wt 101.73).

Replacement – The substitution of a new structure for an existing legal structure with no change in size, dimensions, location, configuration, construction, or which conforms in all material aspects to the original structure

Right-of-Way – A corridor of land where National Grid has legal rights (either fee ownership, lease or easement) to construct, operate, and maintain an electric power line and/or natural gas pipeline and may include work on customer owned properties.

River – A watercourse that is larger than a perennial stream and flows all year long.

Routine Utility Rights-of-Way Maintenance Activity – Includes but is not limited to vegetation management and repair or replacement of existing utility structures.

Sedimentation Controls – Silt fences, straw bales, compost socks/berms and other barrier devices strategically placed to intercept and treat sediment-laden site runoff.

Sensitive Water - Includes any sediment or nutrient impaired water or a water that is identified by the state, tribe or EPA as Tier 2, 2.5 or Tier 3 for antidegradation purposes.

Siltation Curtain – An impervious barrier erected to prevent silt and sand and/or fines from being washed into a wetland, surface water body or other area of concern.

Surface Water Body or Surface Waters – Those portions of waters which have standing or flowing water at or on the surface of the ground.

Spill Prevention, Control and Countermeasure Plans – Required for site operations that involve the storage of 1,320 gallons or greater of fuel and oils, both in storage containers and stored in equipment. Response actions to spills and releases are specified in these plans.

Stormwater Pollution Prevention Plan – A site-specific, written document that, among other things: (1) identifies potential sources of stormwater pollution at a construction site; (2) describes stormwater control measures to reduce or eliminate pollutants in stormwater discharge from a construction site; and (3) identifies procedures the operator will implement to comply with the terms and conditions of EPA NPDES Construction General Permit (CGP). SWPPPs must be prepared, maintained on-site, and amended as necessary in order to obtain NPDES permit coverage for specific construction site stormwater discharges under the EPA NPDES CGP.

Temporarily Ceased - Is applicable when there are earth disturbance activities such as clearing, grading, and/or excavation that are not complete, but will be idle in one area for a period of up to 14 or more calendar days, and which will resume in the future. The 14 calendar day timeframe begins as soon as you now that construction work on a portion of the Project will be left incomplete and idle. In circumstances where there are unanticipated delays and you do not know at first how long the work stoppage will continue, the requirement to immediately initiate stabilization is triggered as soon as you know with reasonable certainty that work will be stopped for 14 or more additional calendar days.

Tidal Wetlands – A wetland whose vegetation, hydrology or soils are influenced by periodic inundation or tidal waters.

Topsoil – The uppermost part of the soil, ordinarily moved in tillage, or its equivalent in uncultivated soils and ranging in depth from 2 to 10 inches.

Turbidity – The condition in which solid particles suspended in water make the water cloudy or even opaque in extreme cases.

United States Geological Survey Topographic Map – A map that uses contour lines to represent the three-dimensional features of a landscape on a two-dimensional surface. These maps use a line and symbol representation of natural and artificially created features in an area.

Wetland – An area that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal conditions does support, a prevalence of vegetation (more than 50 percent) typically adapted for life in saturated soil conditions (hydric soils). Wetlands include but are not limited to swamps, marshes, bogs, and similar areas.

Work Site – An area where work is performed.

Worker – Company employee, contractor, consultant working on site.

Zone II - Massachusetts - That area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at safe yield, with no recharge from precipitation). It is bounded by the groundwater divides which result from pumping the well and by the contact of the aquifer with less permeable materials such as till or bedrock. In some cases, streams or lakes may act as recharge boundaries. In all cases, Zone IIs shall extend up gradient to its point of intersection with prevailing hydrogeologic boundaries (a groundwater flow divide, a contact with till or bedrock , or a recharge boundary).

Appendix 2 – Acronyms

ASTM	American Society for Testing and Materials
BMP	Best Management Practices
EFI	Environmental Field Issue
EG	Environmental Guidance
EPA	Environmental Protection Agency
GA/GAA	Rhode Island Groundwater Classifications – see glossary
LGP	Low Ground Pressure
MA	Massachusetts
MA DEP	Massachusetts Department of Environmental Protection
MassDOT	Massachusetts Department of Transportation
NE	New England
NH	New Hampshire
NH DES	New Hampshire Department of Environmental Services
NHESP	Natural Heritage Endangered Species Program
NPDES	National Pollutant Discharge Elimination System
OHM	Oil and/or Hazardous Materials
PSI	Pounds per square inch
RI	Rhode Island
RI DEM	Rhode Island Department of Environmental Management
RI CRMC	Rhode Island Coastal Resources Management Council
RI SESC	Rhode Island soil erosion and sediment control
ROW	Right-of-Way
RTE	Rare, Threatened or Endangered
SPCC	Spill Prevention, Control and Countermeasure
SWPPP	Storm Water Pollution Prevention Plan
TOY	Time-of-Year
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
VT	Vermont

VT DEC	Vermont Department of Environmental Conservation
Zone II	Massachusetts Groundwater Protection district – see glossary

Appendix 3

See EG303NE_Appendix3_Reporting Form published separately

Appendix 4 – BMPs

See EG303NE_Form1 for a list of BMPS

See EG303NE_Form2 for BMP details

APPENDIX 5
CERTIFICATION FORM FOR INVASIVE SPECIES CONTROL

Certain permit conditions, therefore a Condition of Contracts for the Prime Contractor, any Subcontractors, and any equipment or mat vendors for ***National Grid Projects*** shall be required to Certify their equipment[7] {each piece of equipment used on site} as 'clean'[8].

_________________________________ (*name of firm*) hereby Certifies that

_________________________________ (*make, model, and/or type*)

_____________________________________ (*equipment ID tag or #)* meets the following

1. before entry on to the job site, has been sufficiently cleaned to remove all accumulated mud, debris, plant fragments, and detritus that could harbor seeds, roots, or plant fragments of so-called invasive plant species; and

2. that the above piece of equipment has neither been off-loaded nor operated in the interval between cleaning and delivery to the jobsite.

3. that equipment deployed in areas of invasive species (as identified in project plans) shall be cleaned prior to redeployment.

____________________________ (*signed*) _____________ (*dated*)

____________________________ (*printed name*) _____________________________ (*title*)

____________________________ (*Firm*)

The signed original of this form {one for each piece of equipment (or lot[9] of mats)} is to be given to the NG Construction Supervisor assigned to the project.

---

[7] Equipment may include, but is not limited to bulldozers, excavators, backhoes, bucket trucks (tracked or wheeled), pulling equipment, concrete trucks, compressors, drilling equipment, and mats (composite, wood, or other materials).

[8] With regard to invasive species, the definition of clean means free of accumulated mud, debris, plant fragments, and detritus that could harbor seeds, roots, or plant fragments of so-called invasive plant species.

[9] Lot of mats is the number of mats that may be transported by one forwarder/truck at a time.

Appendix 6 – Snow Disposal Guidelines

See EG303NE_App6 published separately

	BMP #	Measure
Sediment & Erosion Controls	SEC-1	Weed free bale barrier
	SEC-2	Sediment control fence
	SEC-3	Silt fence / weed free barrier
	SEC-4	Silt Soxx
	SEC-5	Straw Wattle
	SEC-6	Erosion Control Blanket - Ditch
	SEC-7	Erosion Control Blanket - Slope
	SEC-8	Hydroseeding with Tackifier (slope stabilization)
	SEC-9	Mulch materials, rates and uses (from NY)
	SEC-10	Seeding options - Upland Seed Mixes
	SEC-11	Seeding options - Wetland Seed Mix
	SEC-12	Distribution Pole Erosion Control

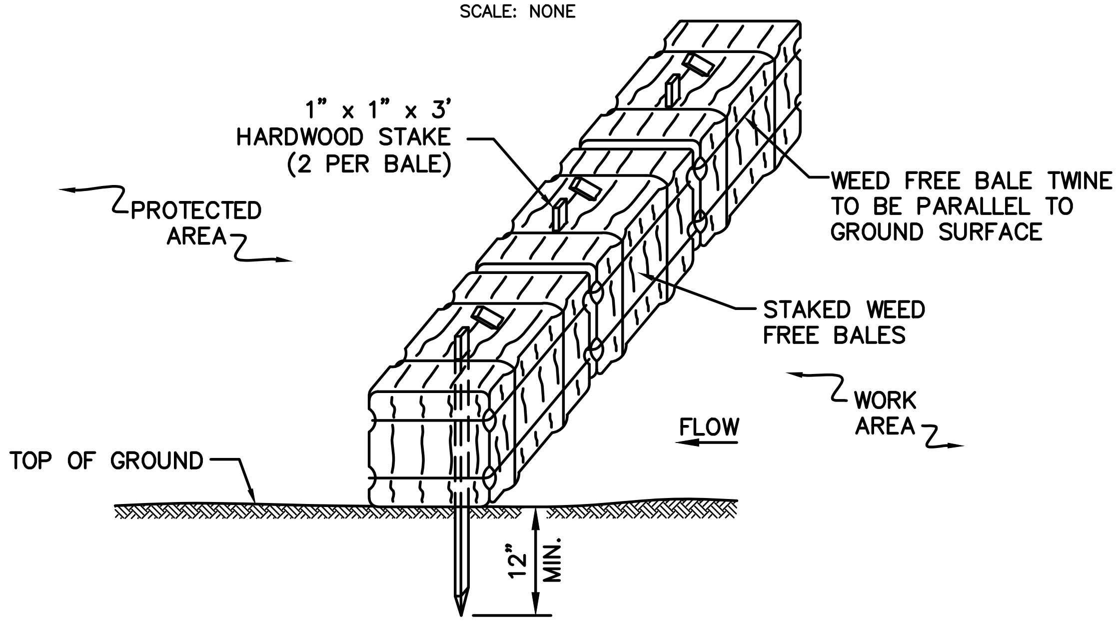
Crossing Measures	CM-1	Prefabricated mats
	CM-2	Construction mat bridge
	CM-3	Construction mat layout (with transition)
	CM-4	Construction mat layout (with transition & BMPs)
	CM-5	Construction mat - Air Bridge
	CM-6	Corduroy road
	CM-7	Rock Ford
	CM-8	Temporary construction entrance / exit
	CM-9	Temporary construction culvert
	CM-10	Access way stabilization
	CM-11	Construction signage
	CM-12	Construction Mat Anchoring

Advanced Applications	AA-1	Reinforced silt fence
	AA-2	Sediment filter
	AA-3	Stone check dams
	AA-4	Straw / haybale check dam
	AA-5	Waterbar
	AA-6	Sandbag check dam
	AA-7	Earth dike
	AA-8	Drainage swale and lined ditch
	AA-9	Sedimentation basin
	AA-10	Dewatering basin - Small scale
	AA-11	Dewatering basin - Large scale
	AA-12	Dirtbag
	AA-13	Concrete waste sump

	AA-14	Outpak concrete washout
Advanced Applications	AA-15	Barrier fence (construction fence)
	AA-16	ROW gates / fences
	AA-17	Bollard
	AA-18	Dust control
	AA-19	Catch Basin Inlet Protection
	AA-20	Silt Sack
	AA-21	Turbidity Curtain
	AA-22	Siltsoxx Amphibian & Reptile Crossing #1
	AA-23	Siltsoxx Amphibian & Reptile Crossing #2
	AA-24	Siltsoxx Amphibian & Reptile Crossing #3
	AA-25	Cultural Avoidance

BMP DETAIL

SCALE: NONE



NOTES:

1. THE GROUND SHALL BE PREPARED TO PROVIDE COMPLETE CONTACT WITH THE BALES.

BMP PICTURE

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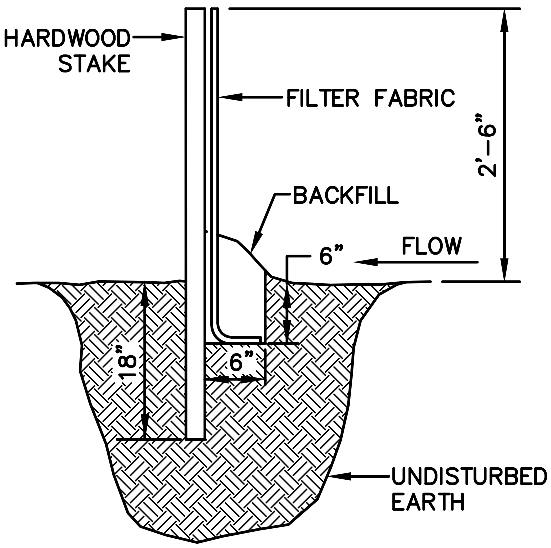
SEC-1
WEED FREE BALE BARRIER

File: BALE_BARRIER.DWG

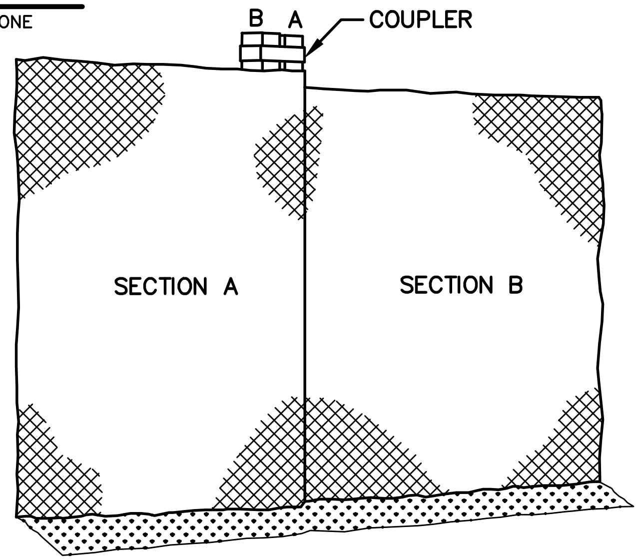
nationalgrid	ENVIRONMENTAL GUIDANCE	Doc. No.	EG-303NE
		Page: 7-2	Rev. No. 4
		Date	02/20/18
SUBJECT Access, Maintenance and Construction Best Management Practices		Reference EP No. 3 - Natural Resource Protection (Chapter 6)	

BMP DETAIL

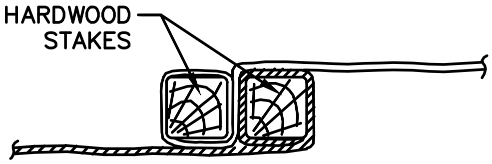
SCALE: NONE



PROFILE



SECTION



PLAN

BMP PICTURE

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SEC-2
SEDIMENT CONTROL FENCE

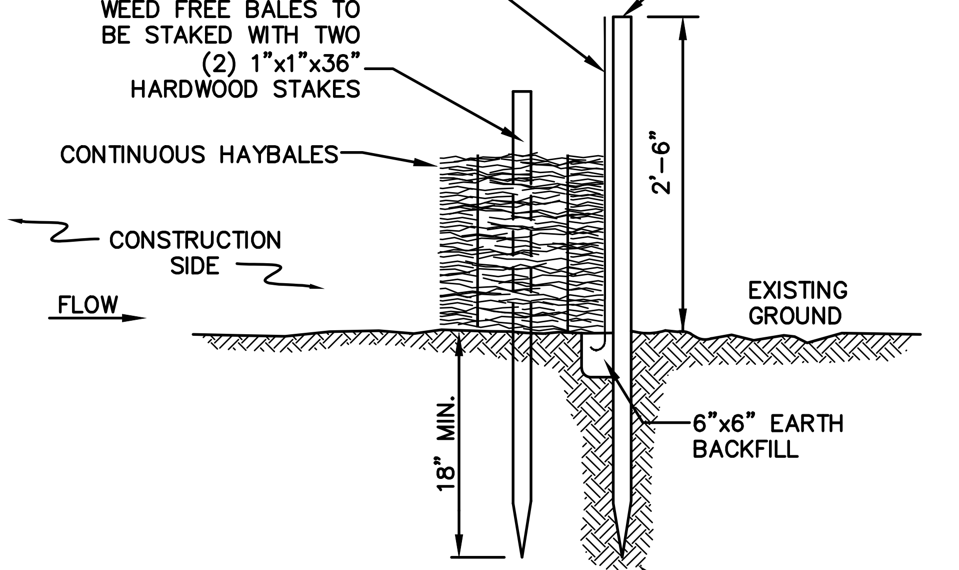
File: Sediment_Fence.dwg

nationalgrid	ENVIRONMENTAL GUIDANCE	Doc. No.	EG-303NE
		Page: 7-3	Rev. No. 4
		Date	02/20/18

SUBJECT Access, Maintenance and Construction Best Management Practices	Reference EP No. 3 - Natural Resource Protection (Chapter 6)

BMP DETAIL

SCALE: NONE



NOTES:

1. BALES SHALL BE PLACED IN A ROW WITH THE ENDS TIGHTLY ABUTTING THE ADJACENT BALES.
2. BALES SHALL BE SECURELY ANCHORED IN PLACE BY TWO (2) 1"X1"X36" HARDWOOD STAKES DRIVEN THROUGH THE BALES. THE FIRST STAKE IN EACH BALE SHALL BE ANGLED TOWARD PREVIOUSLY LAID BALE TO FORCE BALES TOGETHER.
3. INSPECTION SHALL BE FREQUENT AND REPAIR OR REPLACEMENT SHALL BE MADE PROMPTLY AS NEEDED.
4. BALES SHALL BE REMOVED AND REPLACED WHEN THEY BECOME FILLED WITH SEDIMENT AND BLOCK OR IMPEDE STORM FLOW OR DRAINAGE.
5. BALES SHALL BE REMOVED WHEN THE EMBANKMENTS STABILIZE.
6. BALES TO BE TWINE BOUND.

BMP PICTURE

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SEC-3
SILT FENCE /
WEED FREE BARRIER

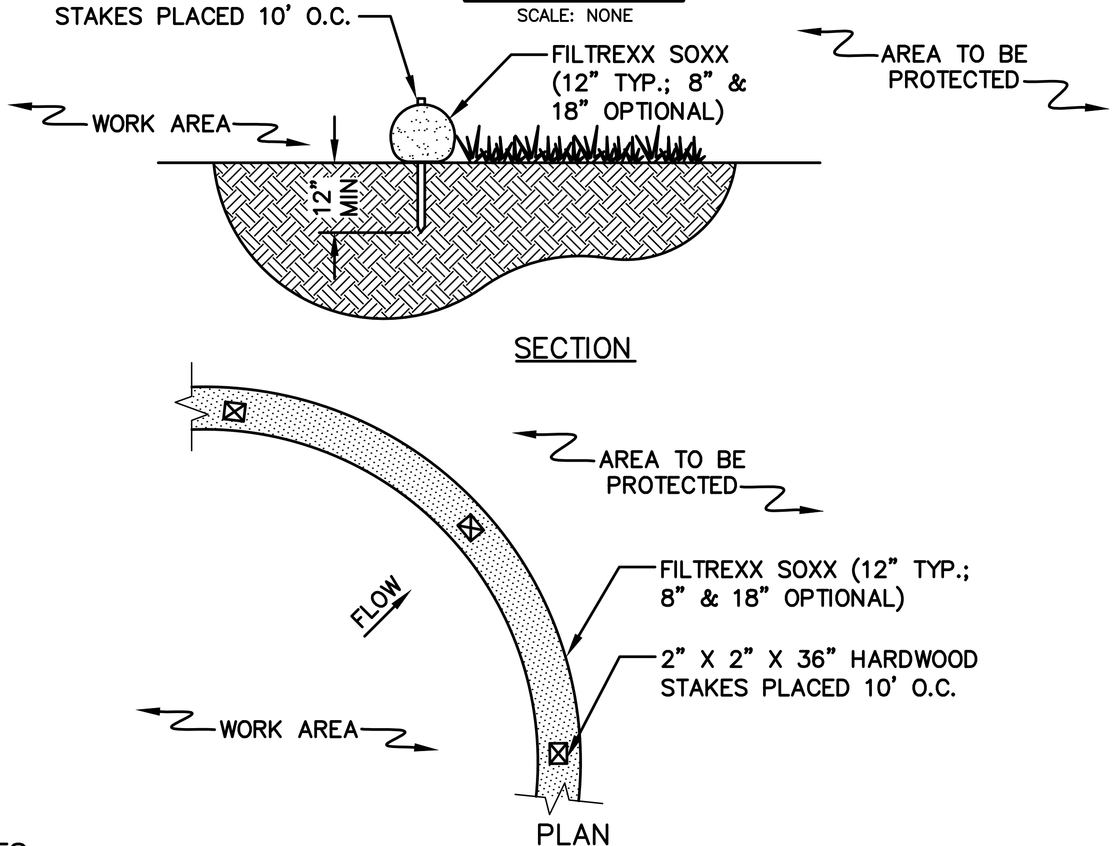
File: Silt_Fence_&_Barrier.dwg

SUBJECT
Access, Maintenance and Construction Best Management Practices

Reference
EP No. 3 - Natural Resource Protection (Chapter 6)

BMP DETAIL

SCALE: NONE



NOTES

1. PRODUCT TO BE FILTREXX SILT SOXX OR APPROVED EQUAL BY NATIONAL GRID ENVIRONMENTAL SCIENTIST.
2. ALL MATERIAL TO MEET FILTREXX SPECIFICATIONS.
3. FILTER MEDIA FILL TO MEET APPLICATION REQUIREMENTS.
4. MESH CONTAINMENT MATERIAL SHOULD BE KNITTED PHOTODEGRADABLE OR BIODEGRADABLE MATERIAL, WITH OPENING SIZES BETWEEN 1/8" – 3/8".
5. COMPOST MEDIA SHOULD HAVE PARTICLE SIZE WHERE 99% < 2", 50% > 1/2".
6. COMPOST MATERIAL TO BE DISPERSED ON SITE, AS DETERMINED BY NATIONAL GRID ENVIRONMENTAL SCIENTIST.

BMP PICTURE

*** PICTURE AND DETAIL PROVIDED BY FILTREXX LAND IMPROVEMENT SYSTEMS**
APPROVED BY: VICE PRESIDENT, ENVIRONMENTAL SERVICES

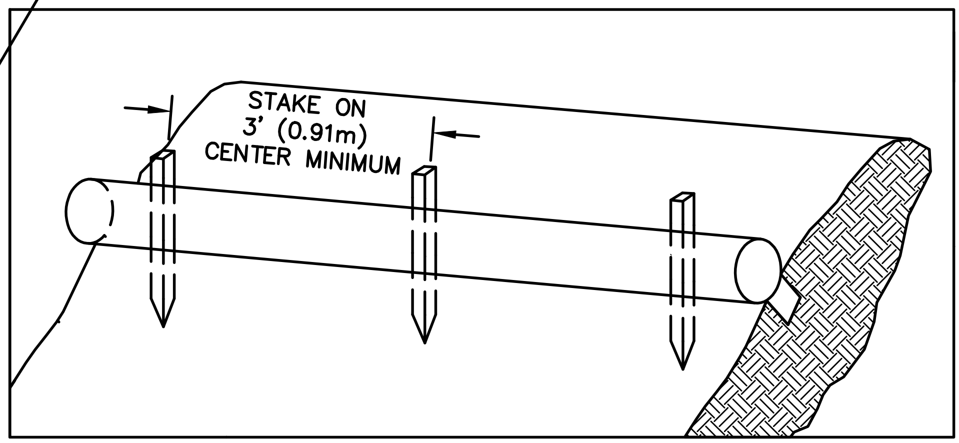
SEC-4
SILT SOXX *

BMP DETAIL

SCALE: NONE

CIRCLED NUMBERS CORRESPOND TO INSTALLATION NOTES FOR THIS STRAW WATTLE BMP DETAIL (TYP.)

③



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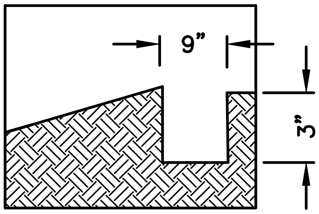

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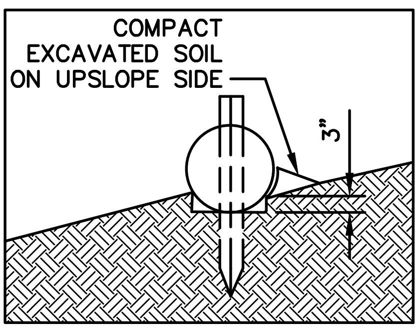
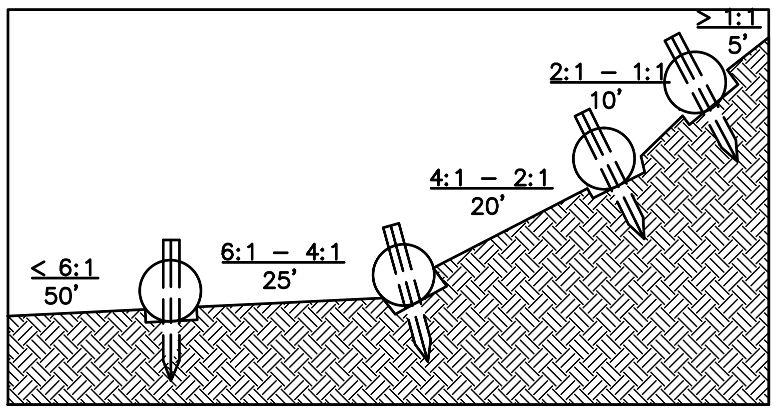




TYPICAL WATTLE SPACING DETAIL

NOTES:

1. PRODUCT TO BE TENSAR NORTH AMERICAN GREEN STRAW WATTLE OR APPROVED EQUAL BY NATIONAL GRID ENVIRONMENTAL SCIENTIST.
2. TYPICAL WATTLE SPACING BASED ON SLOPE GRADIENT. COORDINATE SPACING AND LOCATION WITH NATIONAL GRID ENVIRONMENTAL SCIENTIST.
3. MINIMUM 12" DIAMETER WATTLES SHOULD BE USED FOR HIGHLY DISTURBED AREAS (I.E., HEAVILY USED ACCESS ROAD WITH ADJACENT WETLAND) AND MINIMUM 9–10" WATTLES SHOULD BE USED FOR LESS DISTURBED SOILS.

INSTALLATION NOTES:

1. BEGIN AT THE LOCATION WHERE THE WATTLE IS TO BE INSTALLED BY EXCAVATING A 2–3" DEEP X 9" WIDE TRENCH ALONG THE CONTOUR OF THE SLOPE. EXCAVATED SOIL SHOULD BE PLACED UPSLOPE FROM THE ANCHOR TRENCH.
2. PLACE THE WATTLE IN THE TRENCH SO THAT IT CONTOURS TO THE SOIL SURFACE. COMPACT SOIL FROM THE EXCAVATED TRENCH AGAINST THE WATTLE ON THE UPHILL SIDE. ADJACENT WATTLES SHOULD TIGHTLY ABUT.
3. SECURE THE WATTLE WITH 18–24" HARDWOOD STAKES EVERY 3–4' AND WITH A STAKE ON EACH END. STAKES SHOULD BE DRIVEN THROUGH THE MIDDLE OF THE WATTLE LEAVING AT LEAST 2–3" OF STAKE EXTENDING ABOVE THE WATTLE. STAKES SHOULD BE DRIVEN PERPENDICULAR TO THE SLOPE FACE.

BMP PICTURE

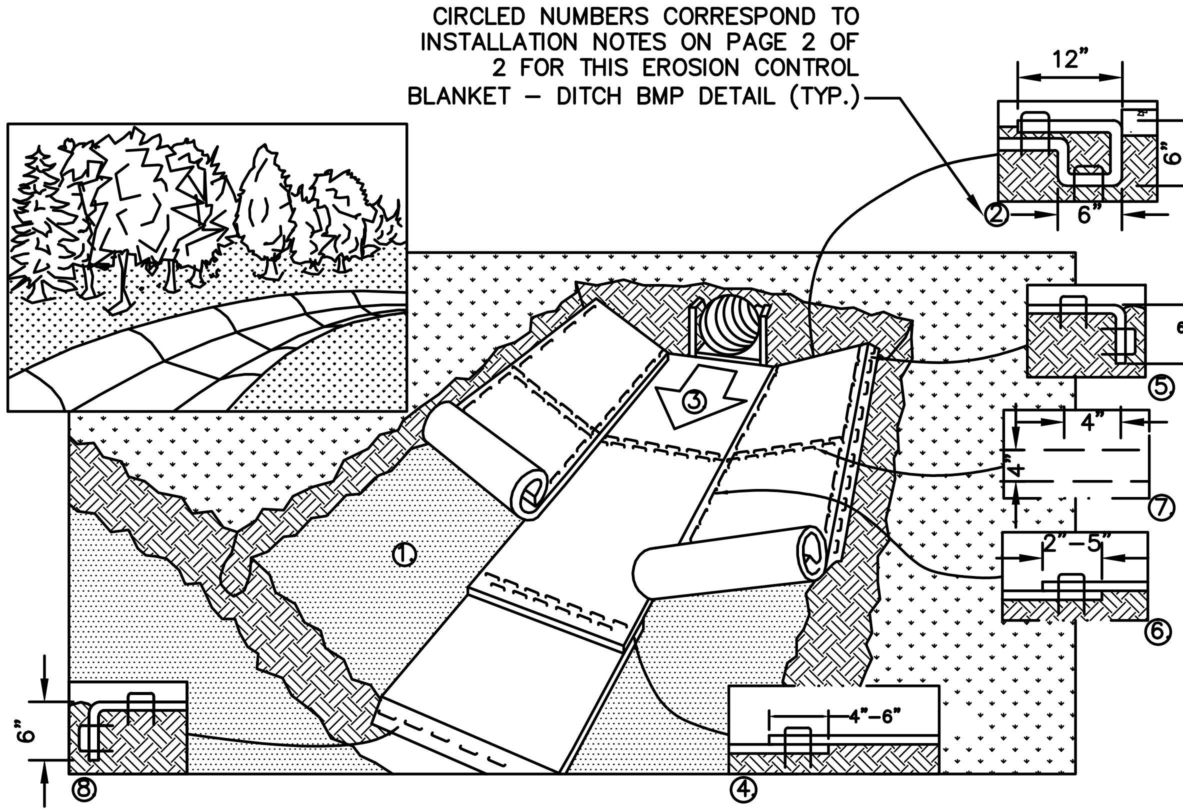
STRAW WATTLE – SHALLOW SLOPE (≤4:1)
(ALTERNATE STAKING)

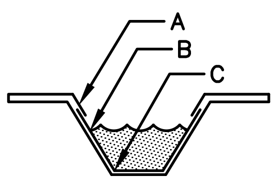
ALTERNATE STAKING INSTALLATION NOTES:

1. ON SHALLOW SLOPES (≤4:1), STRAW WATTLE MAY BE SECURED WITH 18–24" HARDWOOD STAKES DRIVEN AGAINST THE SIDES OF THE WATTLE INSTEAD OF THROUGH. STAKES SHALL ALTERNATE SIDES, AND BE SPACED 3–4' MAX.
2. TWINE SHALL BE TIED FROM STAKE TO STAKE, CRISS–CROSSING THE STRAW WATTLE. TIE TWINE TO STAKES BELOW THE HEIGHT OF THE WATTLE.

BMP DETAIL

SCALE: NONE





CRITICAL POINTS

A. OVERLAPS AND SEAMS
B. PROJECTED WATER LINE
C. CHANNEL BOTTOM/SIDE SLOPE VERTICES

NOTES:

1. PRODUCT TO BE NORTH AMERICAN GREEN EROSION CONTROL BLANKET OR APPROVED EQUAL BY NATIONAL GRID ENVIRONMENTAL SCIENTIST.
2. HORIZONTAL STAPLE SPACING SHOULD BE ALTERED IF NECESSARY TO ALLOW STAPLES TO SECURE THE CRITICAL POINTS ALONG THE CHANNEL SURFACE.
3. IN LOOSE SOIL CONDITIONS, THE USE OF STAPLE OR STAKE LENGTHS GREATER THAN 6" (15 CM) MAY BE NECESSARY TO PROPERLY ANCHOR THE ROLLED EROSION CONTROL PRODUCTS (RECP's).

BMP DETAIL

INSTALLATION NOTES:

1. PREPARE SOIL BEFORE INSTALLING ROLLED EROSION CONTROL PRODUCTS (RECP's), INCLUDING ANY NECESSARY APPLICATION OF LIME, FERTILIZER, AND SEED. NOTE: WHEN USING CELL-O-SEED DO NOT SEED PREPARED AREA. CELL-O-SEED MUST BE INSTALLED WITH PAPER SIDE DOWN.
2. BEGIN AT THE TOP OF THE CHANNEL BY ANCHORING THE RECP's IN A 6" (15 CM) DEEP X 6" (15 CM) WIDE TRENCH WITH APPROXIMATELY 12" (30 CM) OF RECP's EXTENDED BEYOND THE UP-SLOPE PORTION OF THE TRENCH. ANCHOR THE RECP's WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" (30 CM) APART IN THE BOTTOM OF THE TRENCH. BACKFILL AND COMAPCT THE TRENCH AFTER STAPLING. APPLY SEED TO COMPACTED SOIL AND FOLD REMAINING 12" (30 CM) PORTION OF RECP's BACK OVER SEED AND COMPACTED SOIL. SECURE RECP's OVER COMPACTED SOIL WITH A ROW OF STAPLES/STAKES SPACED APPROXIMATELY 12" (30 CM) ACROSS THE WIDTH OF THE RECP's.
3. ROLL CENTER RECP's IN DIRECTION OF WATER FLOW IN BOTTOM OF CHANNEL. RECP's WILL UNROLL WITH APPROPRIATE SIDE AGAINST THE SOIL SURFACE. ALL RECP's MUST BE SECURELY FASTENED TO SOIL SURFACE BY PLACING STAPLES/STAKES IN APPROPRIATE LOCATIONS AS SHOWN IN THE STAPLE PATTERN GUIDE. ™ WHEN USING THE DOT SYSTEM , STAPLES/STAKES SHOULD BE PLACED THROUGH EACH OF THE COLORED DOTS CORRESPONDING TO THE APPROPRIATE STAPLE PATTERN.
4. PLACE CONSECUTIVE RECP's END OVER END (SHINGLE STYLE) WITH A 4" - 6" (10 CM -15 CM) OVERLAP. USE A DOUBLE ROW OF STAPLES STAGGERED 4" (10 CM) APART AND 4" (10 CM) ON CENTER TO SECURE RECP's.
5. FULL LENGTH EDGE OF RECP's AT TOP OF SIDE SLOPES MUST BE ANCHORED WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" (30 CM) APART IN A 6" (15 CM) DEEP X 6" (15 CM) WIDE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING.
6. ADJACENT RECP's MUST BE OVERLAPPED APPROXIMATELY 2" - 5" (5 CM -12.5 CM) (DEPENDING ON RECP's TYPE) AND STAPLED.
7. IN HIGH FLOW CHANNEL APPLICATIONS, A STAPLE CHECK SLOT IS RECOMMENDED AT 30 TO 40 FOOT (9 M - 12 M) INTERVALS. USE A DOUBLE ROW OF STAPLES STAGGERED 4" (10 CM) APART AND 4" (10 CM) ON CENTER OVER ENTIRE WIDTH OF THE CHANNEL.
8. THE TERMINAL END OF THE RECP's MUST BE ANCHORED WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" (30 CM) APART IN A 6" (15 CM) DEEP X 6" (15 CM) WIDE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING.

BMP PICTURE

*** PICTURE AND DETAIL PROVIDED BY TENSAR NORTH AMERICAN GREEN**

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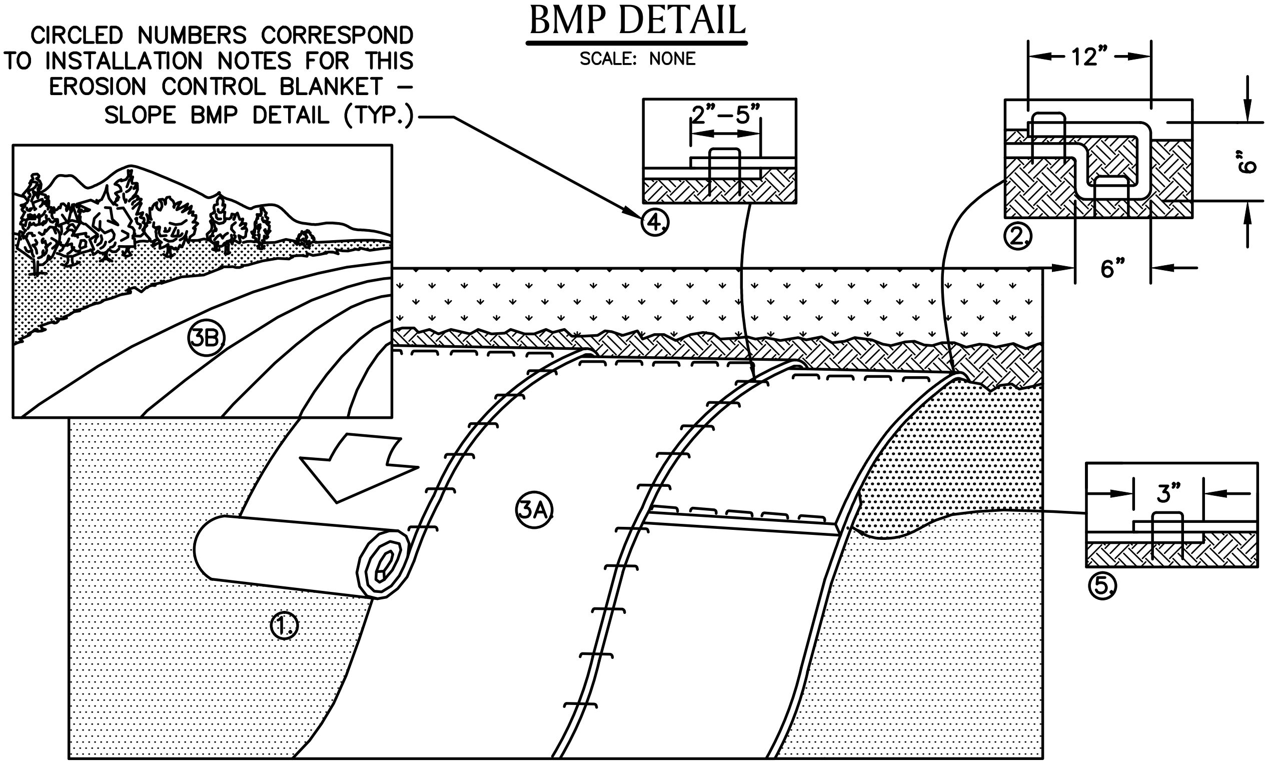
SEC-6

EROSION CONTROL BLANKET - DITCH * (2 OF 2)

BMP DETAIL

SCALE: NONE



NOTES:

1. PRODUCT TO BE NORTH AMERICAN GREEN EROSION CONTROL BLANKET OR APPROVED EQUAL BY NATIONAL GRID ENVIRONMENTAL SCIENTIST.
2. IN LOOSE SOIL CONDITIONS, THE USE OF STAPLES OR STAKE LENGTHS GREATER THAN 6" (15 CM) MAY BE NECESSARY TO PROPERLY SECURE THE RECP's.

INSTALLATION NOTES:

1. PREPARE SOIL BEFORE INSTALLING ROLLED EROSION CONTROL PRODUCTS (RECP's), INCLUDING ANY NECESSARY APPLICATION OF LIME, FERTILIZER, AND SEED. NOTE: WHEN USING CELL-O-SEED DO NOT SEED PREPARED AREA. CELL-O-SEED MUST BE INSTALLED WITH PAPER SIDE DOWN.
2. BEGIN AT THE TOP OF THE SLOPE BY ANCHORING THE RECP's IN A 6" (15 CM) DEEP X 6" (15 CM) WIDE TRENCH WITH APPROXIMATELY 12" (30 CM) OF RECP's EXTENDED BEYOND THE UP-SLOPE PORTION OF THE TRENCH. ANCHOR THE RECP's WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" (30 CM) APART IN THE BOTTOM OF THE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING. APPLY SEED TO COMPACTED SOIL AND FOLD REMAINING 12" (30 CM) PORTION OF RECP's BACK OVER SEED AND COMPACTED SOIL. SECURE RECP's OVER COMPACTED SOIL WITH A ROW OF STAPLES/STAKES SPACED APPROXIMATELY 12" (30 CM) APART ACROSS THE WIDTH OF THE RECP's.
3. ROLL THE RECP's (A.) DOWN OR (B.) HORIZONTALLY ACROSS THE SLOPE. RECP's WILL UNROLL WITH APPROPRIATE SIDE AGAINST THE SOIL SURFACE. ALL RECP's MUST BE SECURELY FASTENED TO SOIL SURFACE BY PLACING STAPLES/STAKES ™ IN APPROPRIATE LOCATIONS AS SHOWN IN THE STAPLE PATTERN GUIDE. WHEN USING THE DOT SYSTEM , STAPLES/STAKES SHOULD BE PLACED THROUGH EACH OF THE COLORED DOTS CORRESPONDING TO THE APPROPRIATE STAPLE PATTERN.
4. THE EDGES OF PARALLEL RECP's MUST BE STAPLED WITH APPROXIMATELY 2" – 5" (5 CM – 12.5 CM) OVERLAP DEPENDING ON RECP's TYPE.
5. CONSECUTIVE RECP's SPLICED DOWN THE SLOPE MUST BE PLACED END OVER END (SHINGLE STYLE) WITH AN APPROXIMATE 3" (7.5 CM) OVERLAP. STAPLE THROUGH OVERLAPPED AREA, APPROXIMATELY 12" (30 CM) APART ACROSS ENTIRE RECP's WIDTH.

BMP PICTURE

*** PICTURE AND DETAIL PROVIDED BY TENSAR NORTH AMERICAN GREEN**
APPROVED BY: VICE PRESIDENT, ENVIRONMENTAL SERVICES

BMP PICTURE

NOTES:

1. COORDINATE MIXTURE TYPE AND APPLICATION AREAS WITH NATIONAL GRID ENVIRONMENTAL SCIENTIST PRIOR TO CONSTRUCTION.
2. A MINIMUM OF 1500 LBS. PER ACRE OF A PAPER/CORN FIBER OR EQUIVALENT WITH NATURAL TACKIFIERS WILL BE USED ON SLOPES LESS THAN 3:1.
3. A BFM (BONDED FIBER MATRIX) WILL BE USED ON SLOPES GREATER THAN 2:1.
4. A FGM (FLEXIBLE GROWTH MATRIX) OR ESM (EXTREME SLOPE MATRIX) WILL BE USED ON SLOPES GREATER THAN 1:1.
5. REFER TO BMP #10 FOR SEED MIXTURE OPTIONS.

File: Hydroseeding.dwg

*** PICTURE PROVIDED BY TENSAR NORTH AMERICAN GREEN**
*** TACKIFIER INFORMATION PROVIDED BY FILTREXX LAND IMPROVEMENT SYSTEMS AND TENSAR NORTH AMERICAN GREEN**

APPROVED BY: VICE PRESIDENT, ENVIRONMENTAL SERVICES

SEC-8
HYDROSEEDING WITH TACKIFIER
(SLOPE STABILIZATION) *

BMP

Definition

Applying coarse plant residue or chips, or other suitable materials, to cover the soil surface.

Purpose

The primary purpose is to provide initial erosion control while a seeding or shrub planting is establishing. Mulch will conserve moisture and modify the surface soil temperature and reduce fluctuation of both. Mulch will prevent soil surface crusting and aid in weed control. Mulch is also used alone for temporary stabilization in non-growing months.

Conditions Where Practice Applies

On soils subject to erosion and on new seedings and shrub plantings. Mulch is useful on soils with low infiltration rates by retarding runoff.

Criteria

Site preparation prior to mulching requires the installation of necessary erosion control or water management practices and drainage systems.

Slope, grade and smooth the site to fit needs of selected mulch products.

Remove all undesirable stones and other debris to meet the needs of the anticipated land use and maintenance required.

Apply mulch after soil amendments and planting is accomplished or simultaneously if hydroseeding is used.

Select appropriate mulch material and application rate or material needs. Determine local availability.

Select appropriate mulch anchoring material.

NOTE: The best combination for grass/legume establishment is straw (cereal grain) mulch applied at 2 ton/acre (90 lbs./1000sq.ft.) and anchored with wood fiber mulch (hydromulch) at 500 – 750 lbs./acre (11 – 17 lbs./1000 sq. ft.). The wood fiber mulch must be applied through a hydroseeder immediately after mulching.

NOTE:

1. PICTURE DEPICTS STRAW MULCH APPLICATION (FROM MULCH SPREADER) ON STEEP SLOPE WITH AN IMPROVED DRAINAGE SWALE.
2. COORDINATE MULCH MATERIALS AND RATES WITH NATIONAL GRID ENVIRONMENTAL SCIENTIST.

UPLAND ROW RESTORATION MIX – GENERAL

Species Composition Options:

- Andropogon gerardii; Niagra Big Bluestem
- Schizachyrium scoparium; Little Bluestem
- Elymus Canadensis; Canada Wild Rye
- Elymus virginicus; Virginia Wildrye
- Lolium multiflorum; Annual Ryegrass
- Sorghastrum nutans; Indiangrass
- Chamaecrista fasciculate; Partridge Pea
- Desmodium canadense; Showy Tick Trefoil
- Helioposis helianthoides; Ox-Eye Sunflower
- Panicum virgatum; Switchgrass
- Rudbeckia hirta; Black Eyed Susan
- Poa palustris; Fowl Bluegrass
- Agrostis perennans; Upland Bentgrass
- Agrostis alba; Redtop
- Festuca rubra; Red Fescue
- Lotus corniculatus; Birds-Foot Trefoil
- Chrysanthemum leucanthem; Ox-Eye Daisy
- Aster novae-angliae; New England Aster

Example Seed Mixes:

1. Native Upland wildlife forage and Cover Meadow Mix – Ernst Conservation Seeds (ERNMX-123)
2. Eastern Ecotype Native Grass Mix– Ernst Conservation Seeds (ERNMX-177)
3. New England Native Warm Season Grass Mix – New England Wetland Plants, Inc.
4. New England Logging Road Mix – New England Wetland Plants, Inc.
5. Northeast Upland Wildflower/Restoration Erosion Mix – Southern Tier Consulting (STCMX-2)

UPLAND ROW RESTORATION MIX – DRY/ROCKY SITES

Species Composition Options:

- Festuca rubra; Red Fescue
- Schizachyrium scoparium; Little Bluestem
- Elymus Canadensis; Canada Wild Rye
- Bouteloua gracillis; Blue Grama
- Lolium multiflorum; Annual Ryegrass
- Lolium perenne; Perennial Ryegrass
- Agrostics scabra; Rough Bentgrass
- Agrostis perennans; Upland Bentgrass
- Sorghastrum nutans; Indiangrass

Example Seed Mixes:

1. New England Erosion Control/ Restoration Mix for Dry Sites – New England Wetland Plants, Inc.
2. Ernst Conservation Seeds and similar companies can create a custom seed mix matching the composition above (with site specific additions if necessary).

WETLAND ROW RESTORATION MIX

Species Composition Options:

- Agrostis stolonifera; Creeping Bentgrass
- Poa trivialis; Rough Bluegrass
- Alopecurus arundinaceus; Creeping Meadow Foxtail
- Lolium multiflorum; Annual Ryegrass
- Festuca rubra; Creeping Red Fescue
- Elymus virginicus; Virginia Wildrye
- Schizachyrium scoparium; Little Bluestem
- Andropogon gerardii; Niagra Big Bluestem
- Carex vulpinoidea; Fox sedge
- Panicum virgatum; Switchgrass
- Agrostis scabra; Rough Bentgrass
- Aster novae-angliae; New England Aster
- Eupatorium perfoliatum; Boneset
- Euthamia graminifolia; Grass Leaved Goldenrod
- Scirpus atrovirens; Green Bulrush
- Verbene hastate; Blue Vervain
- Juncus effusus; Soft Rush
- Scirpus cyperinus; Wool Grass
- Panicum clandestinum; Deertongue

Example Seed Mixes

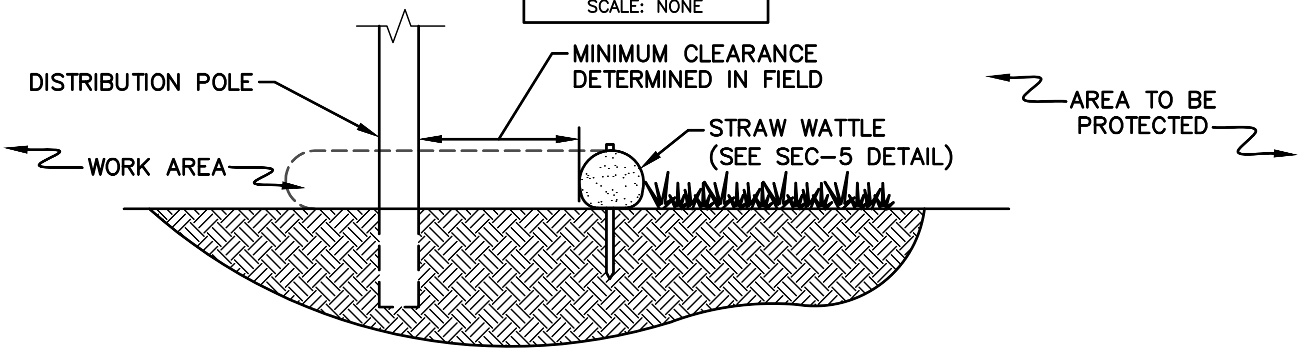
1. New England Erosion Control/Restoration Mix for Detention Basins and Moist Sites – New England Wetland Plants, Inc.
2. Northeast Wetland Grass Seed Mix – Southern Tier Consulting (STCMX-7)
3. Ernst Conservation Seeds and similar companies can create a custom seed mix matching the composition above (with site specific additions if necessary).

GERNERAL NOTES:

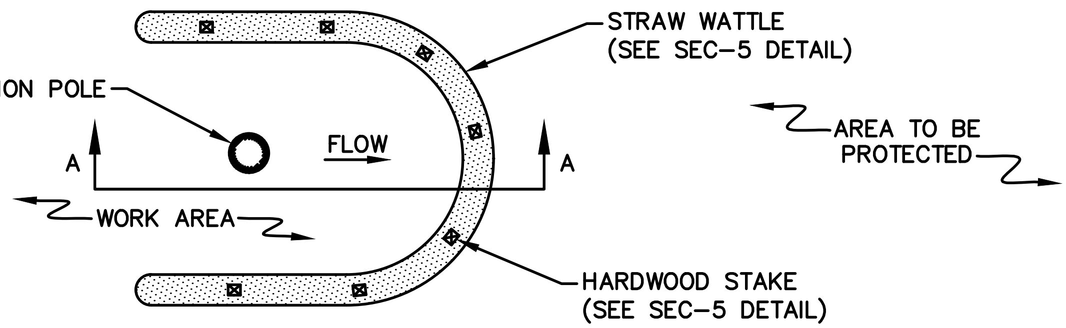
1. Seed mixes described herein are intended to cover a variety of typical new england landscapes. However, site specific seed mixes will need to be evaluated in coastal or mountainous regions.
2. Seed mixes described herein are intended for general ROW restoration. Site specific wetland seed mixes may be required by local, state and/or federal regulators for certain impacts to wetlands.
3. All seed mixes are to be approved by National Grid Environmental Scientist prior to construction and must conform with all project permits.
4. Seedbed preparation and maintenance as well as temporary erosion and sediment controls are crucial to the establishment of newly seeded areas. Coordinate with National Grid Environmental Scientist on seed bed preparation and maintenance as well as temporary erosion and sediment controls prior to construction.

BMP DETAIL

SCALE: NONE



SECTION A-A



PLAN

NOTES

1. PRODUCT TO BE STRAW WATTLE OR APPROVED EQUAL BY NATIONAL GRID ENVIRONMENTAL SCIENTIST (SEE SEC-5 BMP DETAIL).
2. STRAW BALE BARRIER PER SEC-1 BMP DETAIL TO BE AN AVAILABLE ALTERNATE DEPENDING ON SITE CONDITIONS AT THE DIRECTION OF NATIONAL GRID ENVIRONMENTAL SCIENTIST (SEE FIGURE 2).
3. MINIMUM CLEARANCE BETWEEN POLE AND EROSION CONTROL TO BE DETERMINED BY CONDITIONS OF POLE INSTALLATION/REPLACEMENT WORK AND ASSOCIATED DISTURBANCE.

BMP PICTURE

FIGURE 1: TYP. STRAW WATTLE APPLICATION

FIGURE 2: ALT. STRAW BALE APPLICATION

File: SiltSOXX.dwg

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SEC-12
DISTRIBUTION POLE
SEDIMENT CONTROL

BMP PICTURE

SCALE: NONE

NOTES:

1. PRODUCT TO BE ALTURNAMATS' PREFABRICATED MATS OR APPROVED EQUAL BY NATIONAL GRID ENVIRONMENTAL SCIENTIST.
2. PRODUCT AVAILABLE IN 4X8' UNITS.
3. IF MATS ARE INSTALLED IN A WETLAND AREA, INSTALL EROSION CONTROLS TO CONTAIN MATERIAL UTILIZED IN THE MAT TRANSITIONS.

File: Prefab_Mats.dwg

*** PICTURE PROVIDED BY ALTURNAMATS**

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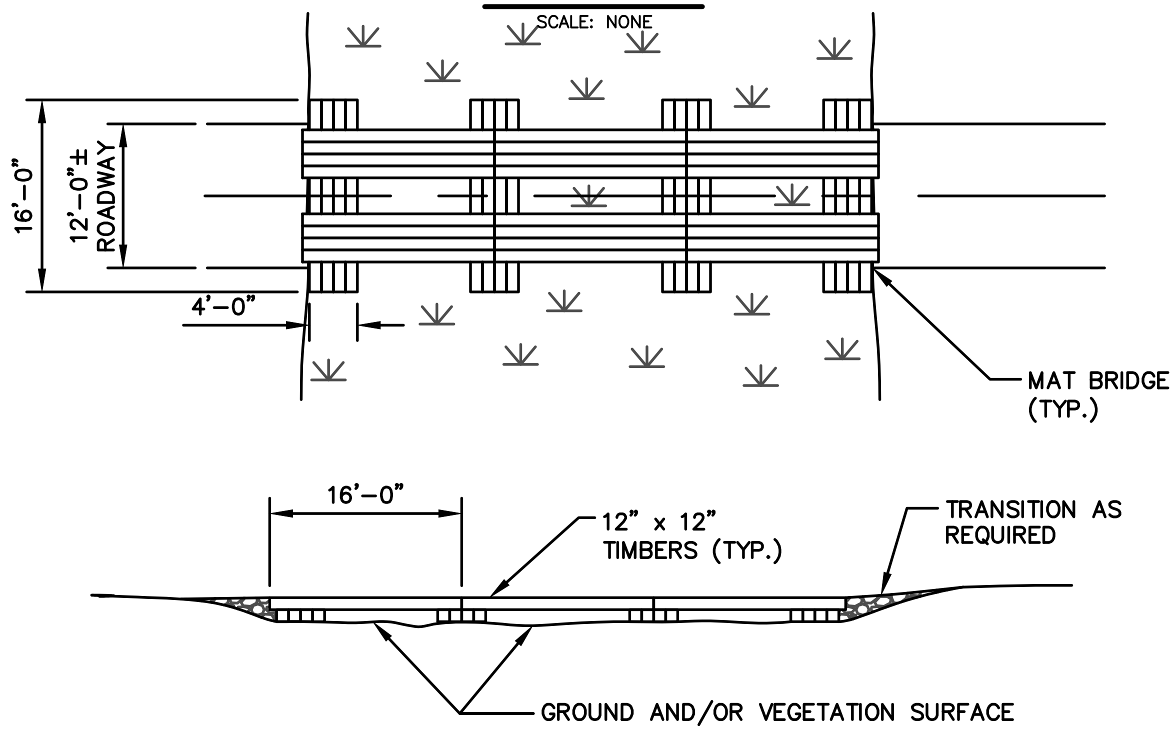
CM-1
PREFABRICATED MATS *

BMP DETAIL

SCALE: NONE



NOTES:

1. IF MATS ARE INSTALLED IN A WETLAND AREA, INSTALL EROSION CONTROLS TO CONTAIN MATERIAL UTILIZED IN THE MAT TRANSITIONS.

BMP PICTURE

BMP PICTURE - SINGLE SPAN

SCALE: NONE

NOTES:

1. WHERE STREAM WIDTH ALLOWS, INSTALL CONSTRUCTION MATS TO SPAN THE WATERCOURSE IN ITS ENTIRETY WITHOUT STRINGER PLACEMENT IN THE WATER OR ANY RESTRICTION OF STREAM FLOW.

2. INSTALLATION OF THE CONSTRUCTION MAT BRIDGE SHALL NOT DAMAGE THE STREAM BED AND BANKS. WHERE POSSIBLE, FOOTERS SHALL BE PLACED PARALLEL TO THE TOP OF THE STREAM BANKS, WITH ACCESS MATTING PLACED ACROSS THE TOP OF THE STRINGERS DISTRIBUTING THE WEIGHT OF THE CONSTRUCTION EQUIPMENT.

3. AT STREAM CROSSINGS THAT CANNOT BE SPANNED BY A SINGLE SECTION OF CONSTRUCTION MATTING, AND WHERE PERMITS ALLOW, STRINGERS SHALL BE PLACED ATOP THE STREAM BED PARALLEL TO THE FLOW OF WATER.

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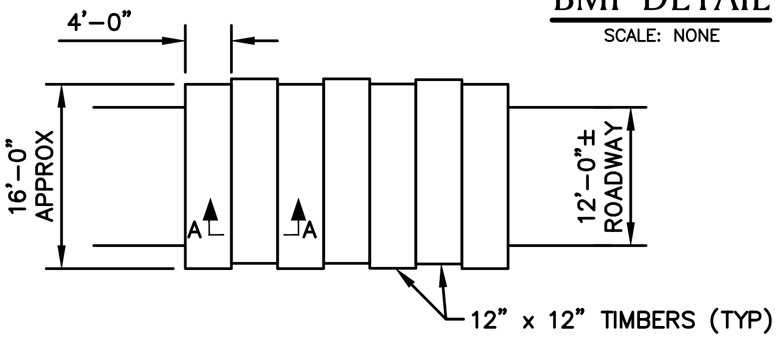
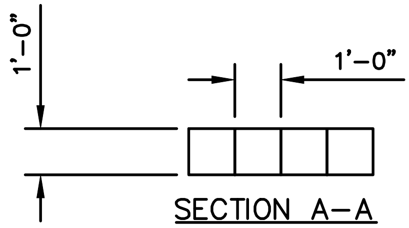
SUBJECT	Reference
Access, Maintenance and Construction Best Management Practices	EP No. 3 - Natural Resource Protection (Chapter 6)

BMP DETAIL

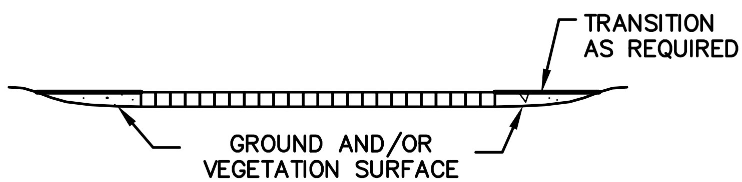
SCALE: NONE



TYPICAL PLAN VIEW



SECTION A–A
TYPICAL MAT SECTION BOLTED TOGETHER



TYPICAL SECTION VIEW

NOTES:

1. TO BE INSTALLED IF NECESSARY TO PREVENT RUTTING, TO ACCESS STRUCTURES.
2. THIS DETAIL SHOWS TYPICAL DIMENSIONS. SOME CONTRACTOR'S CONSTRUCTION MATS ARE DIMENSIONALLY DIFFERENT FROM WHAT IS SHOWN HERE.
3. DEPENDENT ON SITE CONDITIONS, MULTIPLE LAYERS OF CONSTRUCTION MATS MAY BE INSTALLED.

BMP PICTURE

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CM-3
CONSTRUCTION MAT LAYOUT
(WITH TRANSITION)

File: Swamp_Mat_Layout.dwg

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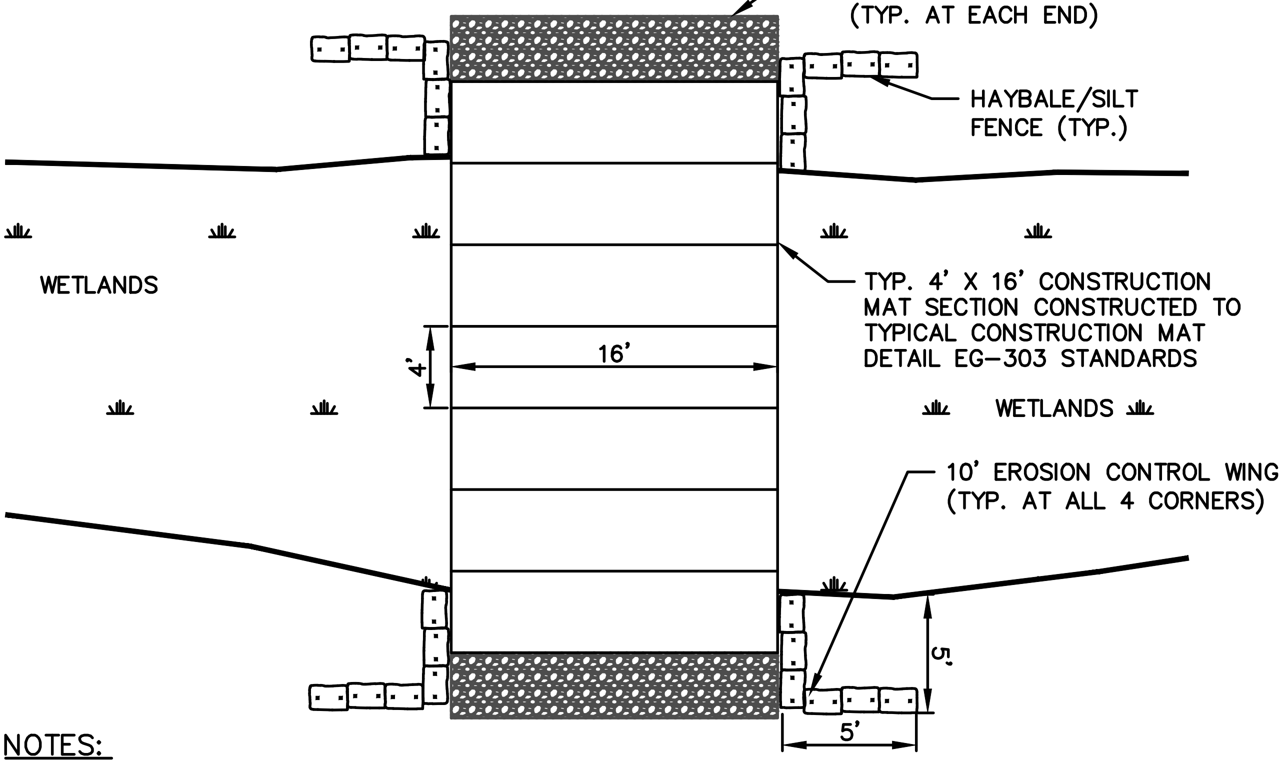
		Date	02/20/18

SUBJECT	Reference
Access, Maintenance and Construction Best Management Practices	EP No. 3 - Natural Resource Protection (Chapter 6)

BMP DETAIL

SCALE: NONE



NOTES:

1. ADD FILTER FABRIC AS NEEDED UNDER STONE TRANSITION RAMPS.
2. ALL MEASUREMENTS AND LOCATIONS ARE APPROXIMATE.

BMP PICTURE

File: Swamp_Mat_Transition and BMPs.dwg

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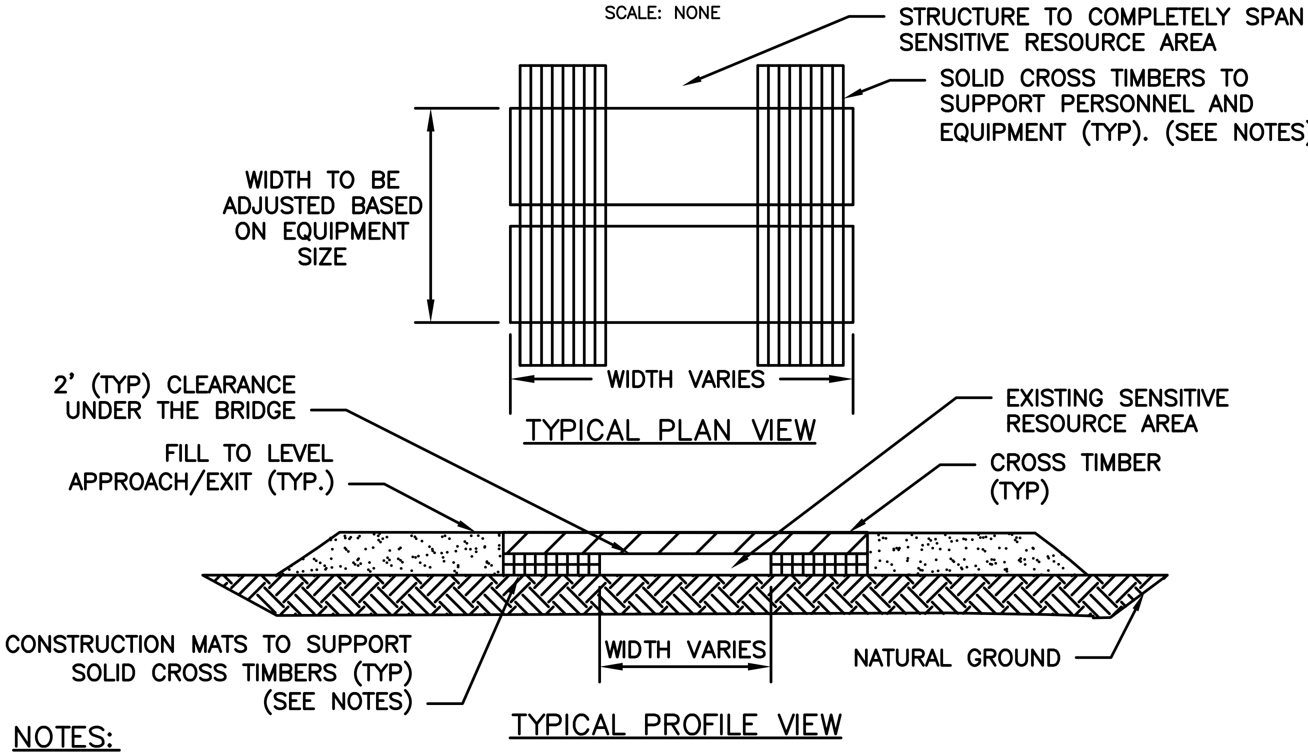
CM-4

CONSTRUCTION MAT LAYOUT (WITH TRANSITION AND BMPs)

BMP DETAIL

SCALE: NONE



NOTES:
1. THE DETAIL SHOWN IS CONCEPTUAL. CONSTRUCTION MATS AND CROSS TIMBERS SHALL BE SIZED AND SELECTED BASED ON SPAN WIDTH, CROSSING EQUIPMENT AND FIELD CONDITIONS.
2. THE NUMBER OF CONSTRUCTION MATS MAY VARY DEPENDING ON THE CLEARANCE HEIGHT.
3. EQUIPMENT AND PERSONNEL LOAD SHALL BE DISTRIBUTED ON ALL TIMBERS.
4. EACH EQUIPMENT OPERATOR AND USER OF THE FIELD BRIDGE SHALL BE FAMILIAR WITH THE DESIGN AND THE MAXIMUM EQUIPMENT AND PERSONNEL LOADS.
5. THIS DETAIL MAY NOT BE APPLICABLE IN ALL FIELD CONDITIONS.
6. INSTALL EROSION CONTROLS ADJACENT TO THE CULVERT ENDS TO PROTECT THE WATERWAY FROM ROADWAY DEBRIS.

BMP PICTURE

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CM-5
CONSTRUCTION MAT - AIR BRIDGE

File: Swamp_Mat_AIR BRIDGE.dwg

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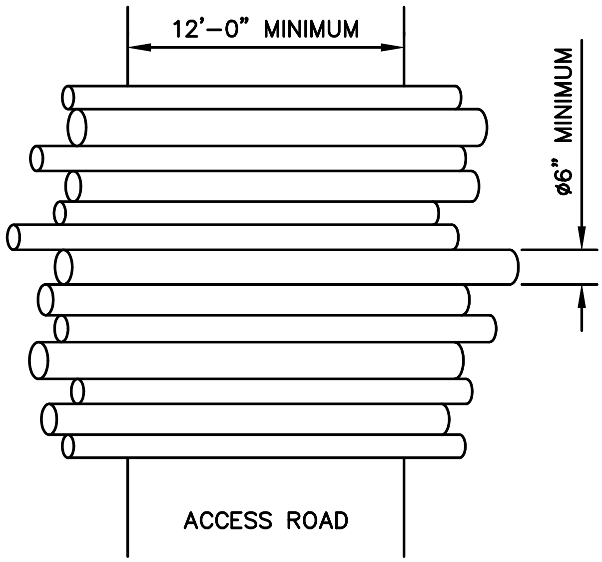
		Date	02/20/18

SUBJECT	Reference
Access, Maintenance and Construction Best Management Practices	EP No. 3 - Natural Resource Protection (Chapter 6)

BMP DETAIL

SCALE: NONE



RANDOM LENGTH AND DIAMETER LOGS PLACED ACROSS AN ACCESS ROAD

NOTE:

1. A SIMILAR BRUSH MAT INSTALLATION CONSISTING OF SMALLER DIAMETER STEMS AND LOGS CAN BE USED.
2. CORDUROY ROADS SHALL ONLY BE USED IN EMERGENCIES OR AFTER APPROVAL FROM THE PROJECT ENVIRONMENTAL CONSULTANT OR NATIONAL GRID ENVIRONMENTAL SCIENTIST.

BMP PICTURE

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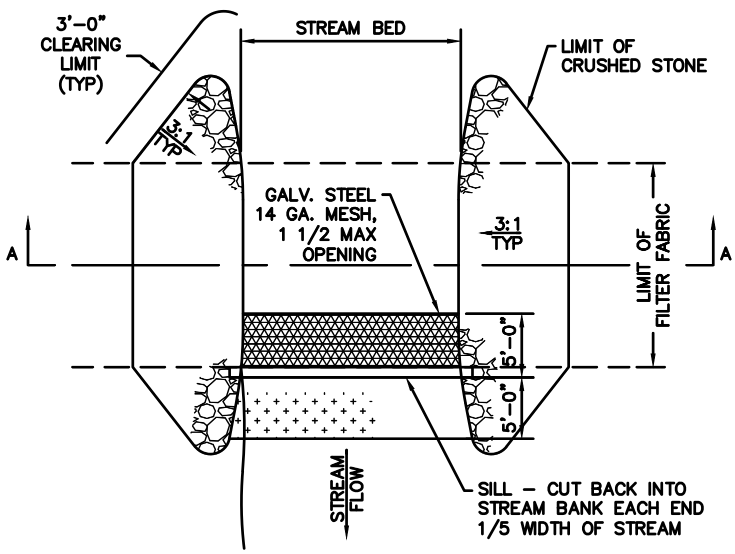
CM-6
CORDUROY ROAD

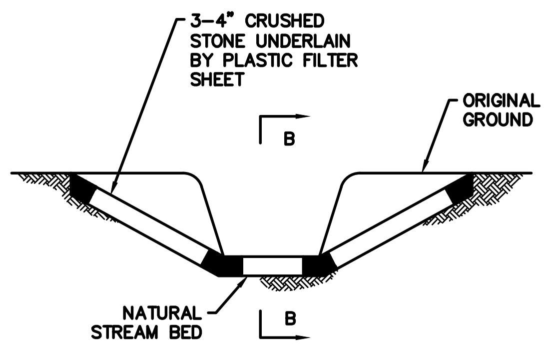
File: Corduroy_Road.dwg

BMP DETAIL

SCALE: NONE



PLAN VIEW

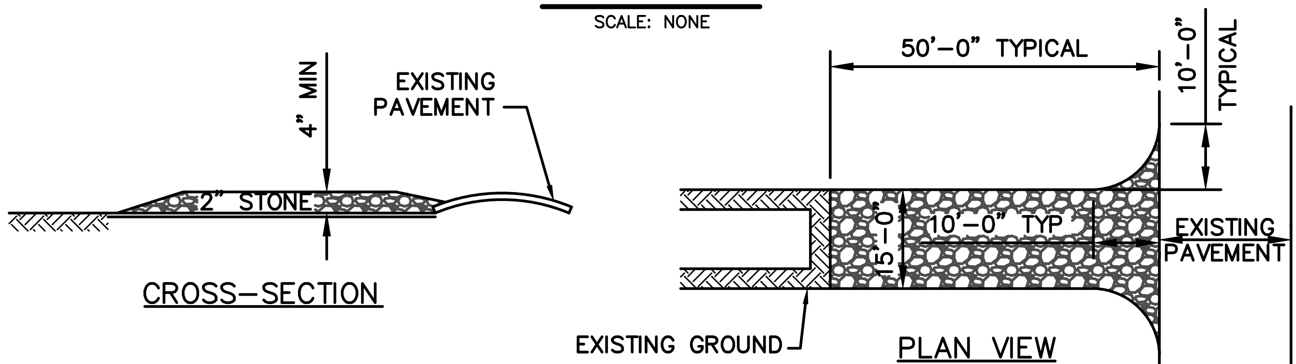


SECTION 'A-A'

BMP PICTURE

BMP DETAIL

SCALE: NONE



NOTES:

1. STONE SIZE – USE 2" STONE (MINIMUM) TO 6" STONE (MAXIMUM)
2. LENGTH – GREATER THAN OR EQUAL TO 50 FEET
3. THICKNESS – 4"
4. WIDTH – FIFTEEN (15) FOOT TYP., BUT NOT LESS THAN FULL WIDTH AT POINTS WHERE INGRESS OR EGRESS OCCURS.
5. SURFACE WATER – ALL SURFACE WATER FLOWING OR DIVERTED TOWARD CONSTRUCTION ENTRANCES SHALL BE PIPED ACROSS ENTRANCE. IF PIPING IS IMPRACTICAL, MOUNTABLE BERM SHALL BE PERMITTED.
6. MAINTENANCE – THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION WHICH SHALL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHTS–OF–WAY. THIS MAY REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE AS CONDITIONS DEMAND AND REPAIR OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT. ALL SEDIMENT SPILLED, DROPPED, WASHED OR TRACKED ONTO PUBLIC RIGHTS–OF–WAY MUST BE REMOVED IMMEDIATELY.
7. PERIODIC INSPECTION AND NEEDED MAINTENANCE SHALL BE PROVIDED.
8. THE CLEAN STONE SHOULD BE INSTALLED OVER A GEOTEXTILE FABRIC. GEOTEXTILE FABRIC MAY BE OMITTED FOR PERMANENT CONSTRUCTION ENTRANCES/EXITS ON A CASE–BY–CASE BASIS WITH THE APPROVAL OF THE NATIONAL GRID ENVIRONMENTAL SCIENTIST.
9. FOLLOWING CONSTRUCTION, THE CONSTRUCTION ENTRANCE/EXIT SHALL BE REMOVED AND THE AREA GRADED, SEEDED, AND MULCHED AS NEEDED. ENTRANCE/EXITS MAY REMAIN DEPENDING UPON FUTURE ACCESS NEEDS AND/OR PROJECT–SPECIFIC APPROVALS BUT REQUIRES APPROVALS FROM THE NATIONAL GRID ENVIRONMENTAL SCIENTIST AND PROPERTY LEGAL.

BMP PICTURE

CM-8
TEMPORARY CONSTRUCTION ENTRANCE/ EXIT

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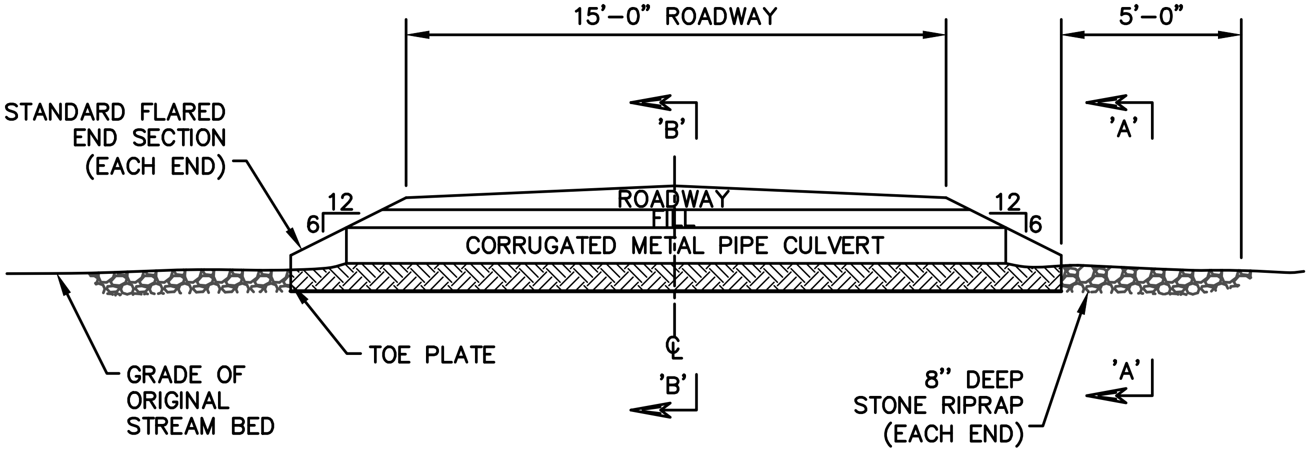
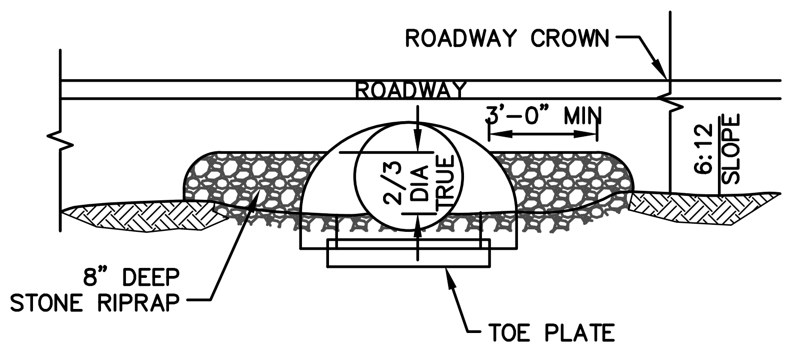
BMP DETAIL

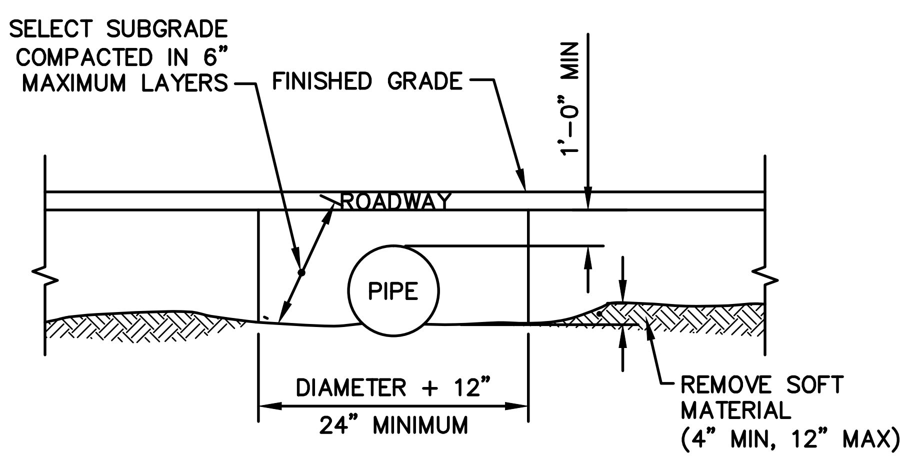
SCALE: NONE



CROSS SECTION



SECTION 'A–A'
(SAME BOTH ENDS)



SECTION 'B–B'

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CM-9
TEMPORARY CONSTRUCTION CULVERT (1 OF 2)

File: Temp_Constr_Culvert.dwg

BMP DETAIL

SCALE: NONE

NOTES:

1. CULVERT DESIGN AND LAYOUT SHALL BE COORDINATED WITH NATIONAL GRID ENVIRONMENTAL SCIENTIST (NGES).
2. CROWN ROADWAY 1/2 INCH PER FOOT.
3. LAY THE CULVERT STRAIGHT AND AS NEARLY AS POSSIBLE ALONG THE EXISTING STREAM BED AND WITH THE INVERTS AT OR SLIGHTLY BELOW BED ELEVATION.
4. CORRUGATED METAL PIPE IS TO BE GALVANIZED STEEL, OR ALUMINIZED STEEL (TYPE 2), WITH BOLTED CONNECTORS.
5. DIAMETERS SHALL BE AS PER THE PROJECT DRAWINGS AND THE SPECIFICATION. THE PIPE GAGE SHALL BE AS FOLLOWS:

DIAMETER (INCHES)	GAGE
12" – 15"	.004"
18" – 24"	.079"
30" – 36"	.109"

6. INSTALLATION OF CULVERTS LARGER THAN 36 INCH DIAMETER SHALL REQUIRE SPECIAL ENGINEERING DESIGN.
7. SELECT SUBGRADE SHALL BE A GRANULAR MATERIAL AS DESCRIBED IN NYSDOT SPECIFICATION ITEM 203–2.02C, OR AS APPROVED BY A NGES.
8. STONE RIPRAP SHALL BE AS DESCRIBED IN NYSDOT SPECIFICATION ITEM 203–2.02D, WITH 8 INCH MAXIMUM SIZE, OR AS APPROVED BY A NGES. EXCEPT WHERE PROTECTED BY STONE, ALL EMBANKMENT SLOPES ARE TO BE STABILIZED, MULCHED AND SEEDED AS PER PROJECT SPECIFICATIONS.
9. OUTLET SHOULD BE CONFIGURED NOT TO CREATE HYDRAULIC JUMP OR PLUNGE POOL.
10. INSTALL EROSION CONTROLS ADJACENT TO THE CULVERT ENDS TO PROTECT THE WATERWAY FROM ROADWAY DEBRIS.

BMP PICTURE

File: Temp_Constr_Culvert.dwg

BMP PICTURE

NOTE:

1. PICTURE SHOWS VIEW OF ACCESS WAY STABILIZATION ADJACENT TO A WETLAND.
2. COORDINATE STABILIZATION DESIGN AND PRODUCT WITH NATIONAL GRID ENVIRONMENTAL SCIENTIST.

File: Access_Stabilization.dwg

CM-10
ACCESS WAY STABILIZATION

BMP PICTURE


NO ACCESS – WETLAND/STREAM CROSSING MATS REQUIRED

NO ACCESS – A.) PROJECT LIMITS E.G. ROW LIMITS
B.) HISTORICAL/CULTURAL
C.) ENVIRONMENTALLY SENSITIVE E.G. THREATENED & ENDANGERED
D.) OTHER

APPROVED ACCESS

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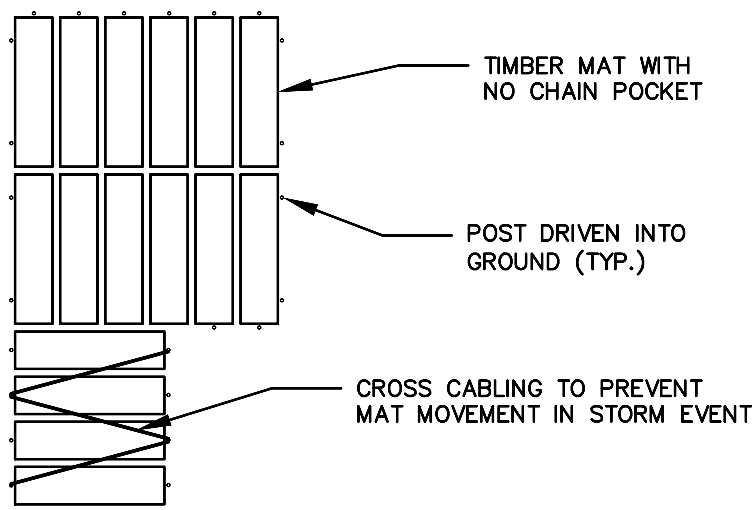
BMP DETAIL 1

SCALE: NONE



TYPICAL PLAN VIEW

NOTES:

1. EXAMPLES OF ANCHORING ONLY. MATTING CONTRACTOR SHALL PROPOSE THE METHOD OF ANCHORING BASED ON FIELD CONDITIONS.

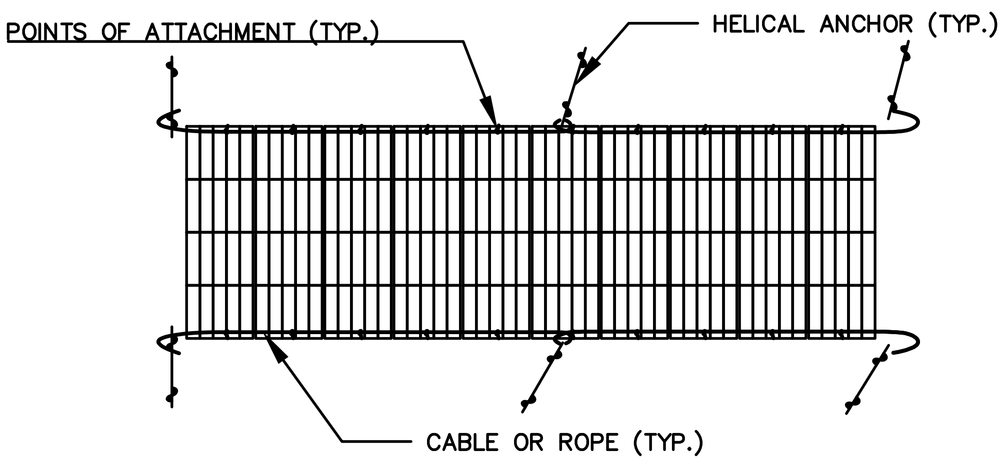
2. ANCHORING METHOD TO BE APPROVED BY THE NATIONAL GRID ENVIRONMENTAL SCIENTIST AND TRANSMISSION LINE CONSTRUCTION SUPERVISOR.

BMP DETAIL 2

NOTES:

1. TYPICAL HELICAL ANCHOR AND CABLE CONFIGURATION FOR MAT CONTAINMENT IN FLOODPLAINS/LAND SUBJECT TO FLOODING.

2. TYPICAL POINTS OF ATTACHMENT HEAVY STAPLES, EYE BOLTS OR OTHER SUITABLE HARDWARE TO SECURE ATTACHMENT OF MAT TO LINEAR CABLE. IF CHAIN POCKETS ARE PRESENT IN THE MATS CABLE OR ROPE CAN BE LOOPED THROUGH RODS.



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CM-12

EXAMPLE OF CONSTRUCTION MAT ANCHORING (1 OF 2)

File: Const_Mat_Anchoring.dwg

BMP PICTURE 1

BMP PICTURE 2

CM-12
EXAMPLE OF CONSTRUCTION MAT ANCHORING (2 OF 2)

BMP DETAIL

SCALE: NONE

WIRE BACKED SILT FENCE

MUTUAL INDUSTRIES WIRE BACKED SILT FENCE
PART # 1776-14-24
36" X 100'
36" MISF 1776 FABRIC
24" 14GA WIRE MESH
OPENING OF MESH 2" X 4"
FABRIC HOG RINGED EVERY 12"-18" ALONG THE TOP OF THE FENCE

ROLL WEIGHT 40 LBS

32 ROLLS PER PALLET

NOTES:

1. PRODUCT TO BE MUTUAL INDUSTRIES' WIRE BACKED SILT FENCE OR APPROVED EQUAL BY NATIONAL ENVIRONMENTAL SCIENTIST.
2. COORDINATE INSTALLATION METHOD AND LOCATION WITH NATIONAL GRID ENVIRONMENTAL SCIENTIST.

File: Reinforced_Silt_Fence.dwg

*** PICTURE AND DETAIL PROVIDED BY MUTUAL INDUSTRIES**
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AA-1
REINFORCED SILT FENCE *

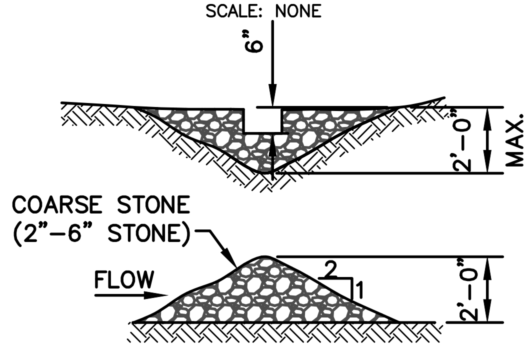
BMP PICTURE

NOTE:

1. PICTURE SHOWS SEDIMENT FILTER WITHIN A WETLAND.

BMP DETAIL

SCALE: NONE



STONE CHECK DAM

NOTES:

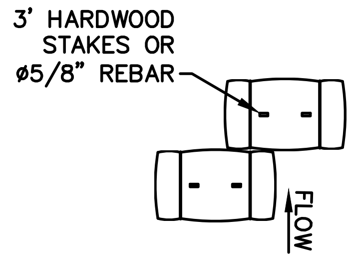
1. USE CHECK DAMS TO SLOW WATER FLOWS AND AS SMALL SEDIMENT TRAPS IN DITCHES ALONG ACCESS ROADS.
2. CLEAN SEDIMENT AND REPLACE DAMS AS NECESSARY.
3. THE CENTER OF THE CHECK DAM MUST BE AT LEAST 6" LOWER THAN THE OUTER EDGES.
4. COORDINATE SPACING WITH NATIONAL GRID ENVIRONMENTAL SCIENTIST.
5. MAX. SPACING: TOE OF THE UPSTREAM DAM IS SAME ELEVATION AS TOP OF DOWNSTREAM DAM.
6. STONE SHALL BE FREE OF FINE PARTICLES TO PREVENT TURBID DISCHARGES.

BMP PICTURE

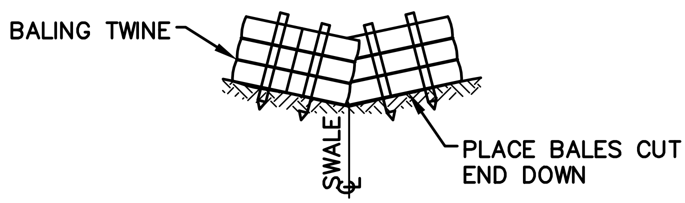
NOTE: A SMALLER STONE SIZE IS SHOWN IN THIS PICTURE.

BMP DETAIL

SCALE: NONE



PLAN VIEW



SECTION VIEW

NOTES:

1. USE CHECK DAMS TO SLOW WATER FLOWS AND AS SMALL SEDIMENT TRAPS IN DITCHES ALONG ACCESS ROADS.
2. CLEAN SEDIMENT AND REPLACE DAMS AS NECESSARY.
3. COORDINATE SPACING WITH NATIONAL GRID ENVIRONMENTAL SCIENTIST.

BMP PICTURE

AA-4
STRAW / HAYBALE CHECK DAM

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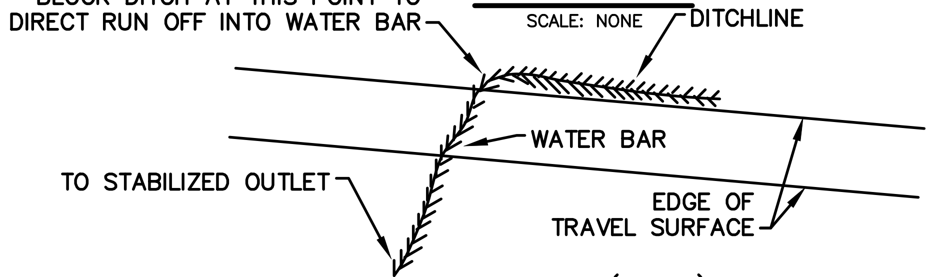
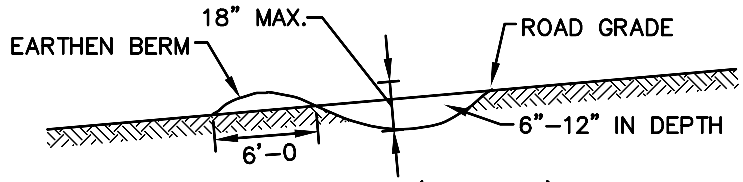
BMP DETAIL

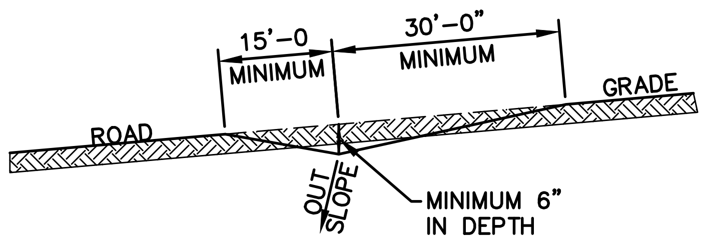
SCALE: NONE



WATERBAR (PLAN)



WATERBAR (SECTION)



DISCHARGE (SECTION)

NOTE:

1. LINE WITH 2"–6" STONE UNDERLAIN BY GEOTEXTILE FILTER FABRIC, KEYED INTO ROAD SURFACE AT LEAST 10 FEET EACH SIDE OF WATERBAR.
2. COORDINATE SPACING WITH NATIONAL GRID ENVIRONMENTAL SCIENTIST.

BMP PICTURE

File: Waterbar.dwg

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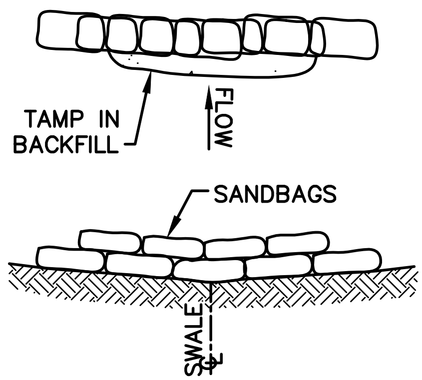
AA-5
WATERBAR

BMP DETAIL

SCALE: NONE



SANDBAG
CHECK DAM

NOTES:

1. USE CHECK DAMS TO SLOW WATER FLOWS AND AS SMALL SEDIMENT TRAPS IN DITCHES ALONG ACCESS ROADS.
2. CLEAN SEDIMENT AND REPLACE DAMS AS NECESSARY.
3. COORDINATE SPACING WITH NATIONAL GRID ENVIRONMENTAL SCIENTIST.

BMP PICTURE

NOTE:

1. PICTURE DOES NOT DEPICT "TAMP IN BACKFILL"

BMP PICTURE

NOTE:

1. EXACT SIZE, LOCATION AND DESIGN IS DEPENDANT ON SITE CONDITIONS, AND LOCAL AND STATE REGULATIONS. COORDINATE THIS BMP WITH NATIONAL GRID ENVIRONMENTAL SCIENTIST PRIOR TO CONSTRUCTION.

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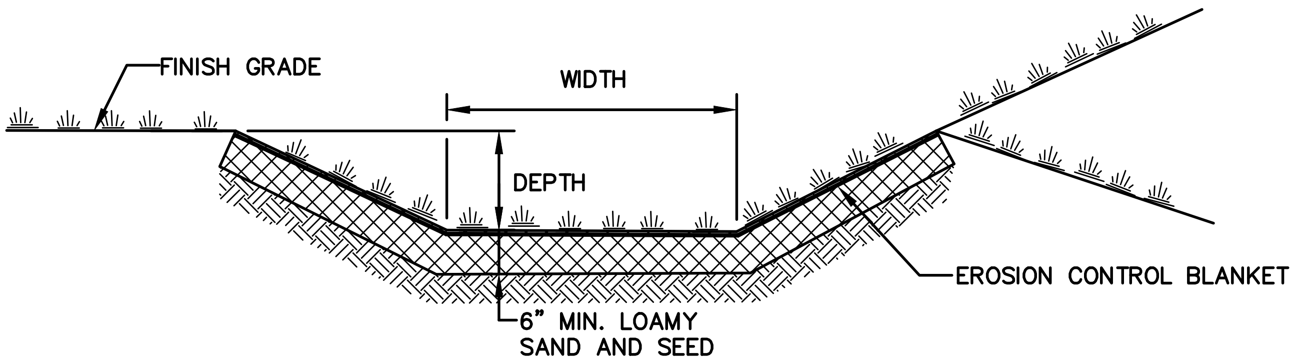
BMP DETAIL

SCALE: NONE



NOTES:

1. WIDTH AND DEPTH OF SWALE, AND EROSION CONTROL BLANKET TYPE TO BE COORDINATED WITH NATIONAL GRID ENVIRONMENTAL SCIENTIST.
2. REFER TO DETAILS SEC-10 AND SEC-11 FOR SEED MIXTURE OPTIONS.

BMP PICTURE

File: Lined_Drainage_Swale.dwg

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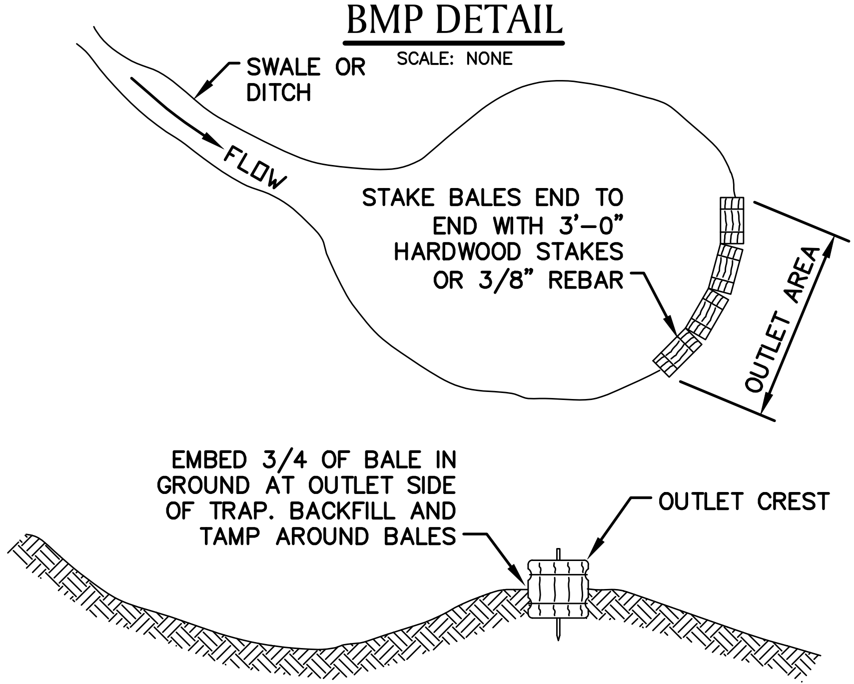
AA-8

DRAINAGE SWALE AND LINED DITCH

BMP DETAIL

SCALE: NONE



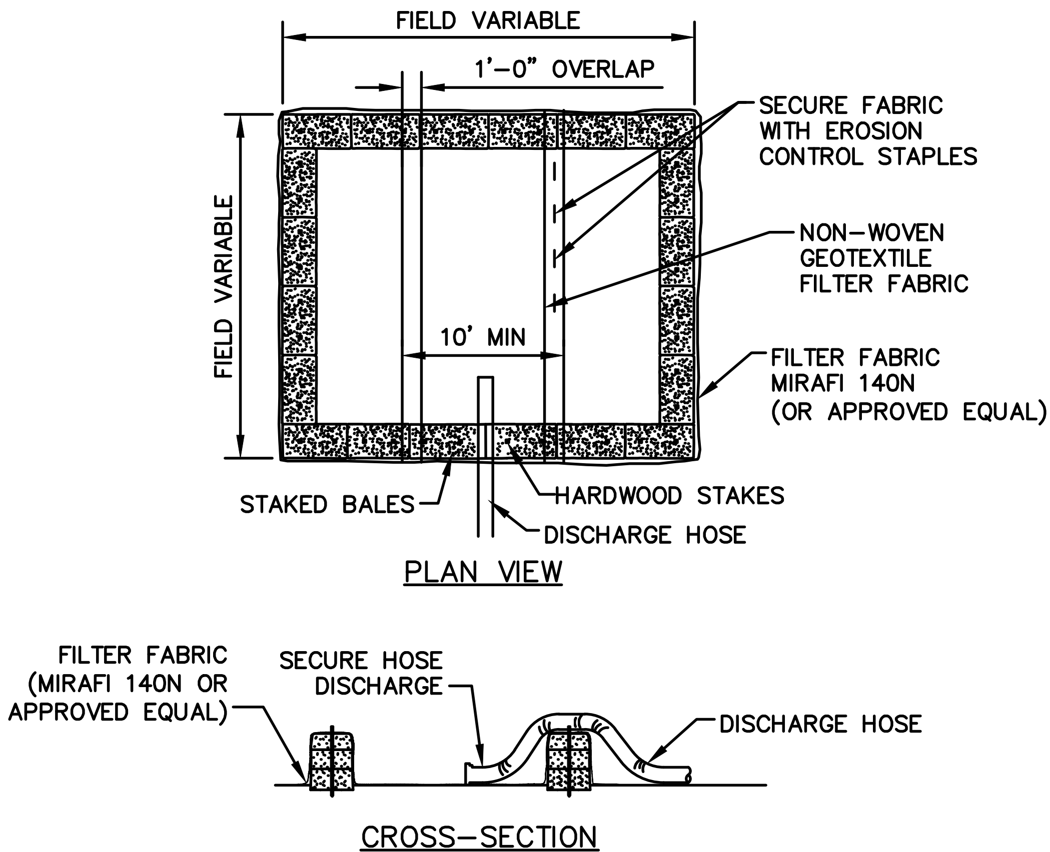
TYPICAL PROFILE

NOTES

1. SIZE, SHAPE AND PROFILE OF SEDIMENT WILL VARY ACCORDING TO ANTICIPATED FLOW VOLUME AND SURROUNDING TERRAIN AND SHALL BE COORDIANTED WITH THE NATIONAL GRID ENVIRONMENTAL SCIENTIST.
2. THE BASIN SHALL BE CUT BELOW THE GROUNDLINE. FILL SHALL NOT BE USED TO HOLD WATER UNLESS ROLLED AND COMPACTED.
3. OUTLET AREA IS TO REMAIN FREE OF EXCAVATION SPOILS.
4. OUTLET CREST ELEVATION SHALL BE LOWER THAN INLET ELEVATION AND AT LEAST 1'–0" BELOW THE TOP OF THE BASIN.ARMOUR SLOPES >8% IN OUTLET AREA WITH STONE OF APPROPRIATE SIZE TO PREVENT SCOUR.
5. ARMOUR SLOPES >8% IN OUTLET AREA WITH STONE OF APPROPRIATE SIZE TO PREVENT SCOUR.

BMP PICTURE

BMP DETAIL



NOTES:

1. NUMBER OF BALES MAY VARY DEPENDING ON SITE CONDITIONS,
2. THE BASIN TO BE SIZED TO PREVENT DISCHARGE WATER FROM OVERTOPPING BASIN.
3. KEEP AS FAR FROM WETLANDS AS PRACTICAL.
4. CLEAN AND REMOVE AS SOON AS DEWATERING IS COMPLETE.

BMP PICTURE

File: Dewat_Bas_Small.dwg

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AA-10
DEWATERING BASIN
(SMALL SCALE)

BMP PICTURE

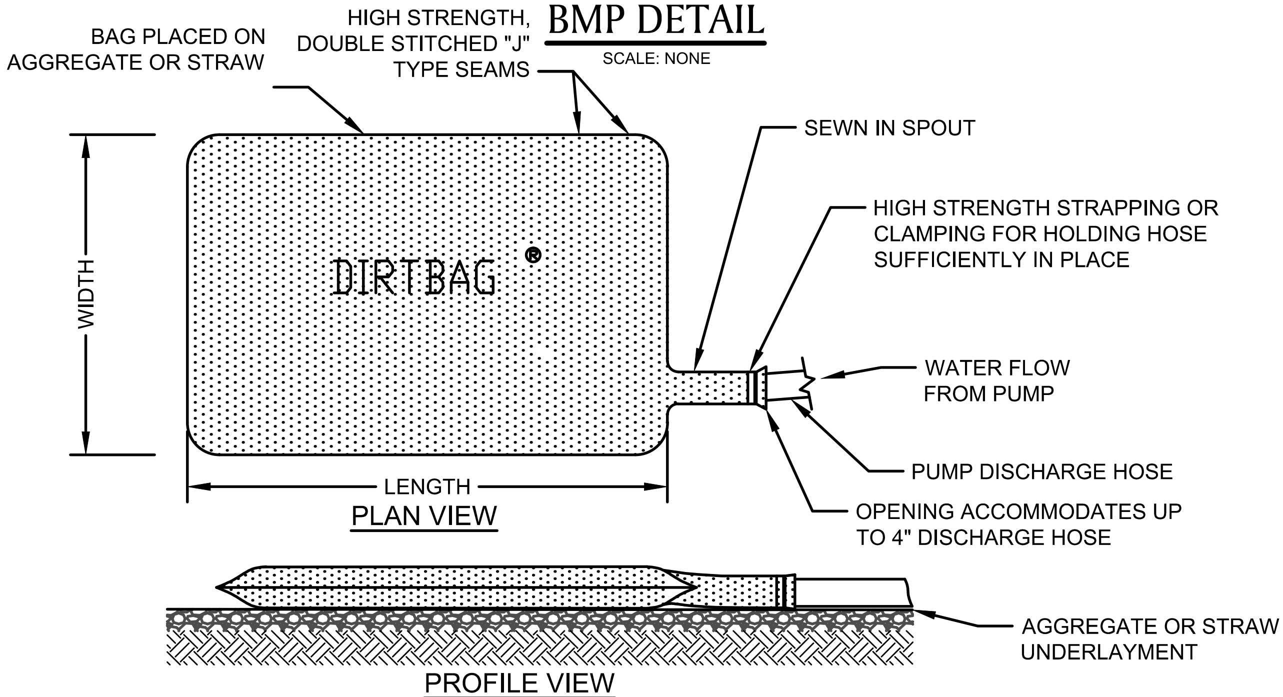
NOTE:

1. EXACT SIZE, LOCATION AND DESIGN IS DEPENDANT ON SITE CONDITIONS, AND LOCAL AND STATE REGULATIONS. COORDINATE THIS BMP WITH NATIONAL GRID ENVIRONMENTAL SCIENTIST PRIOR TO CONSTRUCTION.

AA-11
DEWATERING BASIN -
LARGE SCALE

BMP DETAIL

SCALE: NONE



NOTE:
ONCE PUMPING COMMENCES, THE DIRT BAG SHALL BE MONITORED FREQUENTLY TO ASSURE THAT THE CONNECTIONS ARE SECURELY FASTENED AND THE RATE OF WATER DELIVERY TO THE STRUCTURE IS LOW ENOUGH TO PREVENT UNFILTERED WATER FROM FLOWING FROM THE HOSE CONNECTIONS OR BAG.

BMP PICTURE

* PICTURE AND DETAIL PROVIDED BY ACF ENVIRONMENTAL

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AA-12
DIRTBAG *

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Access, Maintenance and Construction Best Management Practices

Reference
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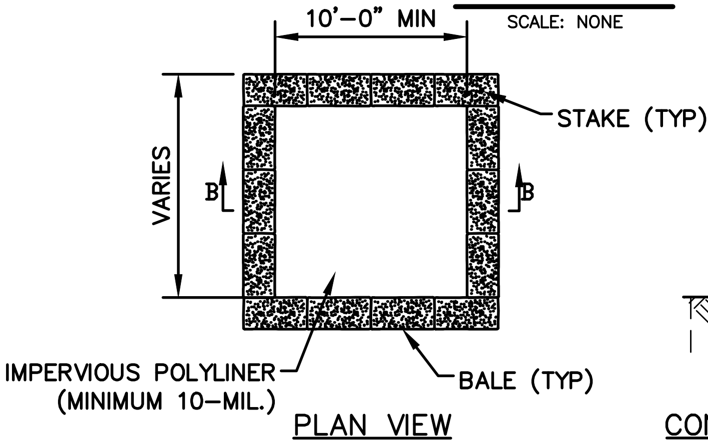
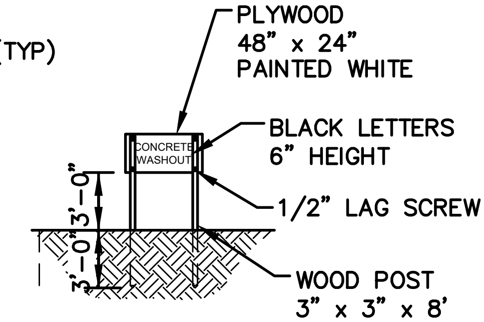
BMP DETAIL

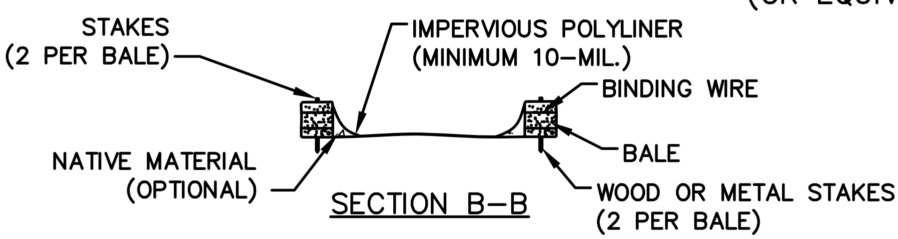
SCALE: NONE



PLAN VIEW
TYPE "ABOVE GRADE" WITH BALES



CONCRETE WASHOUT SIGN DETAIL
(OR EQUIVALENT)



SECTION B–B

NOTES:

1. NUMBER OF BALES MAY VARY DEPENDING ON SITE CONDITIONS. COORDINATE SIZE AND LOCATION OF CONCRETE WASTE SUMP WITH NATIONAL GRID ENVIRONMENTAL SCIENTIST.
2. KEEP AS FAR FROM DRAINAGE CHANNELS AND WETLAND AREAS AS PRACTICAL.
3. SUMPS TO BE CLEANED AND WASTE CONCRETE REMOVED AND PROPERLY DISPOSED OF UPON COMPLETION OF WORK.
4. SEE ADDITIONAL NOTES ON DETAIL AA–14.

BMP PICTURE

File: Conc_Waste_Sump.dwg

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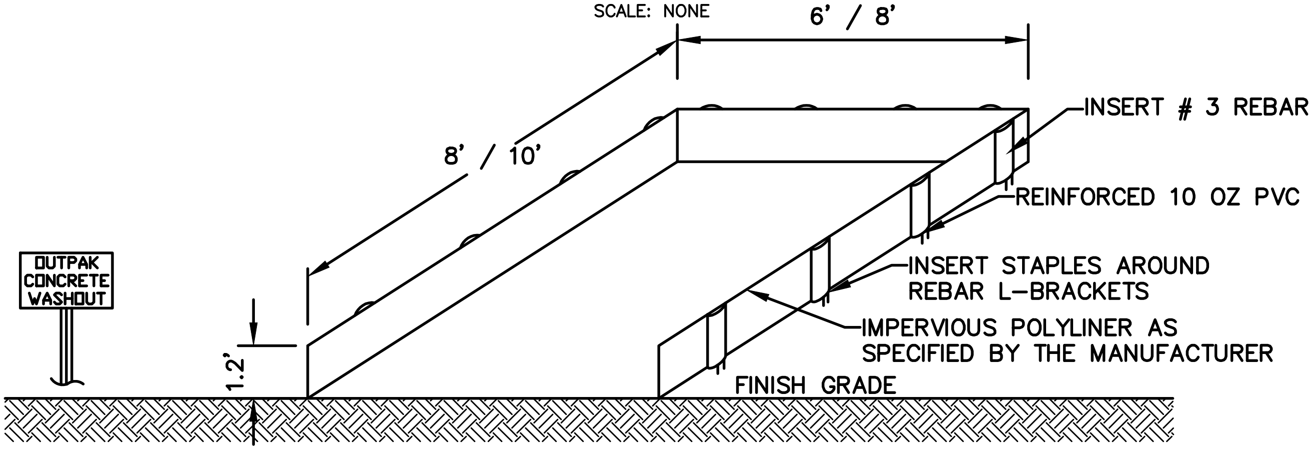
AA-13
CONCRETE WASTE SUMP

BMP DETAIL

SCALE: NONE



CROSS SECTION

NOTES:

1. PRODUCT TO BE OUTPAK PVC CONCRETE WASHOUT OR APPROVED EQUAL BY NATIONAL GRID ENVIRONMENTAL SCIENTIST.
2. THE CONCRETE WASHOUT AREA SHALL BE INSTALLED PRIOR TO ANY CONCRETE PLACEMENT.
3. SIGNS SHALL BE PLACED AS NECESSARY TO CLEARLY INDICATE THE LOCATION OF THE CONCRETE WASHOUT.
4. THE CONCRETE WASHOUT AREA WILL BE REPLACED AS NECESSARY TO MAINTAIN CAPACITY FOR WASTE CONCRETE AND OTHER LIQUID WASTE.
5. WASHOUT RESIDUE SHALL BE REMOVED FROM THE SITE AND DISPENSED OF AT AN APPROVED WASTE SITE.
6. DO NOT MIX EXCESS AMOUNTS OF FRESH CONCRETE OR CEMENT ON-SITE.
7. DO NOT WASH OUT CONCRETE TRUCKS INTO STORM DRAINS, OPEN DITCHES, STREETS, OR STREAMS.
8. AVOID DUMPING EXCESS CONCRETE IN NON-DESIGNATED DUMPING AREAS.
9. LOCATE WASHOUT AREA AT LEAST 50' FROM STORM DRAIN, OPEN DITCHES, OR WATERBODIES. COORDINATE LOCATION WITH NATIONAL GRID ENVIRONMENTAL SCIENTIST.
10. WASH OUT WASTES INTO THE OUTPAK WASHOUT WHERE THE CONCRETE CAN SET, BE BROKEN UP, AND THEN DISPOSED OF PROPERLY.
11. A SECURE, NON-COLLAPSING, NON-WATER COLLECTING COVER MUST BE PLACED OVER CONCRETE WASHOUT PRIOR TO PREDICTED WET WEATHER TO PREVENT ACCUMULATION AND OVERFLOW OF PRECIPITATION.

BMP PICTURE

*** PICTURE AND DETAIL PROVIDED BY OUTPAK WASHOUT**
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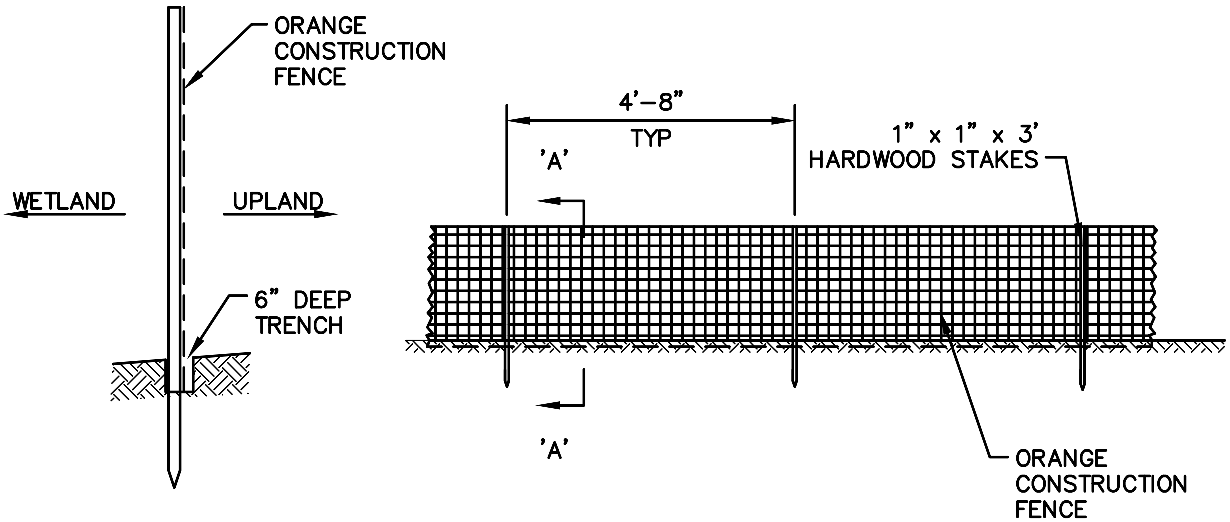
AA-14
OUTPAK CONCRETE WASHOUT *

BMP DETAIL

SCALE: NONE



SECTION A–A

BMP PICTURE

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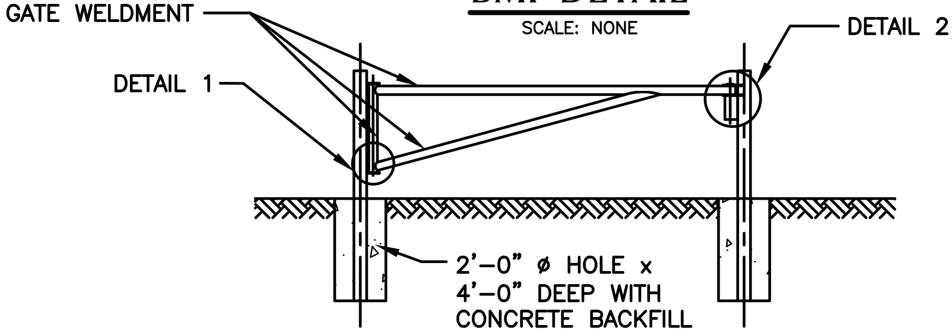
AA-15

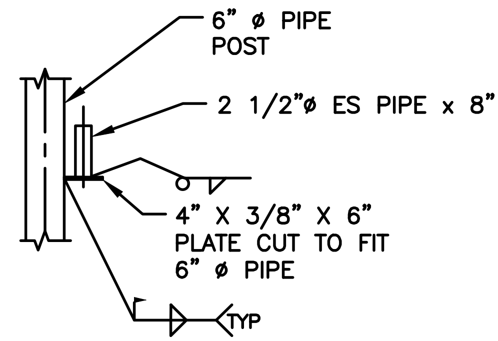
BARRIER FENCE (CONSTRUCTION FENCE)

File: Barrier_Fence.dwg

BMP DETAIL

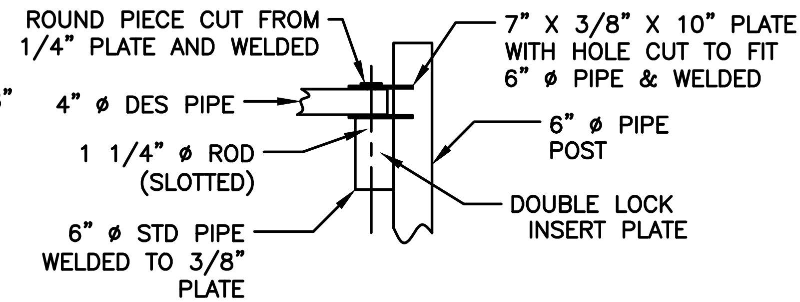
SCALE: NONE





DETAIL 1

SIMILAR DETAIL AT TOP



DETAIL 2

NOTES:

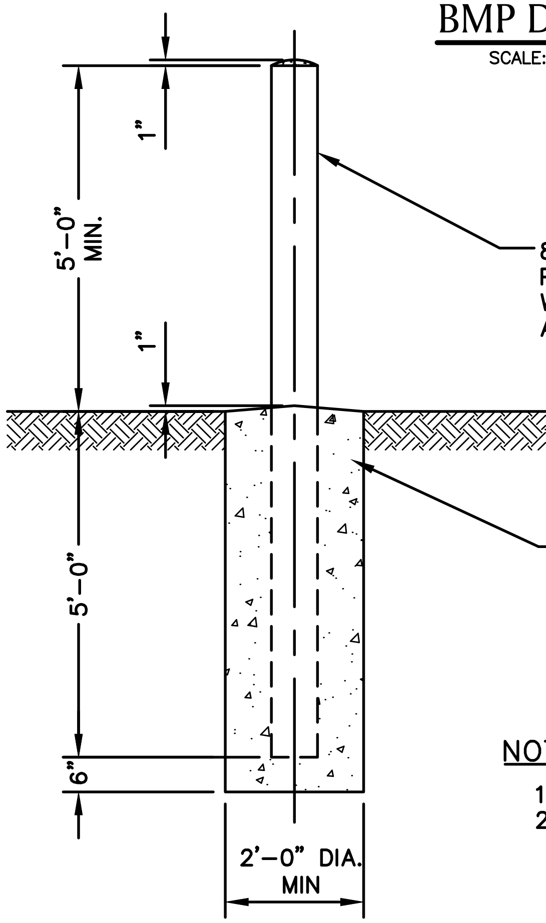
1. ALL GATE STEEL PIPES SHALL BE IN ACCORDANCE WITH ASTM A–501, PLATES SHALL BE ASTM A–36.
2. ALL STEEL PIPES SHALL BE PRIMED WITH ZINC–CHROMATE PRIMER AND FINISHED WITH AN APPROVED OSHA "SAFETY YELLOW" TOP COAT COMPATIBLE WITH THE PRIMER AND FOR EXTERIOR EXPOSURE.
3. REFLECTORS SHALL BE SPACED AT 3 FEET ALONG THE LENGTH OF THE CROSSBAR AND BRACE
4. BACKFILL AT POSTS TO BE COMPACTED.

BMP PICTURE

AA-16
ROW GATE / FENCE

BMP DETAIL

SCALE: NONE



NOTES:

1. ALL CONCRETE TO BE 2500 P.S.I. MINIMUM.
2. COORDINATE LOCATIONS WITH NATIONAL GRID ENVIRONMENTAL SCIENTIST.

BMP PICTURE

BMP

Definition

The control of dust resulting from land-disturbing activities.

Purpose

To prevent surface and air movement of dust from disturbed soil surfaces that may cause off-site damage, health hazards, and traffic safety problems.

Conditions Where Practice Applies

On construction roads, access points, and other disturbed areas subject to surface dust movement and dust blowing where off-site damage may occur if dust is not controlled.

Design Criteria

Construction operations should be scheduled to minimize the amount of area disturbed at one time. Buffer areas of vegetation should be left where practical. Temporary or permanent stabilization measures shall be installed. No specific design criteria is given; see construction specifications below for common methods of dust control.

Water quality must be considered when materials are selected for dust control. Where there is a potential for the material to wash off to a stream, ingredient information must be provided to the local permitting authority.

Construction Specifications

A. Non-driving Areas – These areas use products and materials applied or placed on soil surfaces to prevent airborne migration of soil particles.

Vegetative Cover – For disturbed areas not subject to traffic, vegetation provides the most practical method of dust control (see Section 3).

Mulch (including gravel mulch) – Mulch offers a fast effective means of controlling dust. This can also include rolled erosion control blankets.

Spray adhesives – These are products generally composed of polymers in a liquid or solid form that are mixed with water to form an emulsion that is sprayed on the soil surface with typical hydroseeding equipment. The mixing ratios and application rates will be in accordance with the manufacturer's recommendations for the specific soils on the site. In no case should the application of these adhesives be made on wet soils or if there is a probability of precipitation within 48 hours of its proposed use. Material Safety Data Sheets will be provided to all applicators and others working with the material.

B. Driving Areas – These areas utilize water, polymer emulsions, and barriers to prevent dust movement from the traffic surface into the air.

Sprinkling – The site may be sprayed with water until the surface is wet. This is especially effective on haul roads and access routes.

Polymer Additives – These polymers are mixed with water and applied to the driving surface by a water truck with a gravity feed drip bar, spray bar or automated distributor truck. The mixing ratios and application rates will be in accordance with the manufacturer's recommendations. Incorporation of the emulsion into the soil will be done to the appropriate depth based on expected traffic. Compaction after incorporation will be by vibratory roller to a minimum of 95%. The prepared surface shall be moist and no application of the polymer will be made if there is a probability of precipitation within 48 hours of its proposed use. Material Safety Data Sheets will be provided to all applicators working with the material.

Barriers – Woven geotextiles can be placed on the driving surface to effectively reduce dust throw and particle migration on haul roads. Stone can also be used for construction roads for effective dust control.

Windbreak – A silt fence or similar barrier can control air currents at intervals equal to ten times the barrier height. Preserve existing wind barrier vegetation as much as practical.

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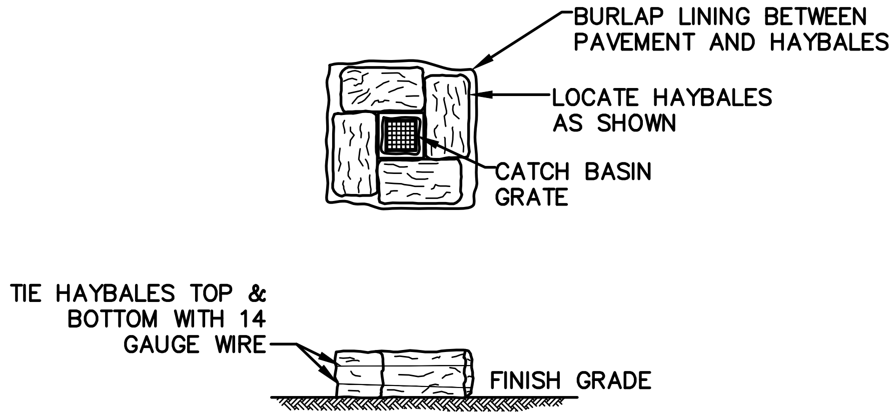
BMP DETAIL

SCALE: NONE



NOTES:

1. SURROUND STREET DRAINAGE STRUCTURE INLET WITH HAY BALES PRIOR TO CONSTRUCTION AND MAINTAIN UNTIL CONSTRUCTION IS COMPLETED. ACCUMULATED SEDIMENTS SHALL BE REMOVED.
2. HAYBALES PLACED ON PAVEMENT SHALL HAVE BURLAP PLACED BETWEEN PAVEMENT AND HAYBALE

BMP PICTURE

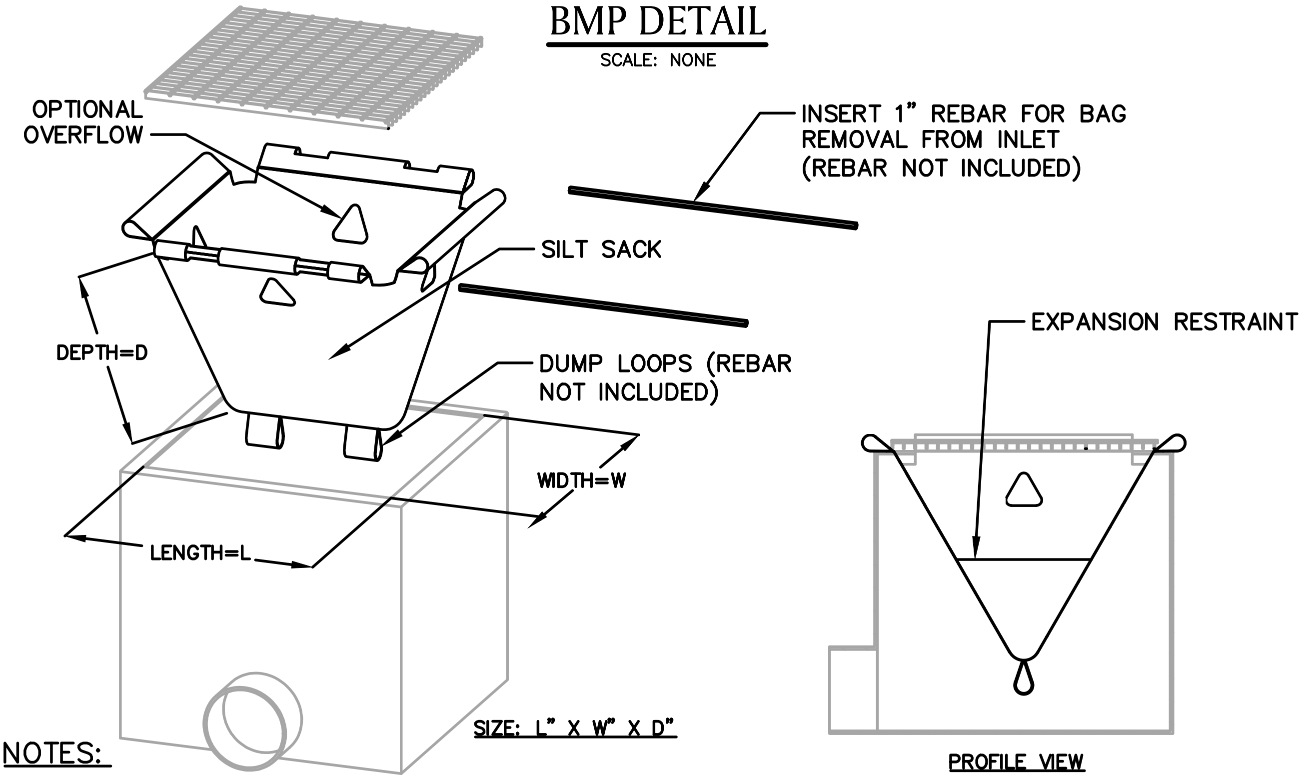
APPROVED BY: VICE PRESIDENT, ENVIRONMENTAL SERVICES

AA-19
CATCH BASIN INLET PROTECTION

File: CB_Inlet_Protection.dwg

BMP DETAIL

SCALE: NONE



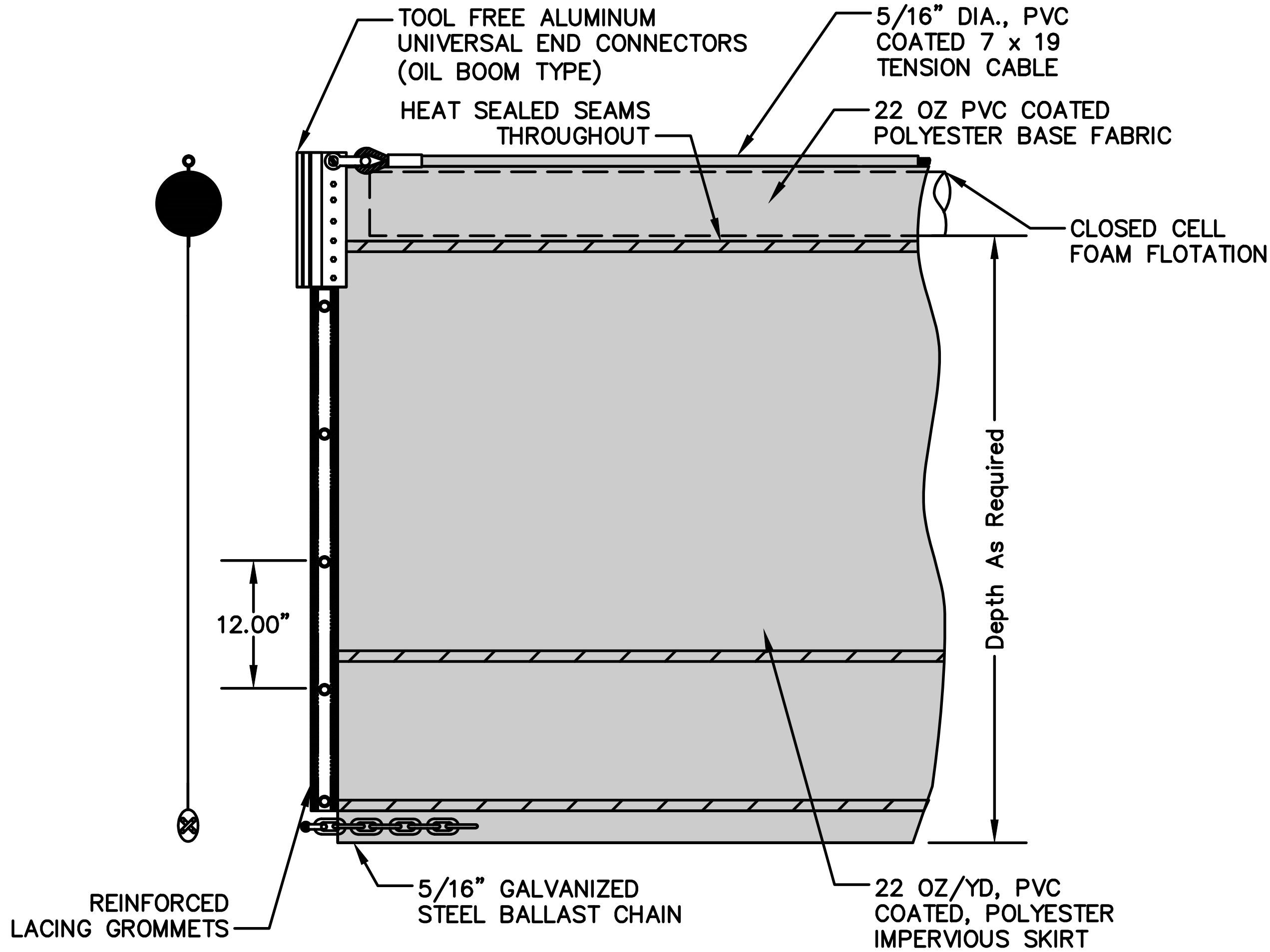
NOTES:

1. PRODUCT TO BE SILT SACK OR APPROVED EQUAL BY NATIONAL GRID ENVIRONMENTAL SCIENTIST.
2. THE USE OF A SILT SACK OPTIONAL OVERFLOW AND OVERALL DIMENSIONS ARE TO BE COORDINATED WITH A NATIONAL GRID ENVIRONMENTAL SCIENTIST.

BMP PICTURE

BMP DETAIL

SCALE: NONE



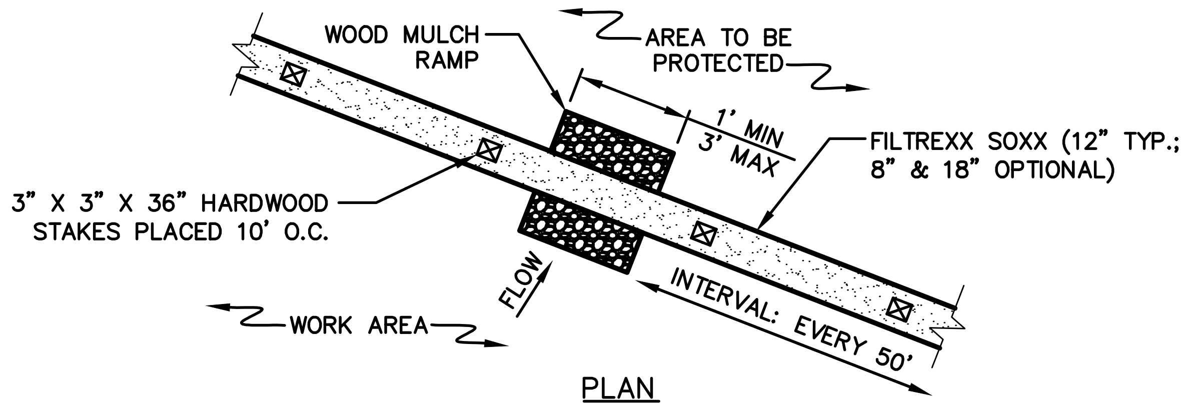
BMP PICTURE

*** DETAIL PROVIDED BY BROCKTON EQUIPMENT / SPILLDAM INC.**
APPROVED BY: VICE PRESIDENT, ENVIRONMENTAL SERVICES

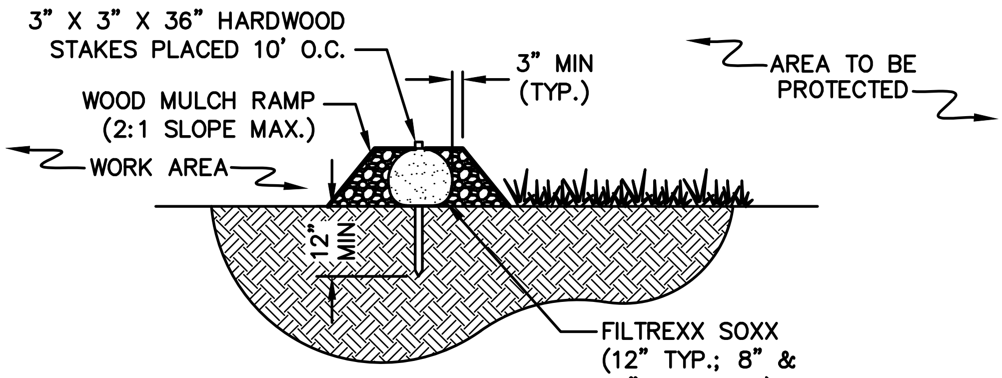
AA-21
TURBIDITY CURTAIN *

BMP DETAIL

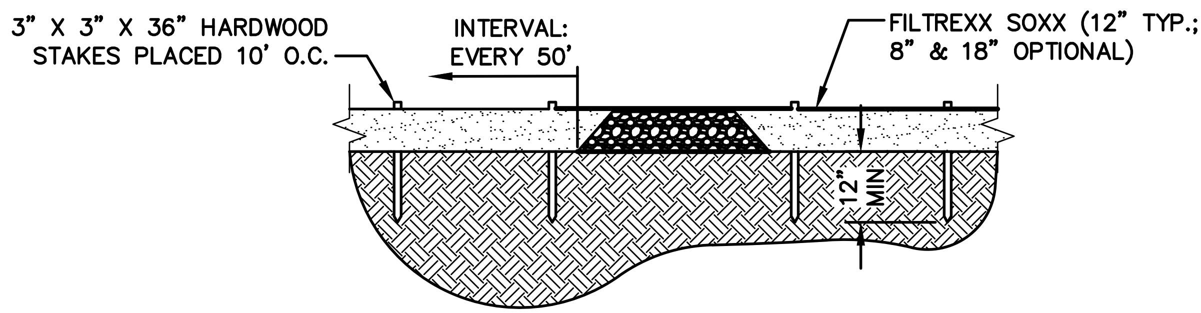
SCALE: NONE



PLAN



SECTION



PROFILE

NOTES

1. PRODUCT TO BE FILTREXX SILT SOXX OR APPROVED EQUAL BY NATIONAL GRID ENVIRONMENTAL SCIENTIST.
2. ALL MATERIAL TO MEET FILTREXX SPECIFICATIONS.
3. FILTER MEDIA FILL TO MEET APPLICATION REQUIREMENTS.
4. NON–MONOFILAMENT CONTAINMENT MATERIAL SHOULD BE KNITTED PHOTODEGRADABLE OR BIODEGRADABLE MATERIAL, WITH OPENING SIZES BETWEEN 1/8" – 1/4".
5. COMPOST MEDIA SHOULD HAVE PARTICLE SIZE WHERE 99% < 2", 50% > 1/2".
6. COMPOST MATERIAL TO BE DISPOSED OF ON–SITE, OR IN ACCORDANCE WITH ENVIRONMENTAL PERMITS AS APPROVED BY NATIONAL GRID ENVIRONMENTAL SCIENTIST.
7. WOOD MULCH RAMP IS OPTIONAL DEPENDING ON SUBSTRATE/SITE CONDITIONS, AND TO BE APPROVED BY NATIONAL GRID ENVIRONMENTAL SCIENTIST.

BMP # AA-22
SILTSOXX AMPHIBIAN & REPTILE CROSSING #1 (1 OF 2)

BMP PICTURE

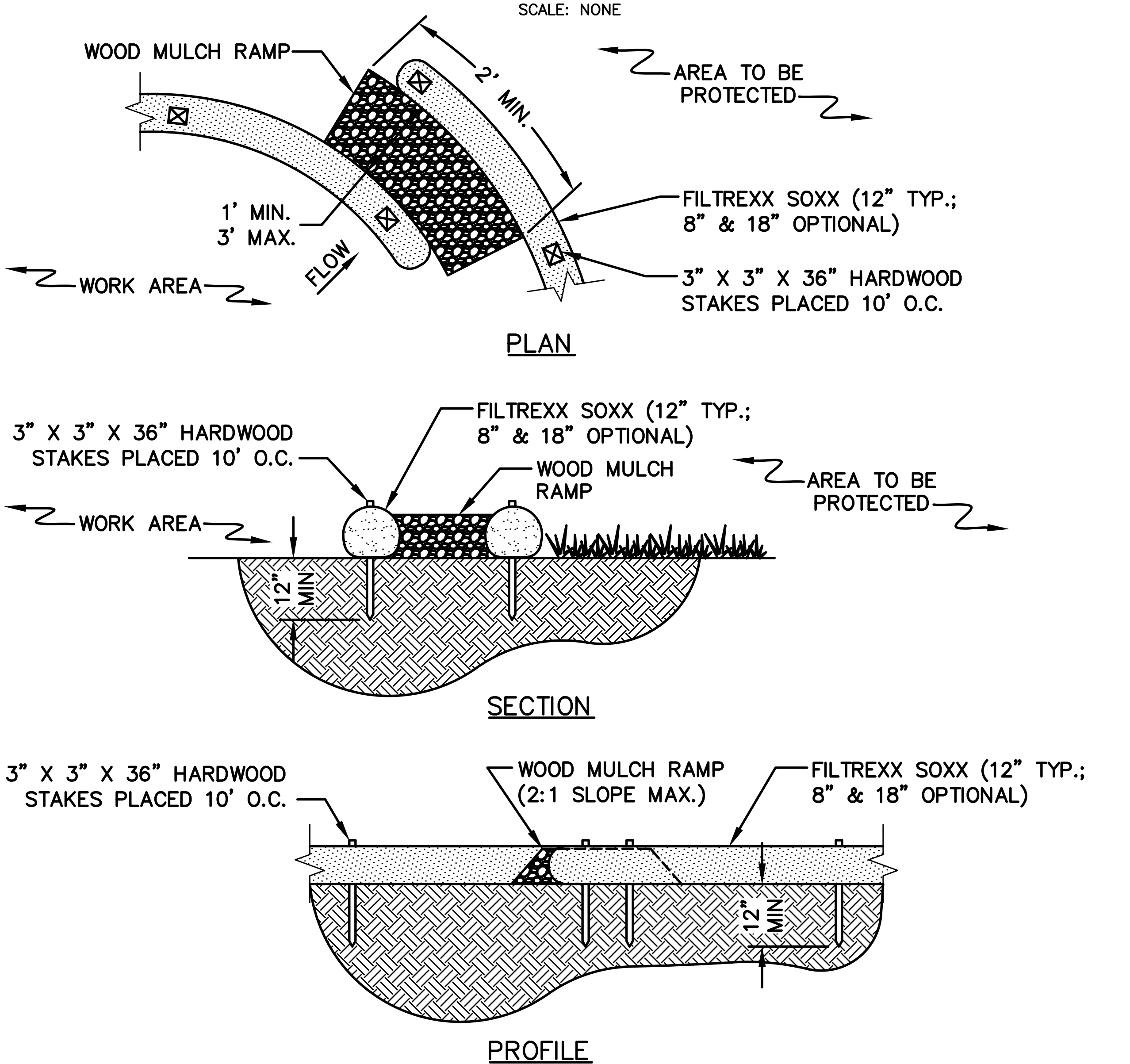
SALAMANDER AND SNAKE CROSSING #1

ALTERNATE WOOD MULCH RAMP SILTSOXX NOTES:

1. SILTSOXX, BY FILTREX INTERNATIONAL, OR APPROVED EQUAL PRODUCT SHALL BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH THE MANUFACTURER'S GUIDELINES.
2. BMP SHOULD ONLY BE UTILIZED IN AREAS WHERE RARE SALAMANDER AND SNAKE HABITAT OCCURS, OR AT THE DIRECTION OF THE NATIONAL GRID ENVIRONMENTAL SCIENTIST.

BMP DETAIL

SCALE: NONE



NOTES

1. PRODUCT TO BE FILTREXX SILT SOXX OR APPROVED EQUAL BY NATIONAL GRID ENVIRONMENTAL SCIENTIST.
2. ALL MATERIAL TO MEET FILTREXX SPECIFICATIONS.
3. FILTER MEDIA FILL TO MEET APPLICATION REQUIREMENTS.
4. NON-MONOFILAMENT CONTAINMENT MATERIAL SHOULD BE KNITTED PHOTODEGRADABLE OR BIODEGRADABLE MATERIAL, WITH OPENING SIZES BETWEEN 1/8" - 1/4".
5. COMPOST MEDIA SHOULD HAVE PARTICLE SIZE WHERE 99% < 2", 50% > 1/2".
6. COMPOST MATERIAL TO BE DISPOSED OF ON-SITE, OR IN ACCORDANCE WITH ENVIRONMENTAL PERMITS AS APPROVED BY NATIONAL GRID ENVIRONMENTAL SCIENTIST.
7. WOOD MULCH RAMP IS OPTIONAL DEPENDING ON SUBSTRATE/SITE CONDITIONS, AND TO BE APPROVED BY NATIONAL GRID ENVIRONMENTAL SCIENTIST.
8. GAPS TO BE SPACED EVERY 50 FT, IF POSSIBLE GIVEN WETLAND PERMIT CONDITIONS.

BMP PICTURE

SILTSOXX AMPHIBIAN & REPTILE CROSSING #2

ALTERNATE WOOD MULCH RAMP SILTSOXX NOTES:

1. SILTSOXX, BY FILTREX INTERNATIONAL, OR APPROVED EQUAL PRODUCT SHALL BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH THE MANUFACTURER'S GUIDELINES.
2. BMP SHOULD ONLY BE UTILIZED IN AREAS WHERE RARE SALAMANDER AND SNAKE HABITAT OCCURS OR AT THE DIRECTION OF THE NATIONAL GRID ENVIRONMENTAL SCIENTIST.

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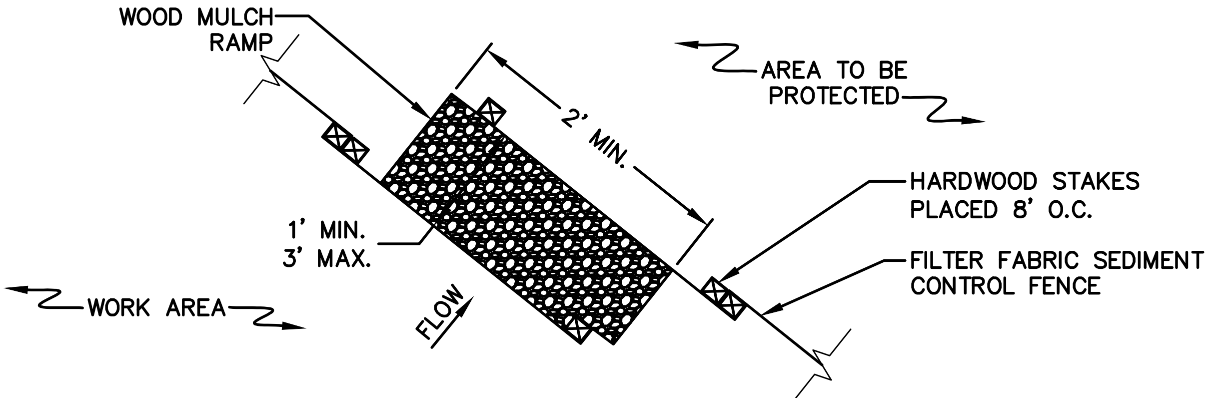
BMP DETAIL

SCALE: NONE



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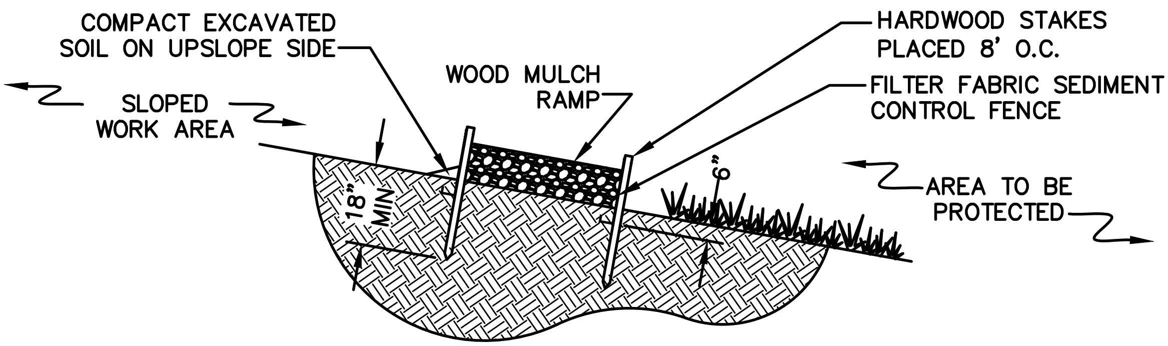
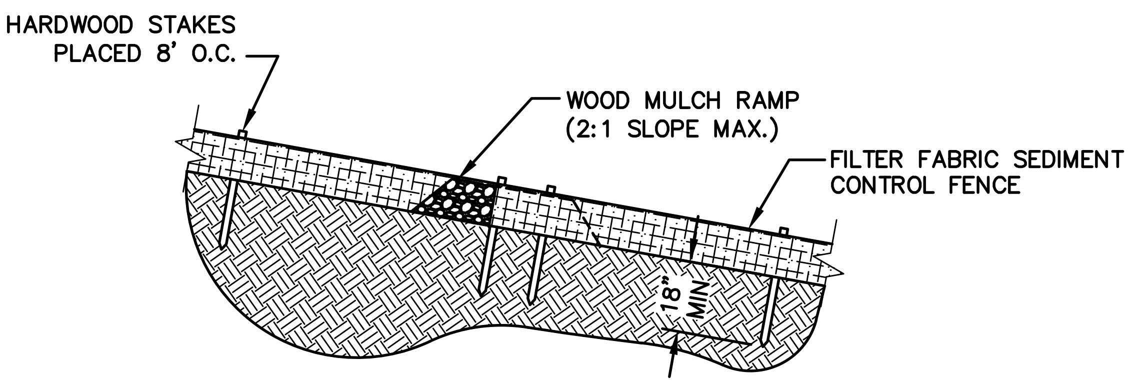


SECTION



PROFILE

NOTES

1. IN AREAS WHERE SLOPES OR RUN-OFF VOLUME PROHIBIT USE OF SILTSOXX, CROSSINGS CAN BE PROVIDED THROUGH TRENCHED SILT FENCE.
2. INTALL SILT FENCE TO SPECIFICATIONS IN EG303 APPENDIX 7 "SEC-2 SEDIMENT CONTROL FENCE."
3. WOOD MULCH RAMP IS OPTIONAL DEPENDING ON SUBSTRATE/SITE CONDITIONS, AND TO BE APPROVED BY NATIONAL GRID ENVIRONMENTAL SCIENTIST.
4. GAPS TO BE SPACED EVERY 50 FT, IF POSSIBLE GIVEN WETLAND PERMIT CONDITIONS.

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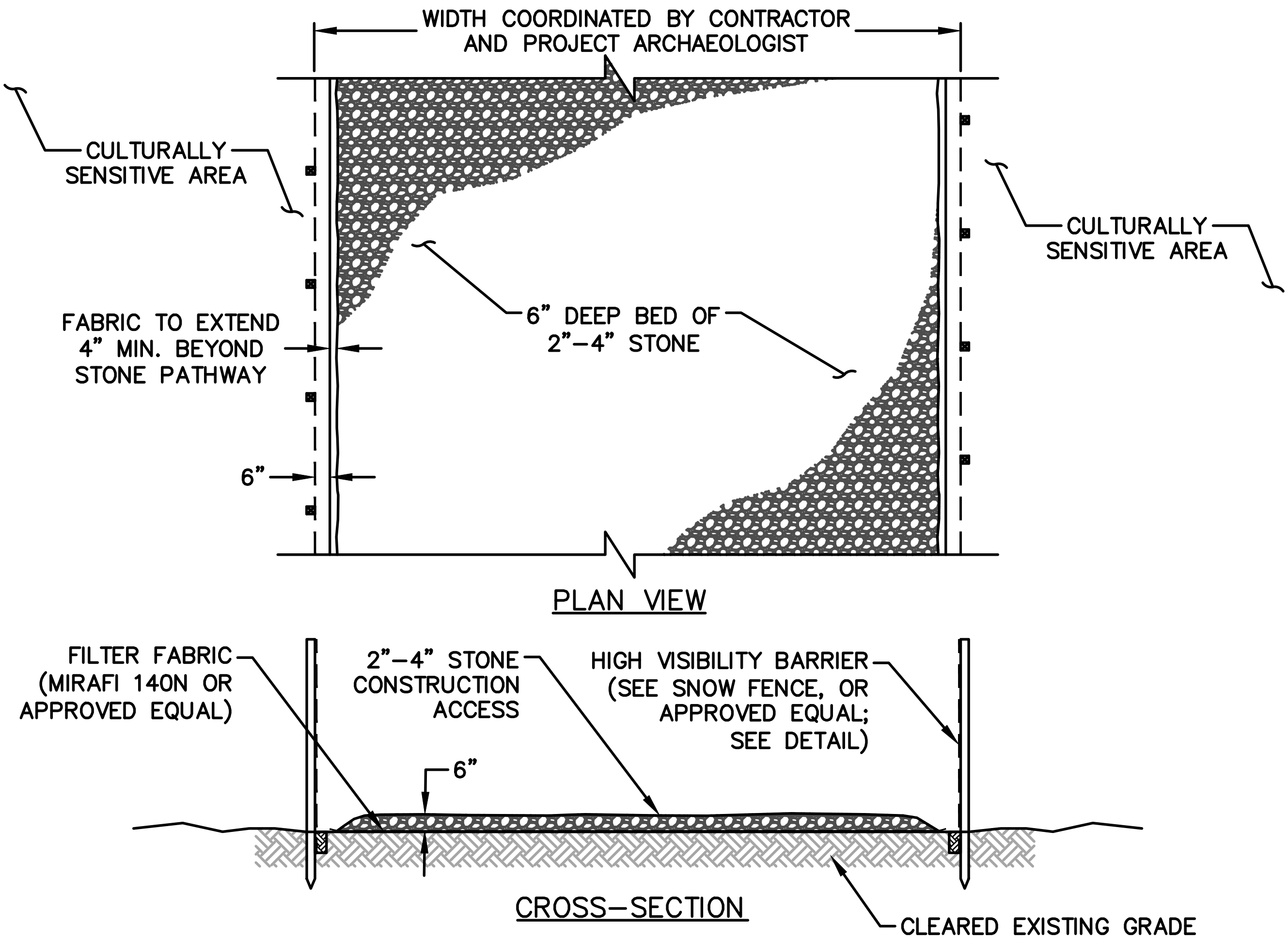
APPROVED BY: VICE PRESIDENT, ENVIRONMENTAL SERVICES

BMP # AA-24
SILT FENCE AMPHIBIAN & REPTILE CROSSING #3

BMP DETAIL

SCALE: NONE



NOTES:

1. ARCHAEOLOGICAL SITE BOUNDARIES, AS DEFINED BY INTENSIVE ARCHAEOLOGICAL SURVEY AND SITE AVOIDANCE AND PROTECTION PLANS, WILL BE DEMARCATED BY STAKING BY THE PROJECT ARCHAEOLOGIST.
2. GEOTEXTILE AND STONE MAY REMAIN IN PLACE FOLLOWING CONSTRUCTION IF PERMANENT PROTECTION IS NECESSARY AND DEPENDENT ON EASEMENT RIGHTS.
3. WHERE APPROVED BY THE PROJECT–SPECIFIC SAPP, CONSTRUCTION MATTING MAY BE ADDED OVER, OR IN PLACE OF, THE FABRIC AND STONE.
4. INSTALLATION AND REMOVAL OF FABRIC AND STONE, EROSION CONTROLS, AND/OR CONSTRUCTION MATTING WILL BE MONITORED BY THE PROJECT ARCHAEOLOGIST AT EACH LOCATION(S).
5. INSTALLATION OF THESE MEASURES WILL BE CONDUCTED WITH LOW–GROUND PRESSURE VEHICLES WHERE FEASIBLE.
6. WHERE REQUIRED BY THE PROJECT–SPECIFIC SAPP, TEMPORARY, HIGH VISIBILITY PROTECTIVE FENCING (E.G., SNOW FENCE OR PLASTIC FENCE) WILL BE ERECTED ALONG THE SITE BOUNDARIES OUTSIDE OF THE WORKSPACE WITHIN THE ROW IN ORDER TO PREVENT VEHICLES FROM TRAVELING THROUGH THOSE SITE AREAS DURING CONSTRUCTION. THE PROTECTIVE FENCE WILL BE POSTED WITH "NO TRESPASSING" SIGNS, SO THAT THE SITES CAN BE AVOIDED BY ALL CONSTRUCTION RELATED ACTIVITIES. THE FENCING WILL BE REMOVED UPON COMPLETION OF THE PROJECT. THE INSTALLATION AND REMOVAL OF FENCING WILL BE MONITORED BY THE PROJECT ARCHAEOLOGIST.

BMP PICTURES

APPENDIX 5
CERTIFICATION FORM FOR INVASIVE SPECIES CONTROL

Certain permit conditions, therefore a Condition of Contracts for the Prime Contractor, any Subcontractors, and any equipment or mat vendors for ***National Grid Projects*** shall be required to Certify their equipment[7] {each piece of equipment used on site} as 'clean'[8].

___________________________________ (*name of firm*) hereby Certifies that

___________________________________ (*make, model, and/or type*)

_______________________________________ (*equipment ID tag or #)* meets the following

1. before entry on to the job site, has been sufficiently cleaned to remove all accumulated mud, debris, plant fragments, and detritus that could harbor seeds, roots, or plant fragments of so-called invasive plant species; and

2. that the above piece of equipment has neither been off-loaded nor operated in the interval between cleaning and delivery to the jobsite.

3. that equipment deployed in areas of invasive species (as identified in project plans) shall be cleaned prior to redeployment.

______________________________ (*signed*) ______________ (*dated*)

______________________________ (*printed name*) _______________________________ (*title*)

______________________________ (*Firm*)

The signed original of this form {one for each piece of equipment (or lot[9] of mats)} is to be given to the NG Construction Supervisor assigned to the project.

---

7 Equipment may include, but is not limited to bulldozers, excavators, backhoes, bucket trucks (tracked or wheeled), pulling equipment, concrete trucks, compressors, drilling equipment, and mats (composite, wood, or other materials).

8 With regard to invasive species, the definition of clean means free of accumulated mud, debris, plant fragments, and detritus that could harbor seeds, roots, or plant fragments of so-called invasive plant species.

9 Lot of mats is the number of mats that may be transported by one forwarder/truck at a time.

APPENDIX 6
SNOW DISPOSAL GUIDELINES

Finding a place to dispose of collected snow poses a challenge. While we are all aware of the threats to public safety caused by snow, collected snow that is contaminated with road salt, sand, litter, and automotive pollutants such as oil also threatens public health and the environment.

As snow melts, road salt, sand, litter, and other pollutants are transported into surface water or through the soil where they may eventually reach the groundwater. Road salt and other pollutants can contaminate water supplies and are toxic to aquatic life at certain levels. Sand washed into water bodies can create sand bars or fill in wetlands and ponds, impacting aquatic life, causing flooding, and affecting our use of these resources.

There are several steps that should be taken to minimize the impacts of snow disposal on public health and the environment.

- **DO NOT** dump snow into any water body, including rivers, the ocean, reservoirs, ponds, or wetlands. In fact, a buffer of at least 50 feet between any snow disposal area and any the high-water mark of any surface water should be kept. A silt fence or equivalent barrier should be securely placed between the snow storage area and the high-water mark. In addition to water quality impacts and flooding, snow disposed in surface waters can cause navigational hazards when it freezes into ice blocks.
- **DO NOT** dump snow within a wellhead protection area (e.g., a Zone II), in a high or medium-yield aquifer, or within 75 feet of a private well, where road salt may contaminate water supplies**. Ask an Environmental Department representative for guidance in determining if a proposed disposal area is located within one of these sensitive areas.**
- Avoid disposing of snow on top of storm drain catch basins or in storm water drainage swales or ditches. Snow combined with sand and debris may block a storm drainage system, causing localized flooding. A high volume of sand, sediment, and litter released from melting snow also may be quickly transported through the system into surface water.
- All debris in a snow storage area should be cleared from the site and properly disposed of no later than May 15 of each year the area is used for snow storage.

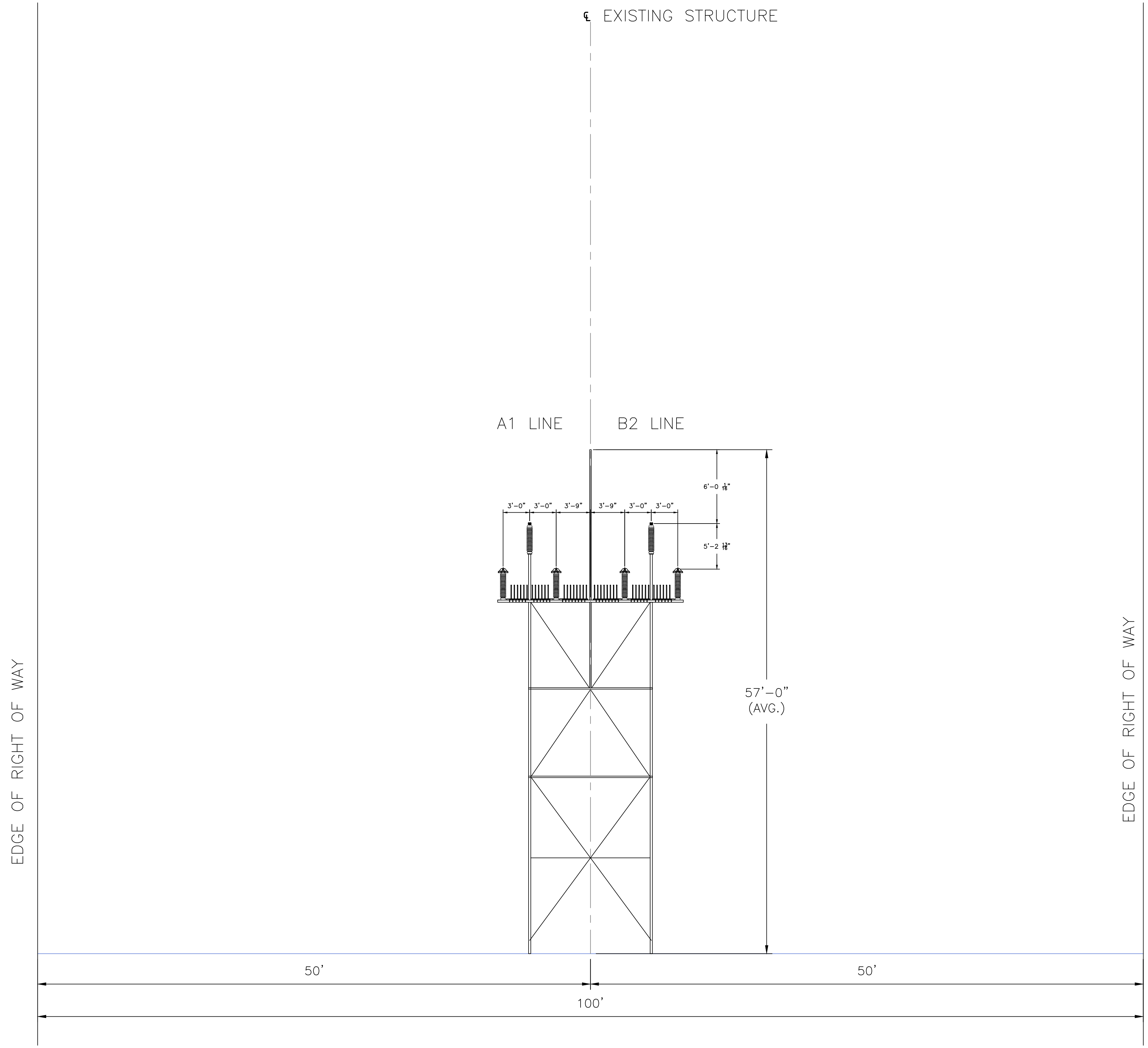
Under extraordinary conditions, when all land-based snow disposal options are exhausted, disposal of snow that is not obviously contaminated with road salt, sand, and other pollutants may be allowed near (within 50 feet) or even in certain water bodies under certain conditions.

In these dire situations, **notify the Environmental Department** so that the local Conservation Commission and the appropriate MassDEP Regional Service Center (in MA), RI DEM Office of Water Resources – RIPDES

Program (in RI), NH Department of Environmental Services – NHDES (in NH) and VT Department of Environmental Conservation - VT DEC (in VT) can be contacted before disposing of snow in a water body.

In emergency situations and after consulting an Environmental Department representative the following guidance should be followed:

- Dispose of snow in open water with adequate flow and mixing to prevent ice dams from forming.
- Do not dispose of snow in saltmarshes, vegetated wetlands, certified vernal pools, shellfish beds, mudflats, drinking water reservoirs and their tributaries, wellhead protection areas, or other environmentally sensitive areas.
- Do not dispose of snow where trucks may cause shoreline or stream bank damage or erosion.



EXISTING DOUBLE CIRCUIT LATTICE TOWER STRUCTURES
LOOKING TOWARDS PRATTS JUNCTION
MA/NH STATE LINE TO STRUCTURE 561
COMMONWEALTH OF MASSACHUSETTS

CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION)
PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION - EXISTING
PROPOSED DOUBLE CIRCUIT STRUCTURES

PREPARED BY	JTF	4/23
REVIEWED BY	TBD	-
APPROVED BY	JTF	4/23
SCALE	AS NOTED	
SHEET	11 OF 22	
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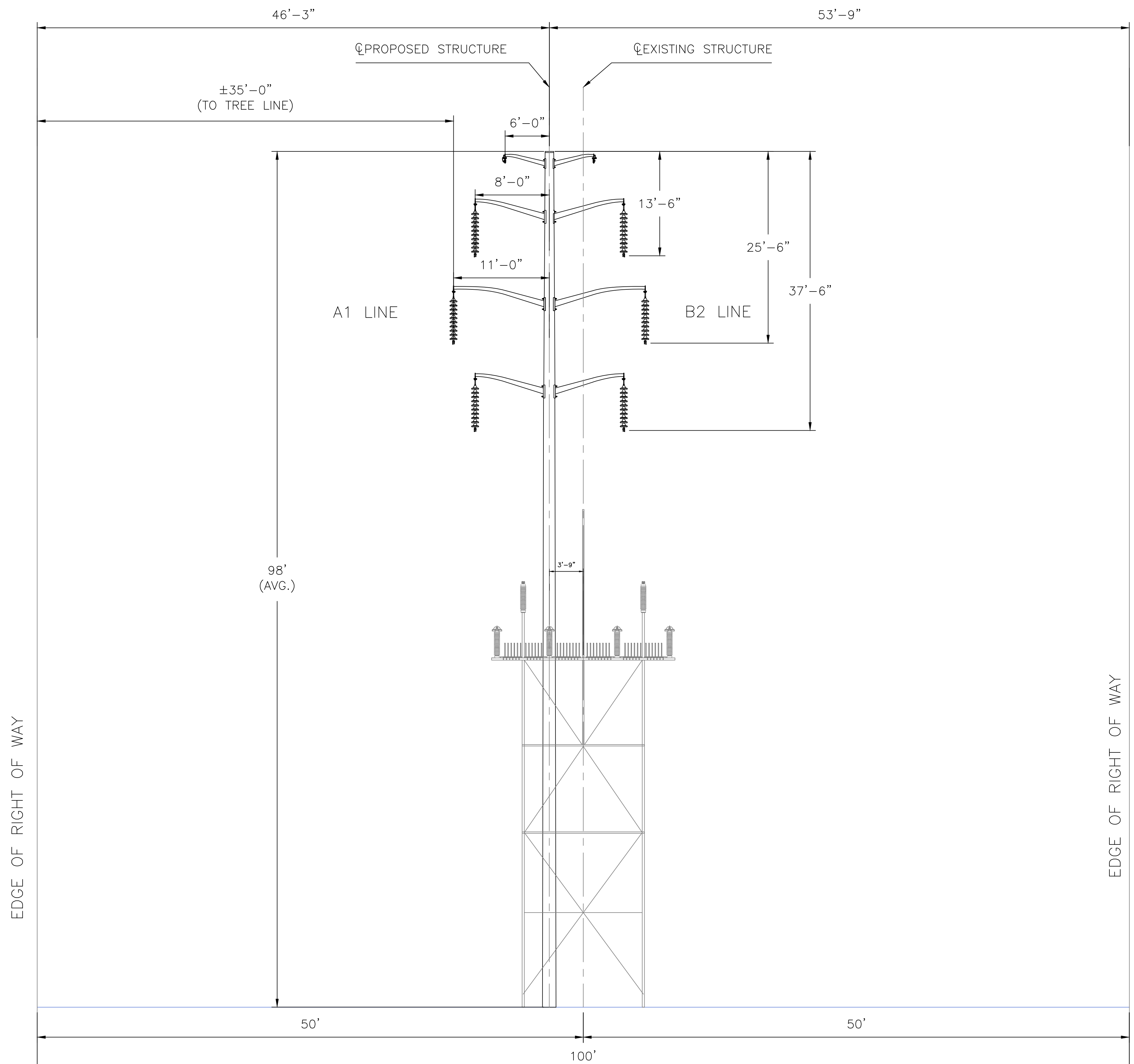
INCHES ON ORIGINAL



PROPOSED DOUBLE CIRCUIT DAVIT ARM STRUCTURES
LOOKING TOWARDS PRATTS JUNCTION
MA/NH STATE LINE TO STRUCTURE 561
COMMONWEALTH OF MASSACHUSETTS

CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION) PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION - PROPOSED
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PREPARED BY	JTF	4/23
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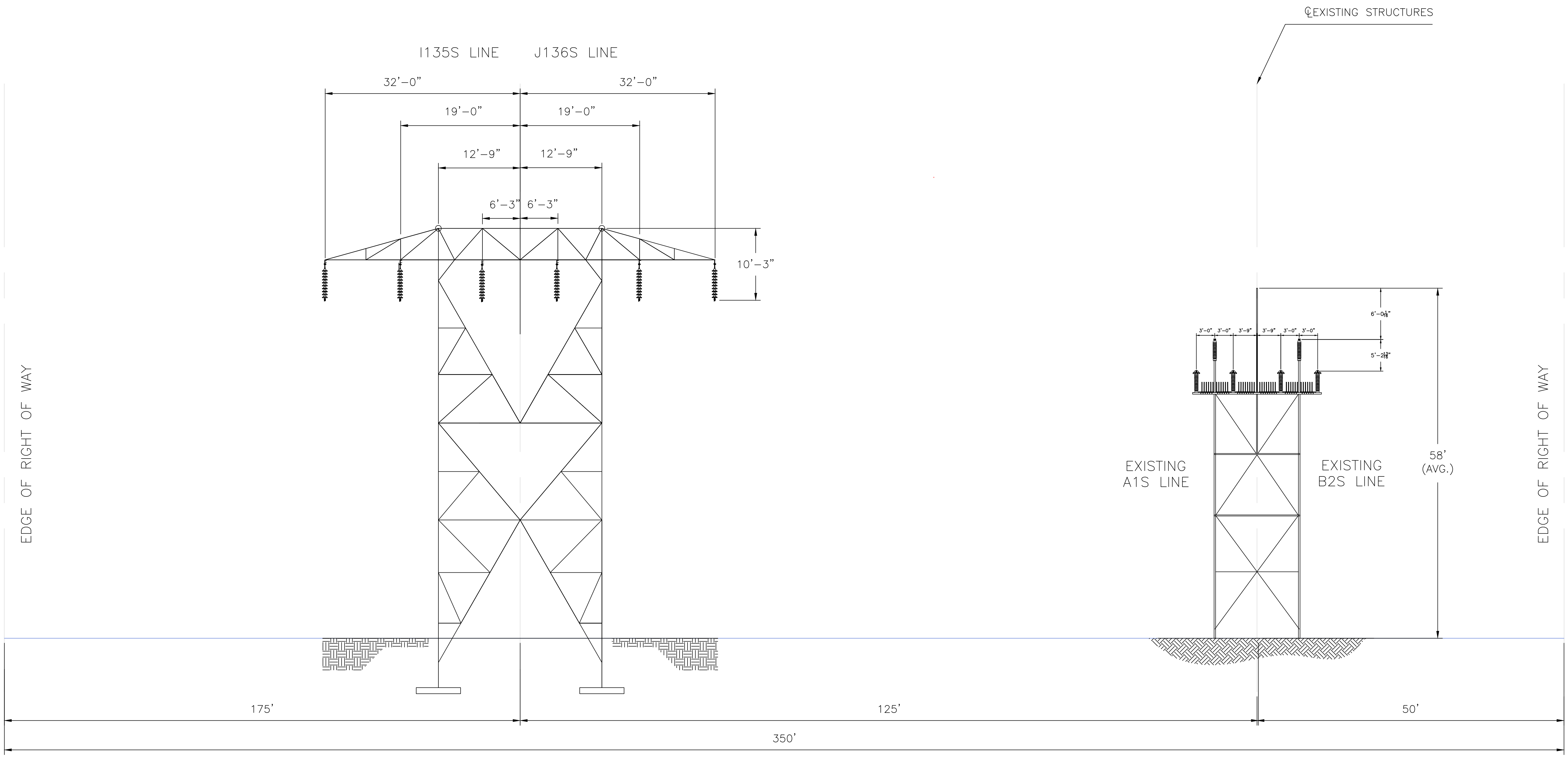

A1/B2 EXISTING DOUBLE CIRCUIT LATTICE TOWER STRUCTURES
CROSS-SECTION FACING PRATTS JUNCTION SUBSTATION
EXISTING STRUCTURE 561 TO EXISTING STRUCTURE 642
COMMONWEALTH OF MASSACHUSETTS

CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION)
PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION - EXISTING
PROPOSED DOUBLE CIRCUIT STRUCTURES

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REVIEWED BY	TBD	4/23
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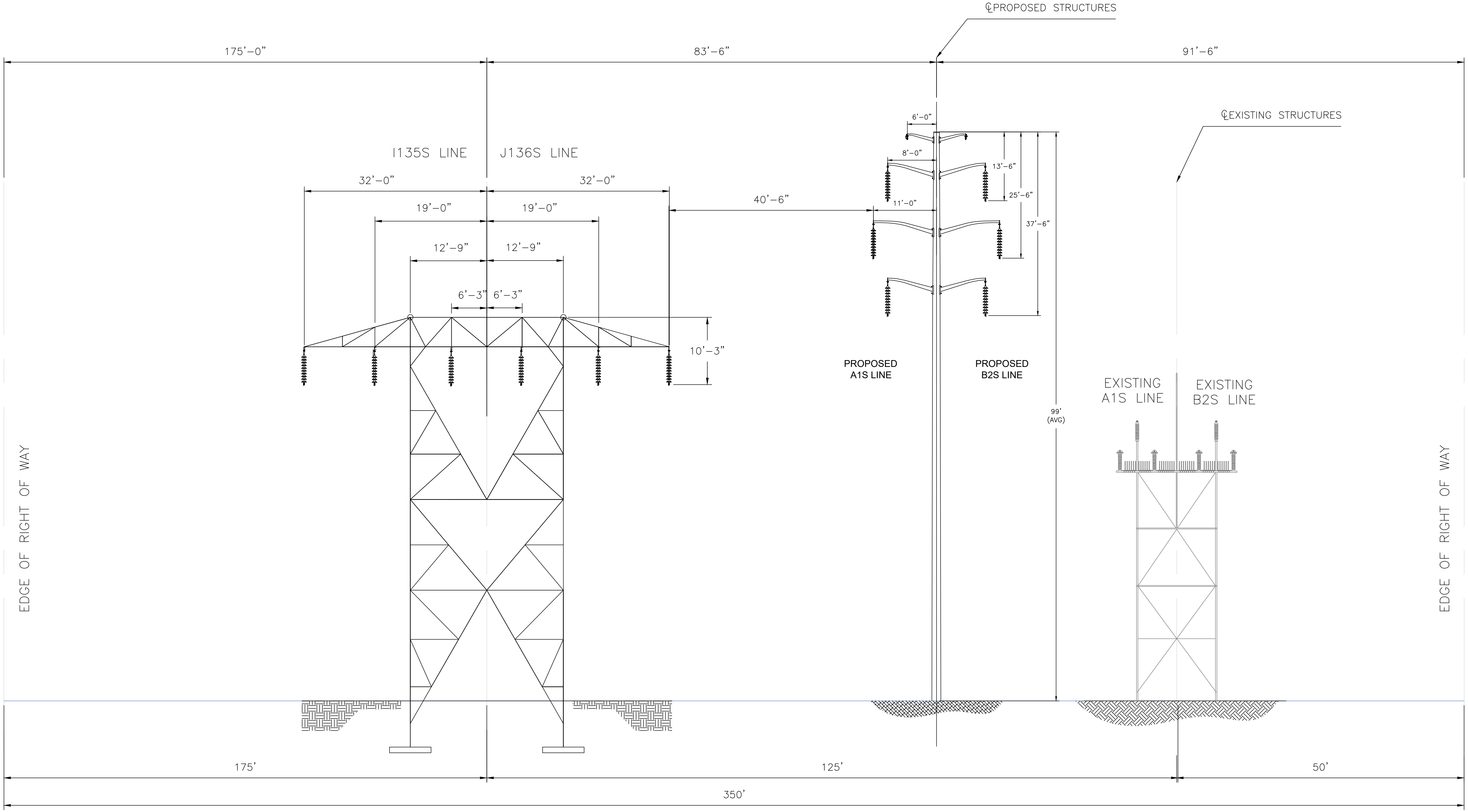
INCHES ON ORIGINAL



A1/B2 PROPOSED DOUBLE CIRCUIT DAVIT ARM STRUCTURES
CROSS-SECTION FACING PRATTS JUNCTION SUBSTATION
EXISTING STRUCTURE 561 TO EXISTING STRUCTURE 642
COMMONWEALTH OF MASSACHUSETTS

VERSION 1

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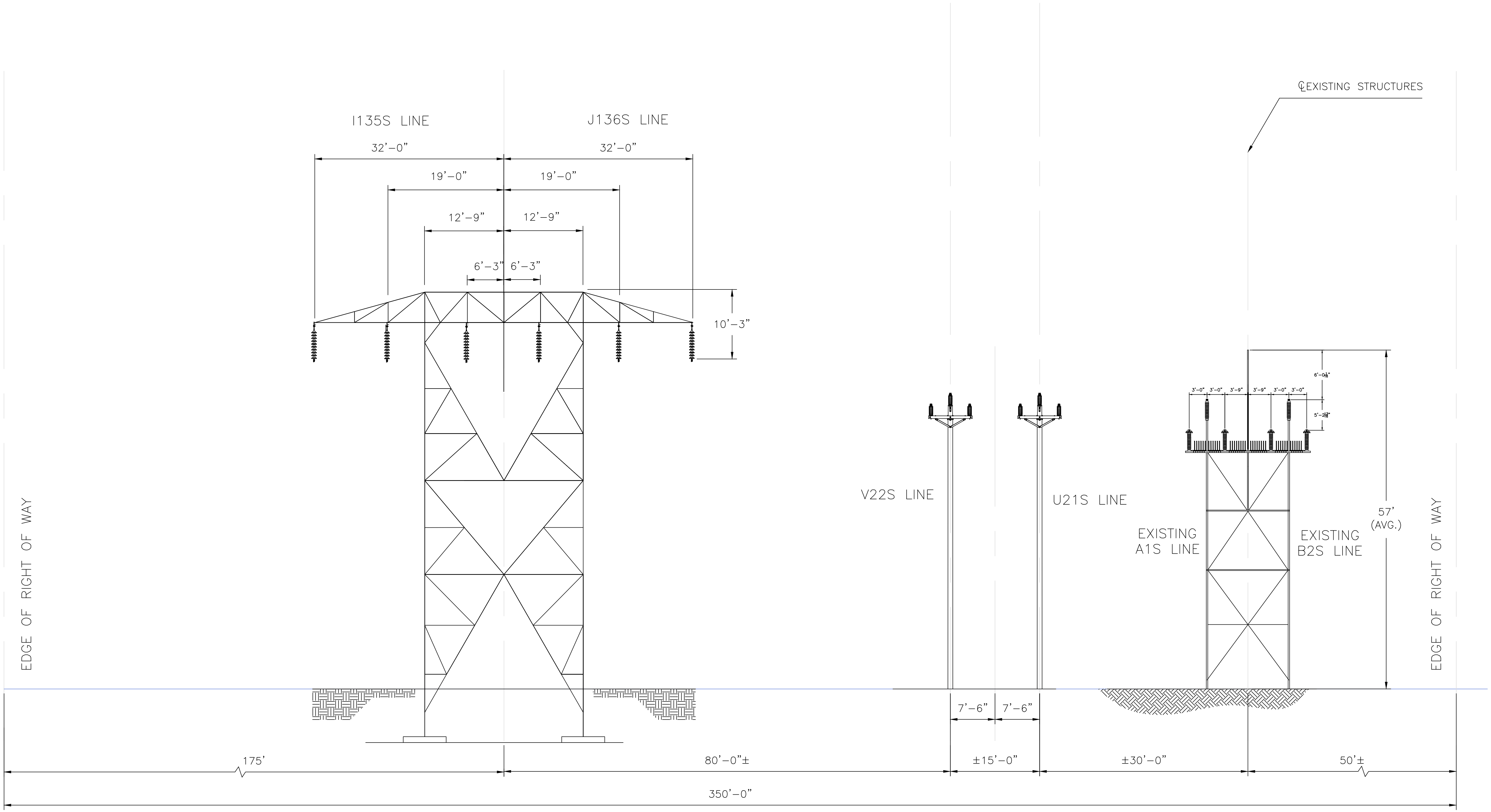
CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION)
PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION - PROPOSED
PROPOSED DOUBLE CIRCUIT STRUCTURES

INCHES ON ORIGINAL



A1/B2 EXISTING DOUBLE CIRCUIT LATTICE TOWER STRUCTURES
CROSS-SECTION FACING PRATTS JUNCTION SUBSTATION
EXISTING STRUCTURE 642 TO EXISTING STRUCTURE 647
COMMONWEALTH OF MASSACHUSETTS

CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION) PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION - EXISTING PROPOSED DOUBLE CIRCUIT STRUCTURES

PREPARED BY	JTF 4/23
REVIEWED BY	TBD 4/23
APPROVED BY	JTF 4/23
SCALE	AS NOTED
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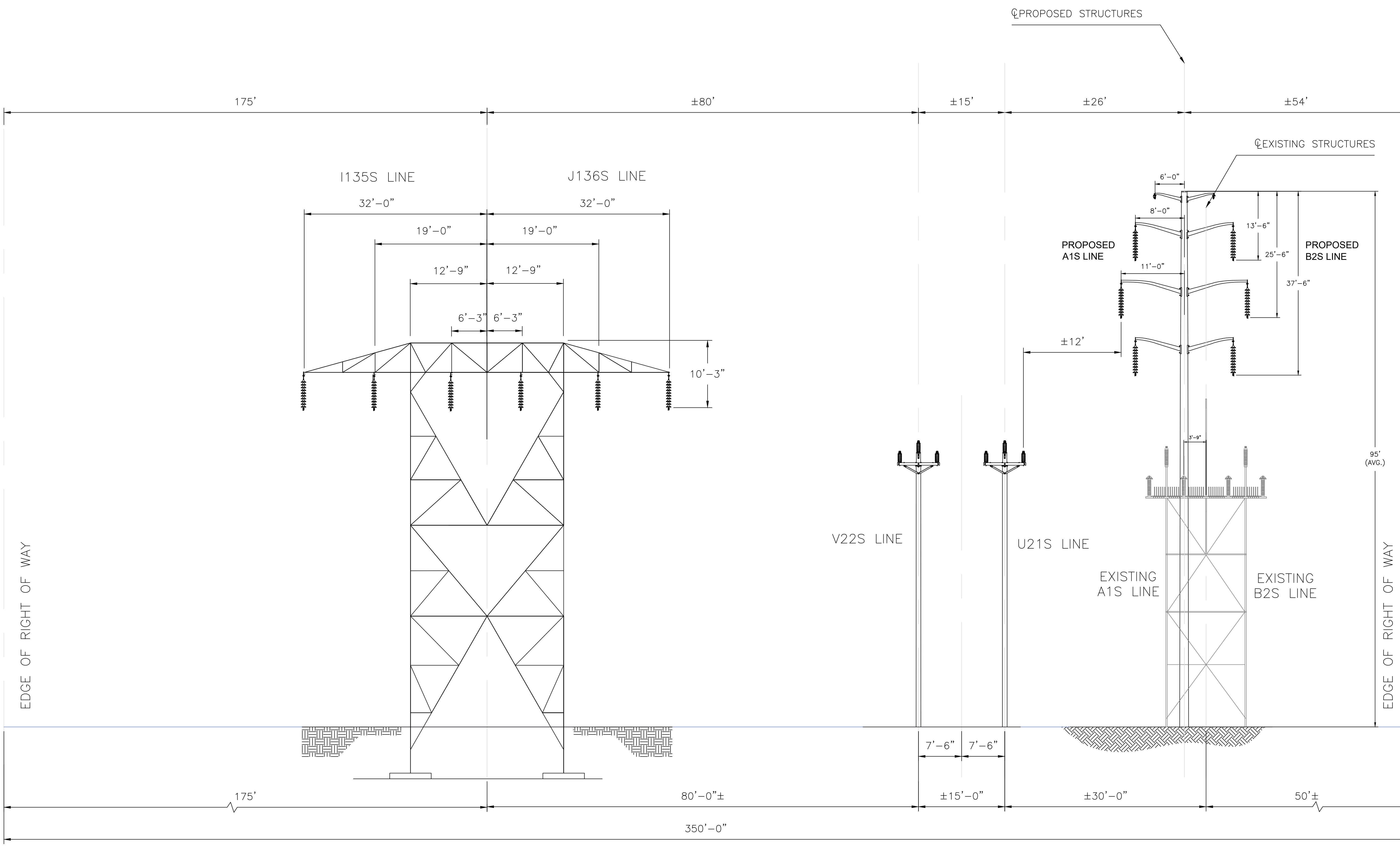

A1/B2 PROPOSED DOUBLE CIRCUIT DAVIT ARM STRUCTURES
CROSS-SECTION FACING PRATTS JUNCTION SUBSTATION
EXISTING STRUCTURE 642 TO EXISTING STRUCTURE 647
COMMONWEALTH OF MASSACHUSETTS

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CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION)
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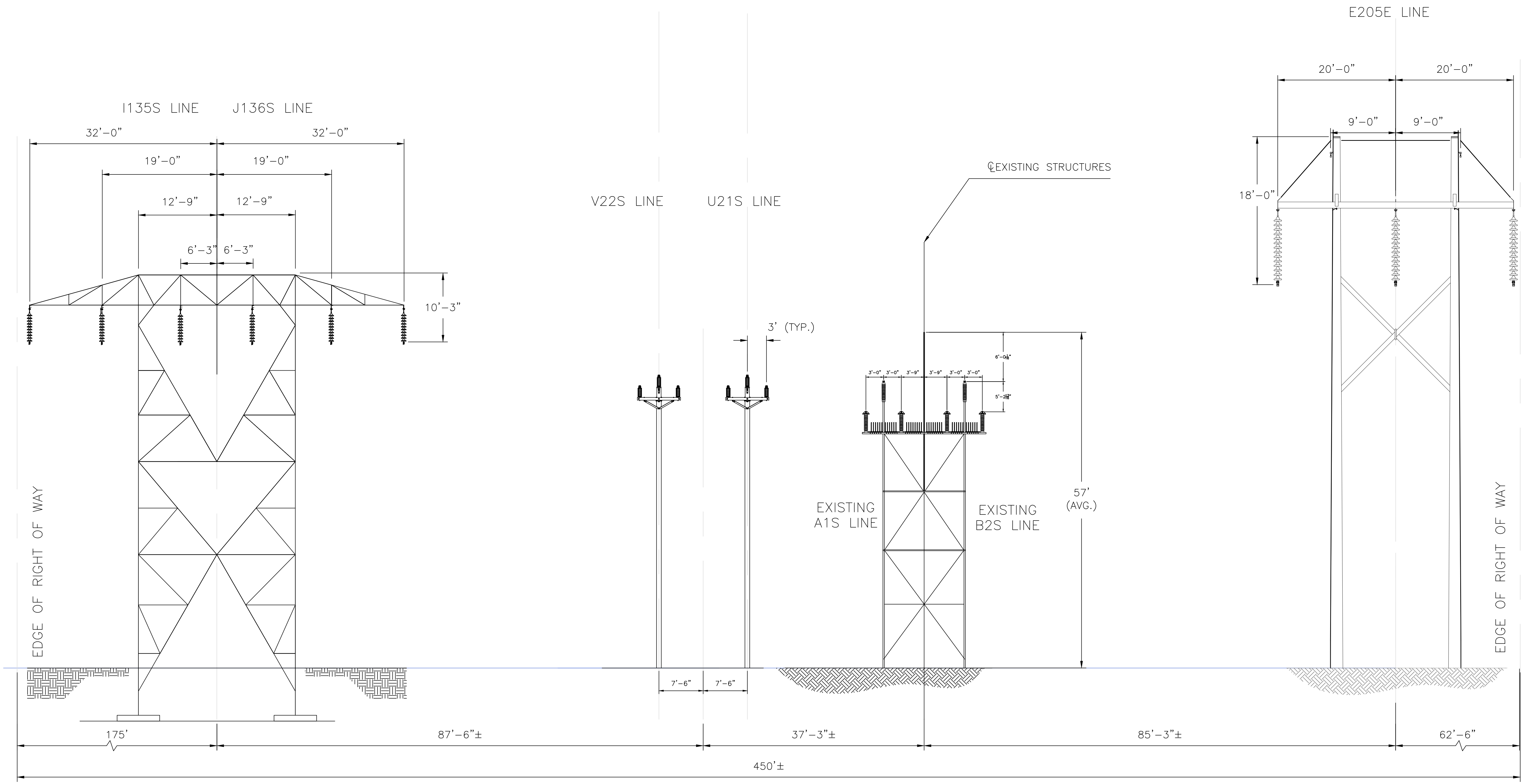
FACING PRATTS JUNCTION - PROPOSED
PROPOSED DOUBLE CIRCUIT STRUCTURES

INCHES ON ORIGINAL



A1/B2 EXISTING DOUBLE CIRCUIT LATTICE TOWER STRUCTURES
CROSS-SECTION FACING PRATTS JUNCTION SUBSTATION
EXISTING STRUCTURE 648 TO EXISTING STRUCTURE 653
COMMONWEALTH OF MASSACHUSETTS

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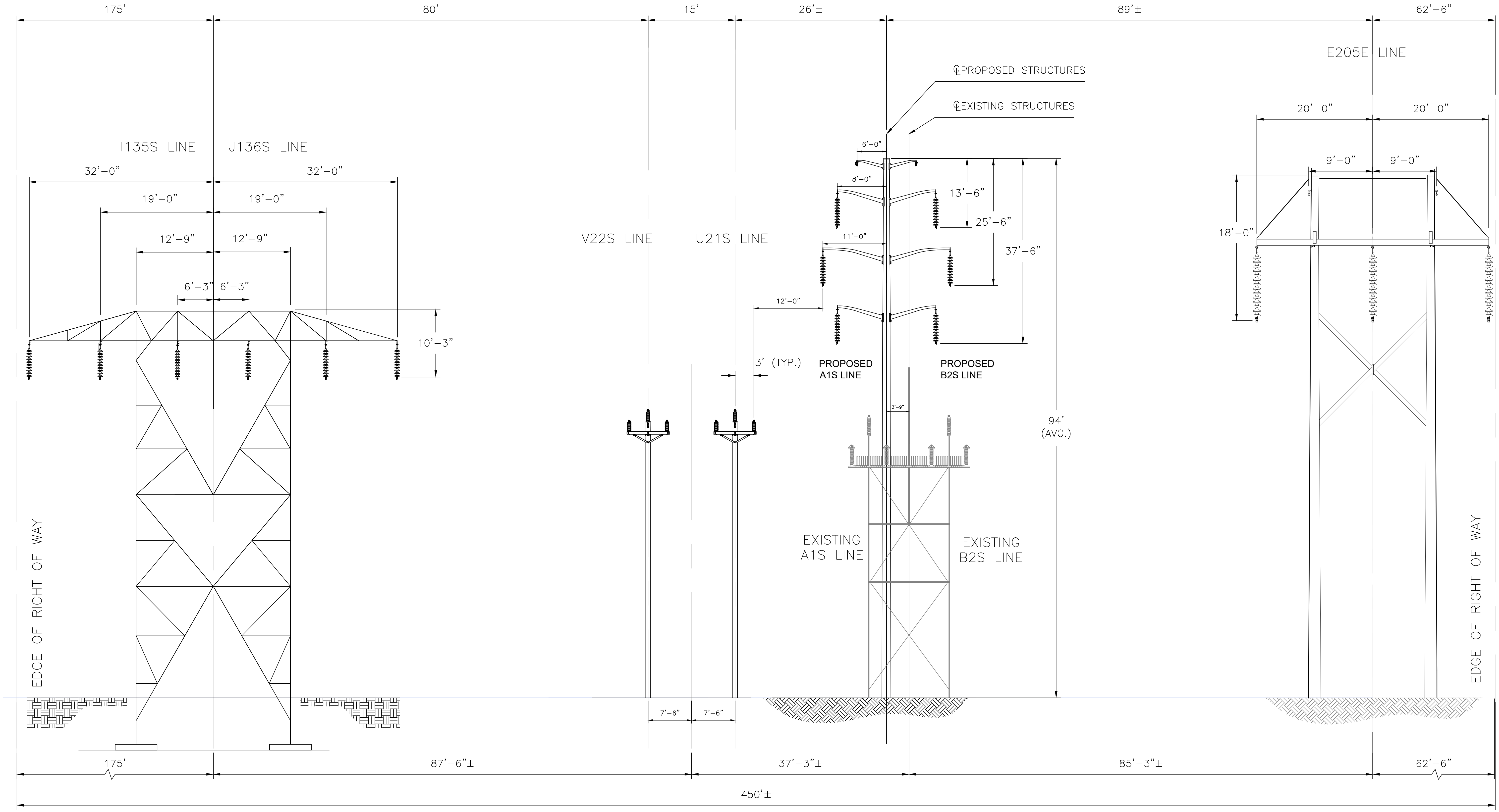
PROJECT (A1/B2 REBUILD PROJECT)
FACING TOWARD PRATTS JUNCTION - EXISTING
PROPOSED DOUBLE CIRCUIT STRUCTURES



A1/B2 PROPOSED DOUBLE CIRCUIT DAVIT ARM STRUCTURES
CROSS-SECTION FACING PRATTS JUNCTION SUBSTATION
EXISTING STRUCTURE 648 TO EXISTING STRUCTURE 653
COMMONWEALTH OF MASSACHUSETTS

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PROPOSED DOUBLE CIRCUIT STRUCTURES

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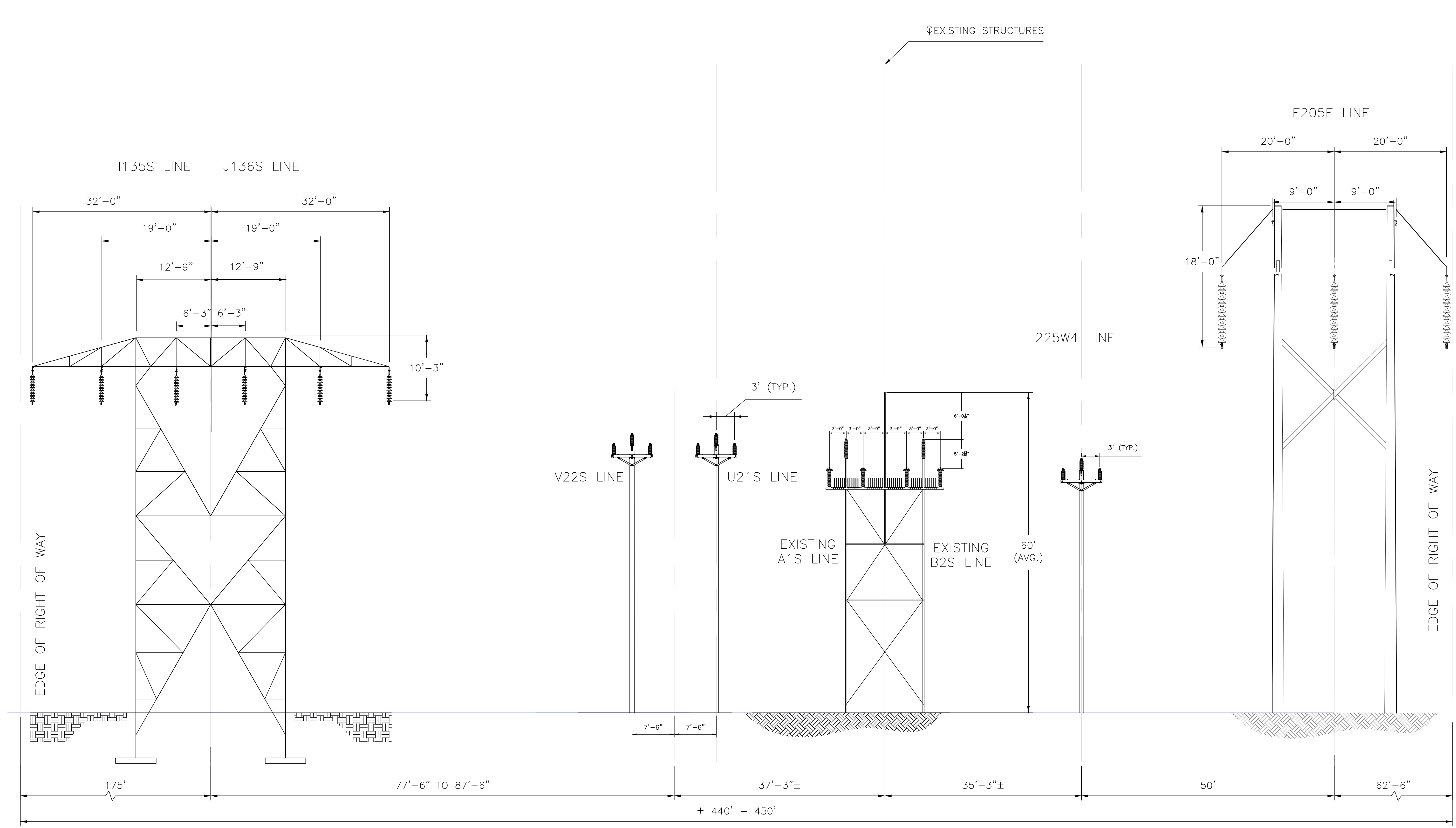

EXISTING A1/B2 DOUBLE CIRCUIT LATTICE TOWER STRUCTURES
CROSS-SECTION FACING PRATTS JUNCTION SUBSTATION
EXISTING STRUCTURE 654 TO PRATTS JUNCTION SUBSTATION
COMMONWEALTH OF MASSACHUSETTS

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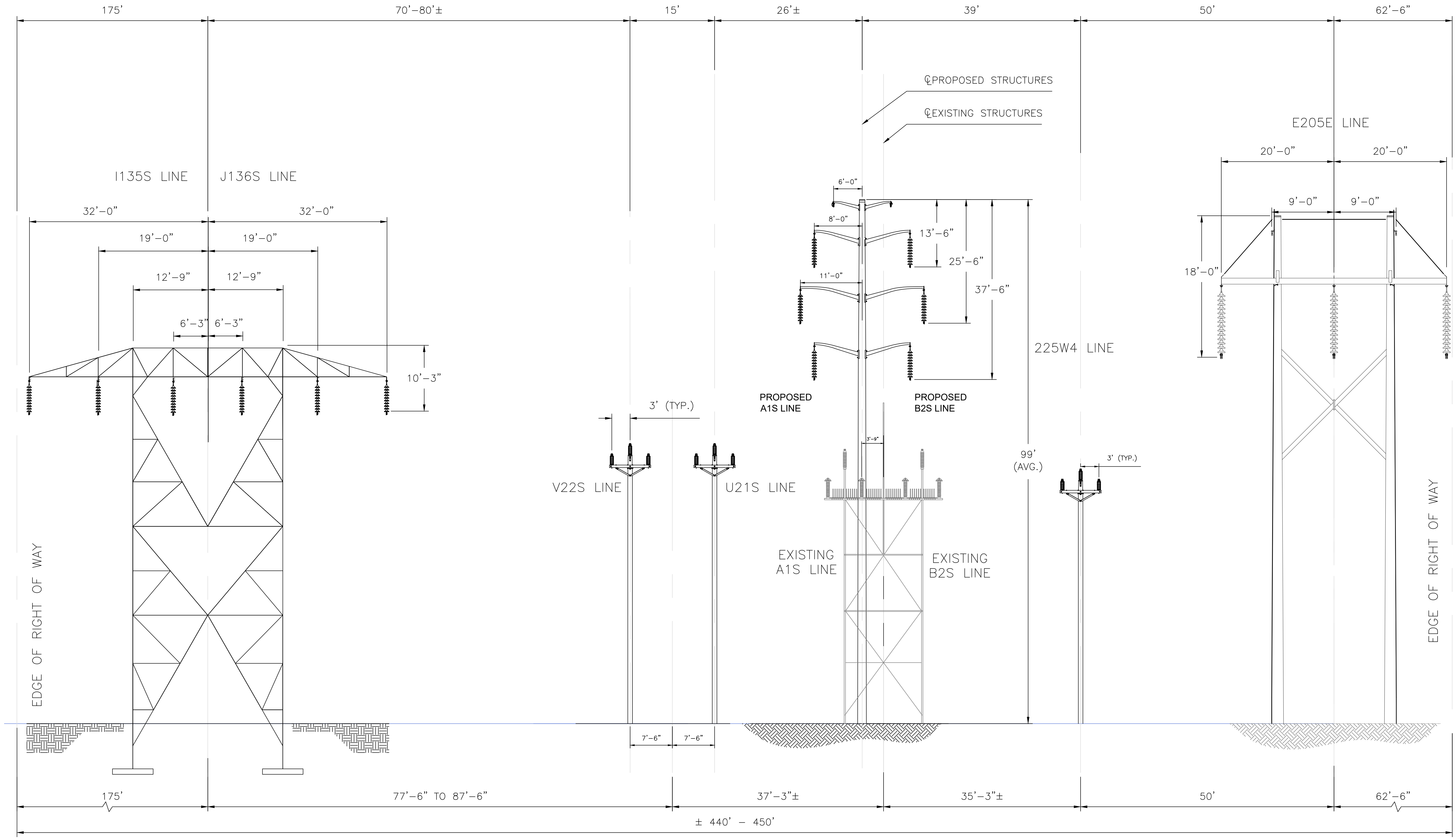

PROPOSED A1/B2 DOUBLE CIRCUIT DAVIT ARM STRUCTURES
CROSS-SECTION FACING PRATTS JUNCTION SUBSTATION
EXISTING STRUCTURE 654 TO PRATTS JUNCTION SUBSTATION
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CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION) PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION - PROPOSED
PROPOSED DOUBLE CIRCUIT STRUCTURES

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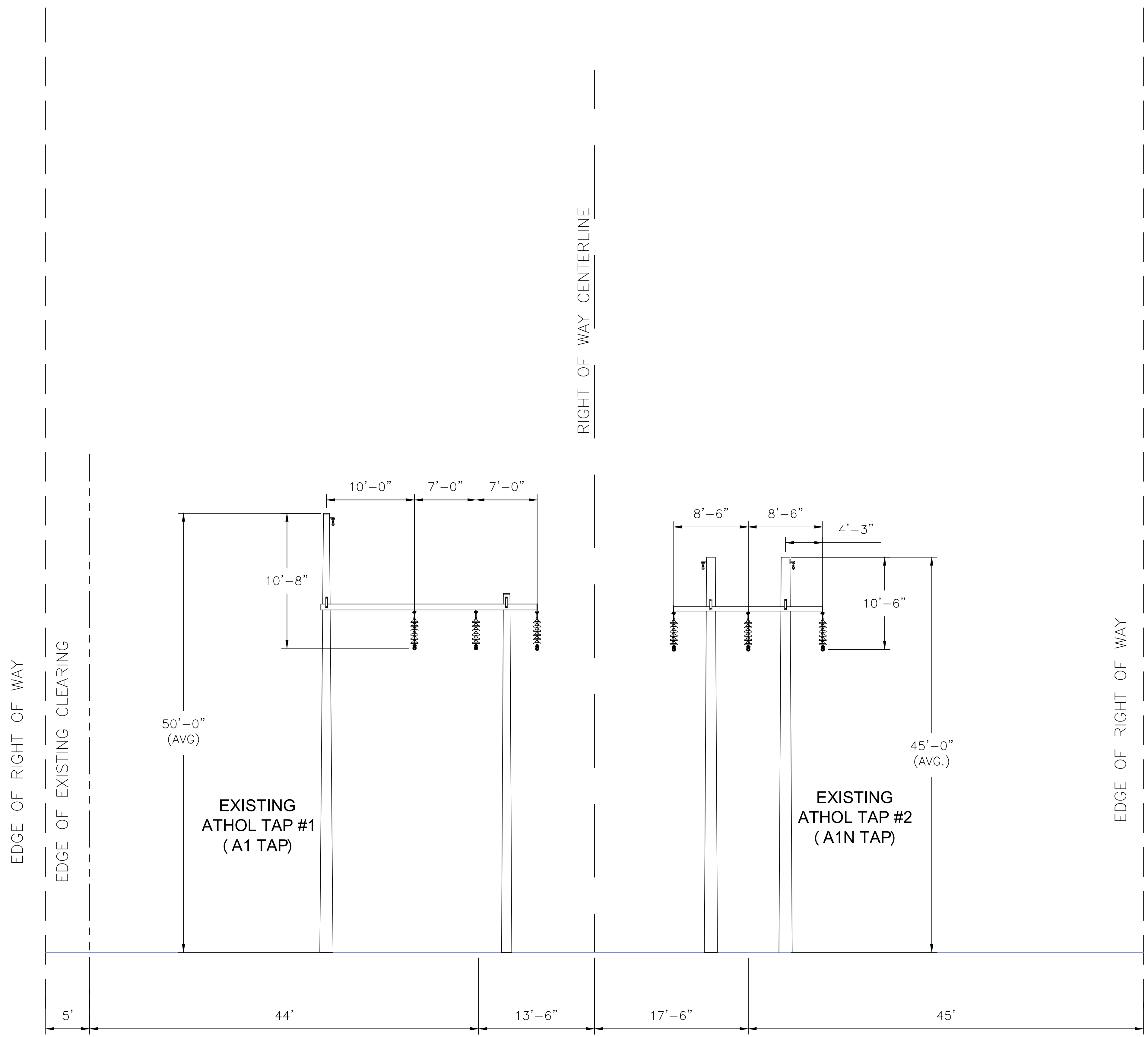

EXISTING SINGLE CIRCUIT WOOD POLARM & H-FRAME STRUCTURES
LOOKING TOWARDS CHESTNUT HILL STATION
ROYALSTON TO STRUCTURES 72 (TAP 2) & 71 (TAP 1)
STATE OF MASSACHUSETTS

INCHES ON ORIGINAL

CROSS-SECTION
ROW (A1/B2 TAP TO CHESTNUT HILL) PROJECT (A1/B2 REBUILD PROJECT) FACING CHESTNUT HILL STATION – EXISTING DELTA DAVIT ARM STRUCTURES

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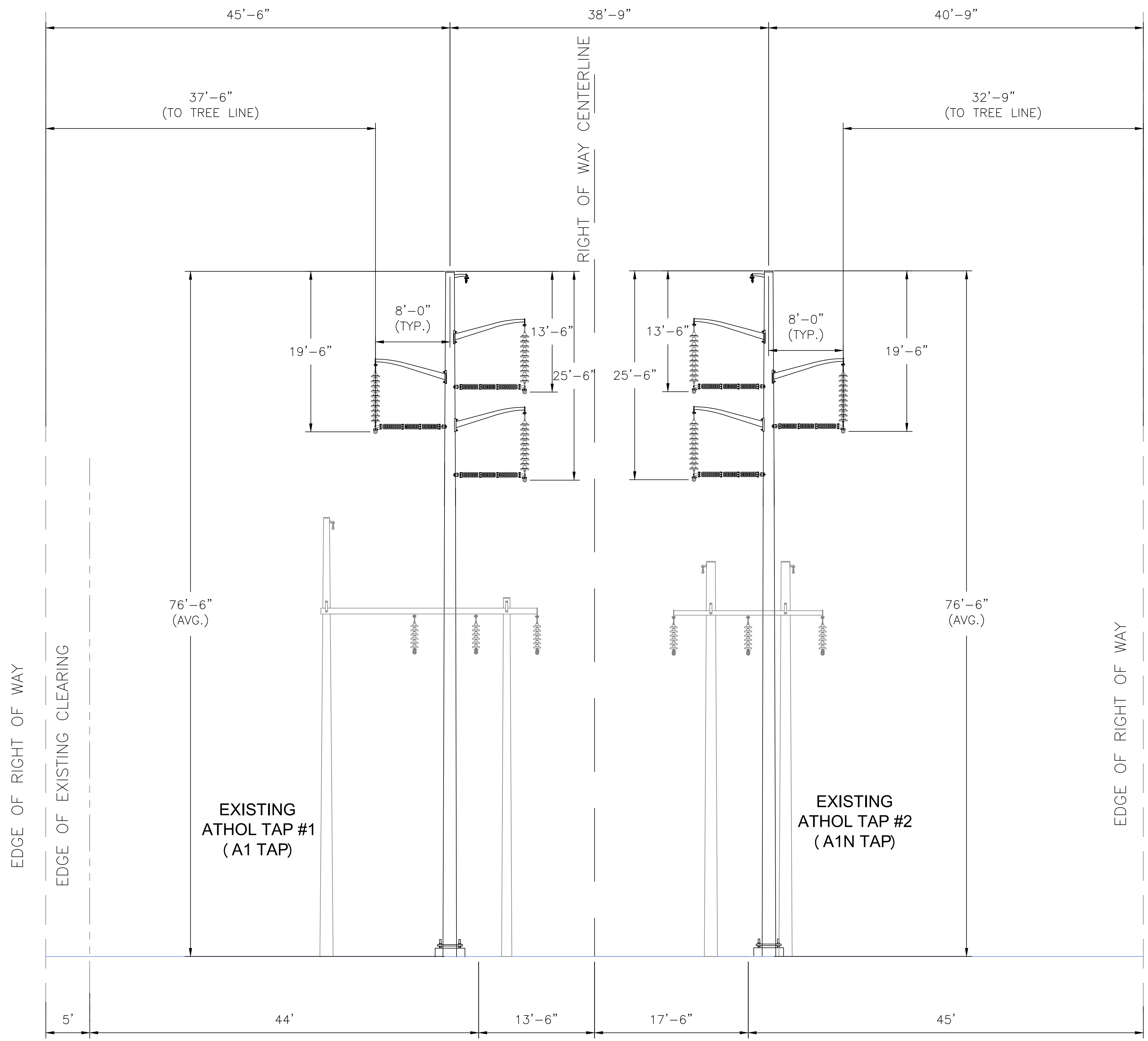

PROPOSED SINGLE CIRCUIT DELTA DAVIT ARM STRUCTURES
LOOKING TOWARDS CHESTNUT HILL STATION
ROYALSTON TO STRUCTURES 72 (TAP 2) & 71 (TAP 1)
STATE OF MASSACHUSETTS

CROSS-SECTION
ROW (A1/B2 TAP TO CHESTNUT HILL) PROJECT (A1/B2 REBUILD PROJECT) FACING CHESTNUT HILL STATION – PROPOSED VERTICAL DAVIT ARM STRUCTURES

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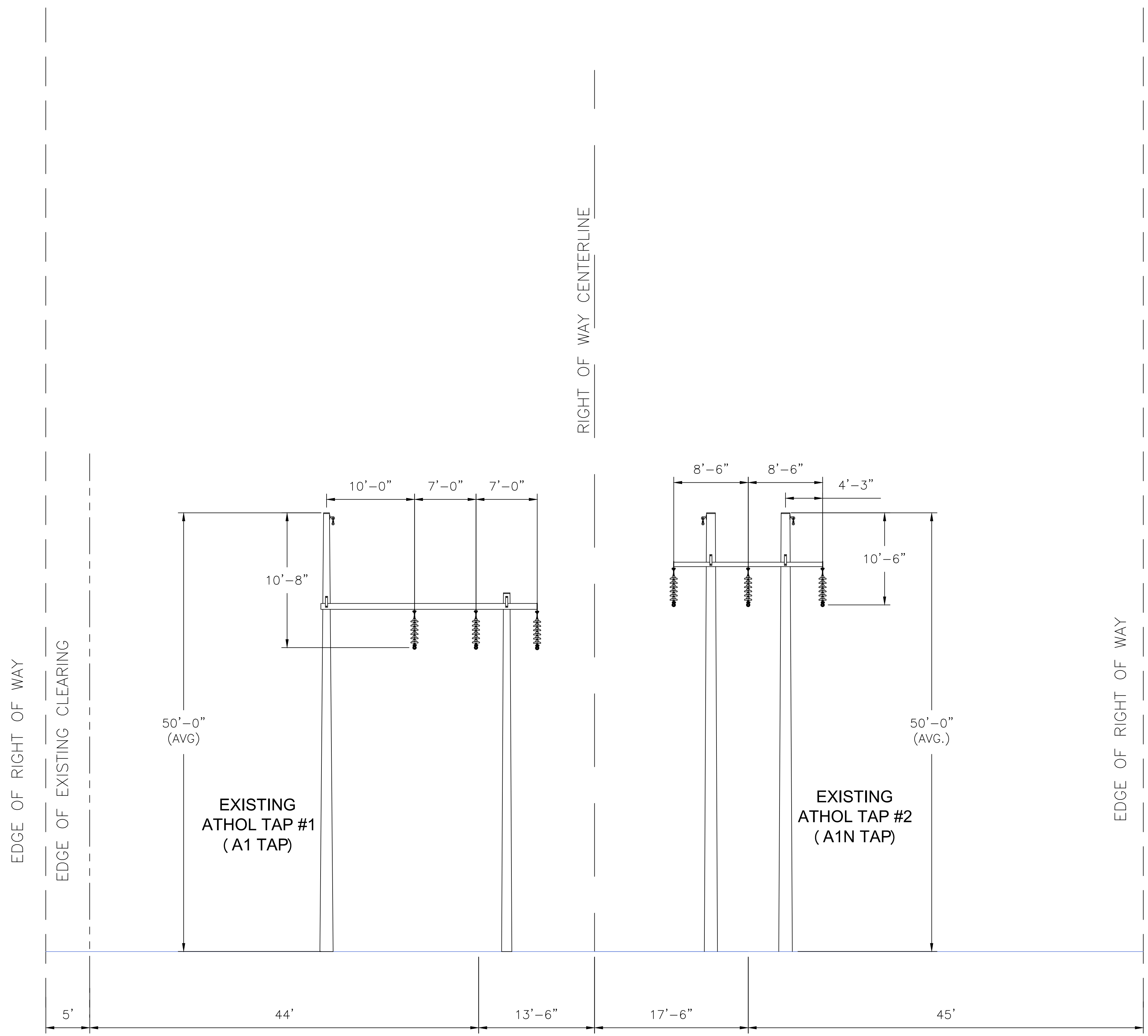

EXISTING SINGLE CIRCUIT WOOD POLARM & H-FRAME STRUCTURES
LOOKING TOWARDS CHESTNUT HILL STATION
STRUCTURES 72 (TAP 2) & 71 (TAP 1) TO CHESTNUT HILL SUBSTATION
STATE OF MASSACHUSETTS

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PROJECT (A1/B2 REBUILD PROJECT)
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DOUBLE CIRCUIT DAVIT ARM STRUCTURES

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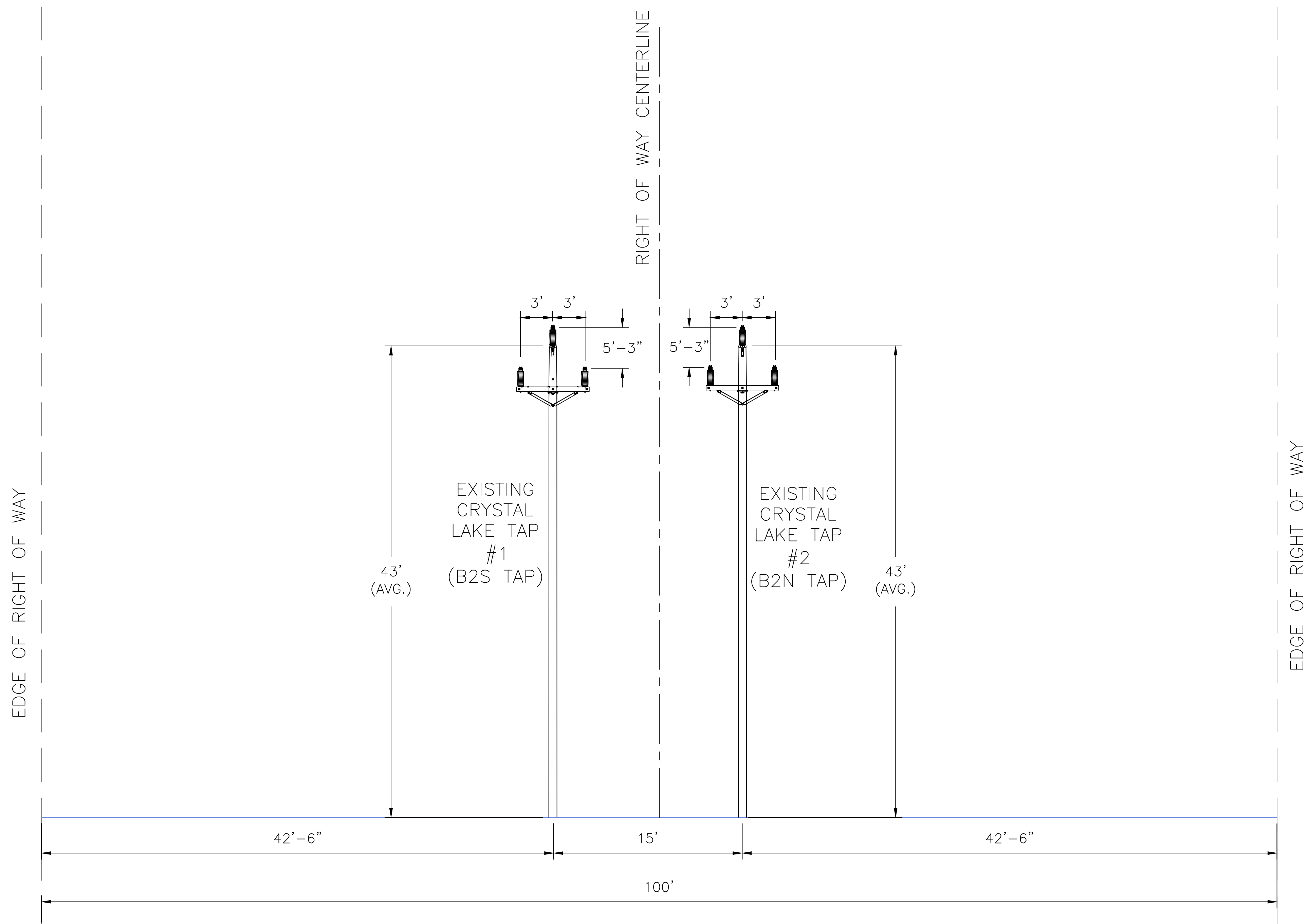

EXISTING WOOD POLE 6' TRIANGULAR STRUCTURES
LOOKING TOWARD CRYSTAL LAKE STATION
TYPICAL
STATE OF MASSACHUSETTS

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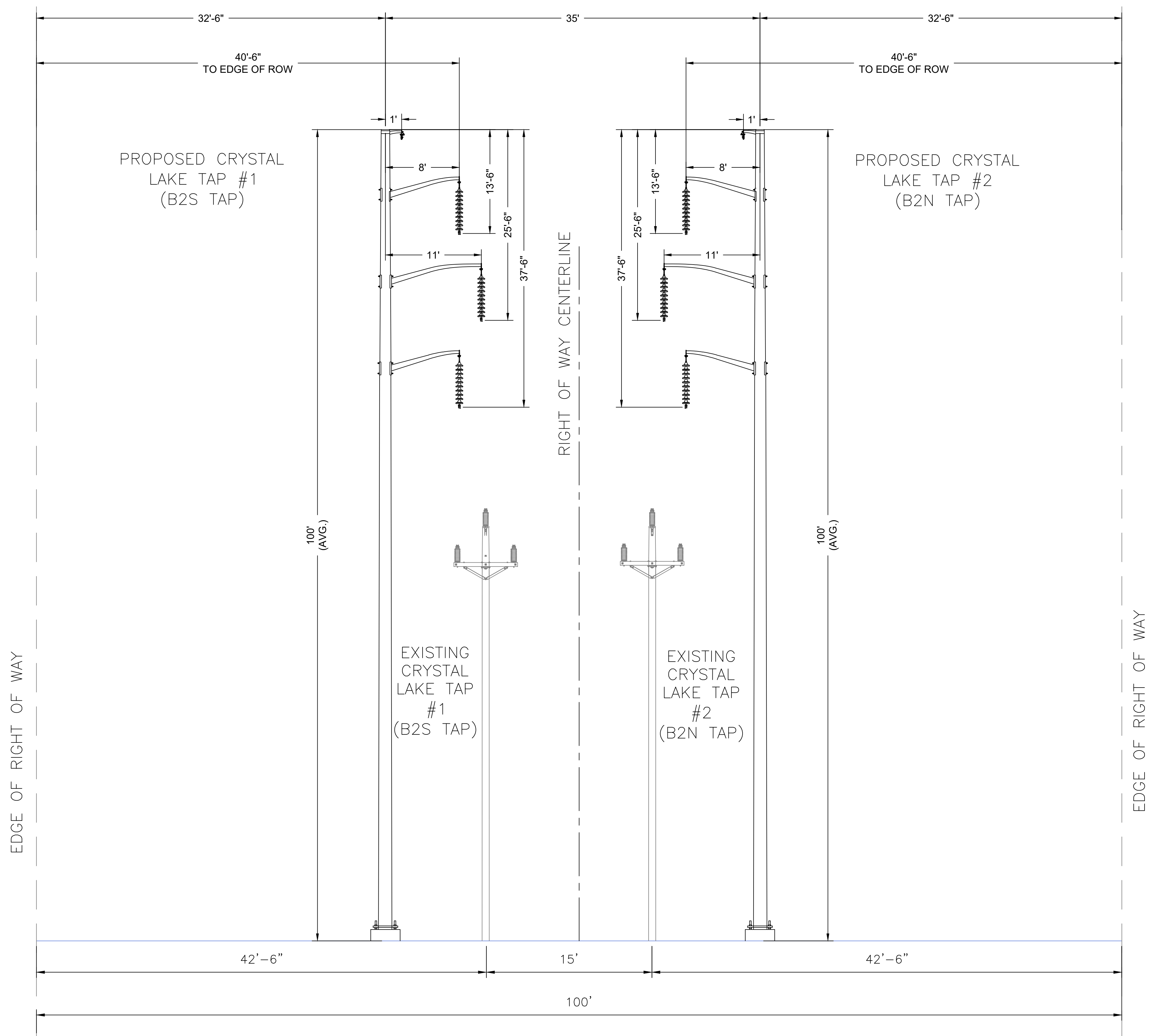
CROSS-SECTION
ROW (A1/B2 TAP TO CRYSTAL LAKE STATION) PROJECT (A1/B2 REBUILD PROJECT)
FACING CRYSTAL LAKE STATION – EXISTING
SINGLE CIRCUIT VERTICAL DAVIT ARM STRUCTURES



PROPOSED SINGLE CIRCUIT VERTICAL DAVIT ARM STRUCTURES
LOOKING TOWARD CRYSTAL LAKE STATION
TYPICAL
STATE OF MASSACHUSETTS

CROSS-SECTION
ROW (A1/B2 TAP TO CRYSTAL LAKE STATION) PROJECT (A1/B2 REBUILD PROJECT) FACING CRYSTAL LAKE STATION – PROPOSED SINGLE CIRCUIT VERTICAL DAVIT ARM STRUCTURES

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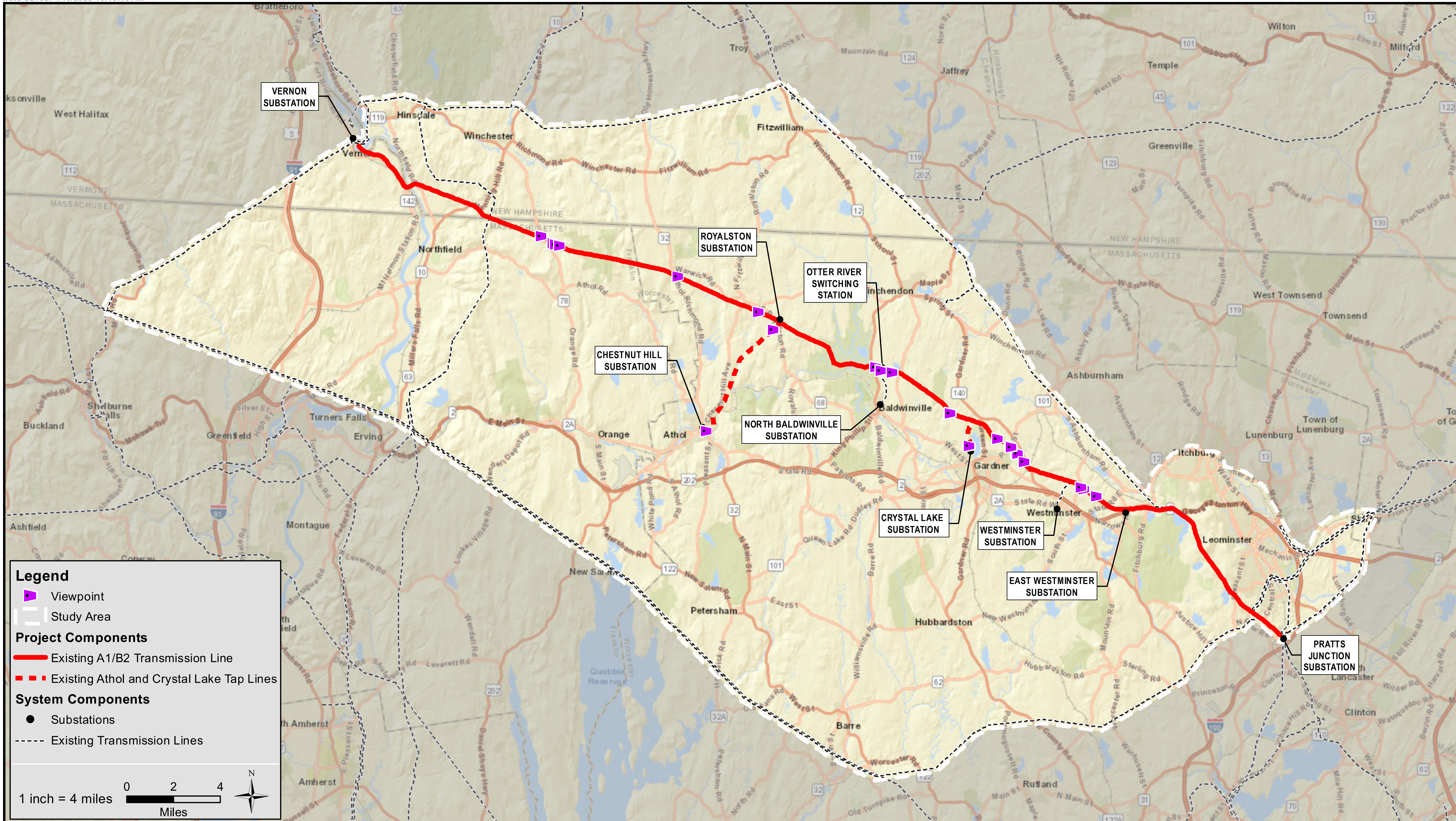

A1/B2 Asset Condition Refurbishment Project

nationalgrid

BSC GROUP

Visual Simulation - Viewpoint Location Map

A1/B2 Lines

Visual Simulations – Public Access, MA

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Winchester Rd, Warwick, MA: View 129, Existing

Winchester Rd, Warwick, MA: View 129 , Proposed

Old Winchester Rd, Warwick, MA: View 142, Existing

Old Winchester Rd, Warwick, MA: View 142 , Proposed

Athol-Richmond Rd, Royalston, MA : View 217, Existing

Athol-Richmond Rd, Royalston, MA : View 217 , Proposed


Millyard Rd, Royalston, MA: View 270, Existing


Millyard Rd, Royalston, MA: View 270, Proposed

Leo Drive, Gardner, MA: View 406, Existing

Leo Drive, Gardner, MA: View 406, Proposed

Robert Dr, Gardner, MA: View 451, Existing

Robert Dr, Gardner, MA: View 451, Proposed


Pearl St, Gardner, MA: View 453, Existing


Pearl St, Gardner, MA: View 453, Proposed


Chapel St, Gardner, MA: View 465, Existing


Chapel St, Gardner, MA: View 465, Proposed

Common Rd, Westminster, MA: View 502, Existing

Common Rd, Westminster, MA: View 502, Proposed

A1/B2 Lines
Visual Simulations – Properties without Public Access, MA


Bathrick, Westminster, MA: View 513, Existing


Bathrick, Westminster, MA: View 513, Proposed


Robbins Rd, Warwick, MA: View 137, Existing


Robbins Rd, Warwick, MA: View 137, Proposed

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A1B2 / Visual Simulations / Existing and Proposed Structures

Main Line

Mill Glen Road, Winchendon, MA: View 349, Existing

Mill Glen Road, Winchendon, MA: View 349 , Proposed

Mill Glen Road, Winchendon, MA: View 353, Existing

Site Location: View 353, Proposed Condition

Mill Glen Road, Winchendon, MA : View 362, Existing

Mill Glen Road, Winchendon, MA : View 362 , Proposed


Matthews St, Gardner, MA: View 129, Existing

Smith St, Gardner, MA: View 458, Existing

Smith St, Gardner, MA: View 458, Proposed


Town Farm Rd, Westminster, MA: View 504, Existing


Town Farm Rd, Westminster, MA: View 504 , Proposed


Park St, Gardner, MA : Crystal Lake-22, Existing


Park St, Gardner, MA : Crystal Lake-22, Proposed

4 STOCKWELL RD., ROYALSTON, MA: Athol Tap Lines 7, Existing

4 STOCKWELL RD., ROYALSTON, MA: Athol Tap Lines 7, Proposed

1128 MAIN ST, ATHOL, MA: Athol Tap Lines 97, Existing

1128 MAIN ST, ATHOL, MA: Athol Tap Lines 97, Proposed

Electric and Magnetic Field Modeling Analysis for the National Grid Line A1 and B2 Asset Condition Refurbishment Project: Massachusetts Route Portion

Prepared for

National Grid
40 Sylvan Road
Waltham, MA 02451

April 11, 2023

GRADIENT

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Abbreviations

A	Ampere
AC	Alternating Current
ACR	Asset Condition Replacement
BPA	Bonneville Power Administration
DC	Direct Current
EF	Electric Field
EMF	Electric and Magnetic Field
Hz	Hertz
ICNIRP	International Commission on Non-Ionizing Radiation Protection
kV	Kilovolt
kV/m	Kilovolts Per Meter
MA EFSB	Massachusetts Energy Facilities Siting Board
MF	Magnetic Field
mG	Milligauss
MRI	Magnetic Resonance Imaging
µT	Microtesla
MVA	Megavolt-Ampere
MW	Megawatt
ROW	Right-of-Way
STR	Structure
US	United States
WHO	World Health Organization

1 Introduction and Summary

National Grid requested that Gradient perform an independent assessment of the electric and magnetic field (EMF) levels associated with the proposed A1 and B2 Line Asset Condition Replacement (ACR) Project. This Project involves replacing the existing 69-kilovolt (kV) overhead A1 and B2 double circuit lines and support structures between the Vernon No. 13 Substation in Vernon, Vermont, and the Pratts Junction No. 225 Substation in Sterling, Massachusetts. The total Project route is approximately 61 miles in length (including tap lines to be refurbished), with approximately 2.5 miles in Vermont, 4.3 miles in New Hampshire, and 54.3 miles in Massachusetts. This report focuses on the portion of the Project route within the Commonwealth of Massachusetts.

Gradient is a Boston-based environmental and risk sciences consulting firm, nationally renowned for its specialties in toxicology, epidemiology, human health and ecological risk assessment, environmental/forensic chemistry, electric and magnetic field (EMF) assessment, contaminant fate and transport modeling, risk-based remedial alternatives assessment, and the application of database management and Geographic Information Systems (GIS) tools for addressing environmental contamination. For over 25 years, Gradient scientists have prepared EMF assessments in support of permitting for proposed overhead and underground transmission line projects, electrical substation projects, electrical generation facility projects, and renewable energy projects (*e.g.*, offshore wind, solar, battery storage). Gradient has provided EMF consulting services to regulatory agencies, electric utility companies, municipal utilities, and renewable energy companies. Gradient scientists have experience testifying at regulatory hearings and presenting on EMF at meetings with regulators, stakeholders, and the general public. Gradient scientists have published book chapters and journal articles on EMF-related topics, including the book chapter "Low-Frequency Magnetic Fields: Potential Environmental Health Impacts" in the 2nd edition of the *Encyclopedia of Environmental Health* (Volume 3).

For this EMF assessment, EMF modeling was conducted at a height of 1 meter (3.28 feet) above the ground surface for 26 representative right-of-way (ROW) cross sections in the Commonwealth of Massachusetts. We performed EMF modeling for the existing overhead circuit configuration in the ROW (referred to in the report as "pre-Project" case) and for two post-Project cases: (1) for the overhead circuit configuration after the A1 and B2 lines have been replaced and current loadings representative of the in-service year operating at 69-kV, and (2) for a second post-Project case with current loadings for the A1 and B2 lines representative of the in-service year operating at 115-kV. EMF modeling was conducted for both annual average and system peak load levels for each case.

As discussed in more detail in Section 2 of this report, a number of national and international organizations have developed EMF exposure guidelines or limits designed to protect humans against any adverse health effects. The limit values should not be viewed as demarcation lines between "safe" and "dangerous" levels of EMFs, but rather, levels that assure safety with adequate margins to allow for uncertainties in the science. For magnetic fields (MFs), these health-based guidelines range from about 1,000 to 10,000 milligauss (mG). The International Commission on Non-Ionizing Radiation Protection (ICNIRP) guideline for allowable public exposure to 60-hertz (Hz) MFs is 2,000 mG, while the ICNIRP guideline for allowable public exposure to 60-Hz electric fields (EFs) is 4.2 kilovolts per meter (kV/m) (ICNIRP, 2010).

Section 2 also describes EMF guidelines that have been adopted by various states in the United States (US), including by the Massachusetts Energy Facilities Siting Board (MA EFSB). These state guidelines are not health-effect based and have typically been adopted to maintain the *status quo* for EMF levels on and near transmission line ROWs.

As discussed in Section 3 of this report, all modeled EMF levels, both within the ROW and at the ROW edges, at the location of lowest conductor sag,[1] were well below the ICNIRP health-based guidelines. Tables 1.1 and 1.2 summarize the modeled pre-Project and post-Project MF results at the ROW edges for the annual average and system peak loading scenarios, respectively, for the 26 representative cross sections in Massachusetts. Although the Project will frequently result in increased edge-of-ROW MF levels, the increases are small (often <1 mG, and nearly all <5 mG and <10 mG for annual average and system peak loading scenarios, respectively); and all edge-of-ROW, post-Project MF values are less than 1% of the ICNIRP health-based guideline of 2,000 mG.

Table 1.3 shows that pre-Project and post-Project modeled EF values at the ROW edges are well below the ICNIRP health-based guideline of 4.2 kV/m for all modeled cases. Although electric fields are not dependent on conductor loading (*i.e.*, current), different sets of results were obtained for the annual average and system peak loading scenarios due to the differences in the midspan heights of the Project conductors at the location of lowest conductor sag that were modeled for the two loading scenarios. Our modeling analysis indicates that the Project will result in little change to EFs at the ROW edges (*i.e.*, all edge-of-ROW EF changes were <0.4 kV/m) for both sets of results.

[1] For the system peak loading scenario, conductor elevations at the location of lowest conductor sag were set at the lowest clearances permissible by governing code. Modeling at the location of lowest conductor sag is conservative because this is the location with the lowest clearance between the lines and the ground surface and is thus representative of the highest EMF levels that will be found beneath the lines.

Table 1.1 Summary of Modeled Pre-Project and Post-Project Edge-of-ROW Magnetic Fields for the Representative ROW Cross Sections for Annual Average Loading Scenarios

Line Segment	Cross Section	Magnetic Field (mG)					
		Northern Edge-of-ROW			Southern Edge-of-ROW		
		Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)	Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)
Vernon – Royalston	B-15191-NE Sh. 1	3.18	6.71	4.31	3.28	5.88	3.79
	B-15191-NE Sh. 2	3.18	7.52	4.85	3.28	6.47	4.19
	B-15191-NE Sh. 3	1.62	7.91	5.11	1.81	6.80	4.40
Royalston – Otter River	B-15191-NE Sh. 4	0.65	1.11	0.68	1.67	2.07	1.54
	B-15191-NE Sh. 5	0.58	1.02	0.62	2.07	1.94	1.44
	B-15191-NE Sh. 6	0.58	5.26	3.39	2.07	4.88	3.21
	B-15191-NE Sh. 7	0.58	5.25	3.21	2.07	4.79	3.02
	B-15191-NE Sh. 8	0.65	6.26	3.82	1.67	5.58	3.53
Otter River – Gardner	B-15191-NE Sh. 9	0.73	1.69	1.33	1.77	3.30	2.31
	B-15191-NE Sh. 10	1.84	1.62	1.27	2.44	2.99	2.09
	B-15191-NE Sh. 11	1.84	4.89	2.97	2.44	4.88	3.08
	B-15191-NE Sh. 12	1.84	4.02	2.52	2.44	4.19	2.73
Gardner – Westminster	B-15191-NE Sh. 13	0.82	1.28	0.57	0.93	0.64	0.19
Westminster – East Westminster	B-15191-NE Sh. 13	0.41	2.60	1.35	0.86	2.19	1.01
	B-15191-NE Sh. 14	0.41	0.93	1.06	0.86	0.85	0.72
East Westminster – Pratts Junction	B-15191-NE Sh. 14	0.97	2.29	0.50	1.35	2.94	0.83
	B-15191-NE Sh. 15	0.84	0.86	0.88	1.22	1.63	1.10
	B-15191-NE Sh. 16	0.84	0.93	0.89	1.22	2.47	1.30
	B-15191-NE Sh. 17	0.89	0.92	0.88	2.87	2.39	1.26
	B-15191-NE Sh. 18	1.05	1.12	1.03	4.05	5.45	2.95
	B-15191-NE Sh. 19	1.24	1.30	1.22	7.69	7.45	7.26
	B-15191-NE Sh. 20	1.26	1.31	1.23	7.89	7.69	7.46
	B-15191-NE Sh. 21	1.28	1.35	1.26	7.26	6.89	6.80
Royalston – Chestnut Hill	B-15192-NE Sh. 1	0.66	1.11	0.67	4.76	0.89	0.50
	B-15192-NE Sh. 2	0.66	0.60	0.37	4.76	0.41	0.24
Gardner – Crystal Lake	B-15193-NE Sh. 1	0.93	3.95	2.61	1.91	5.07	3.38

Notes:
kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way; Sh. = Sheet.

Table 1.2 Summary of Modeled Pre-Project and Post-Project Edge-of-ROW Magnetic Fields for the Representative ROW Cross Sections for System Peak Loading Scenarios

Line Segment	Cross Section	Magnetic Field (mG)					
		Northern Edge-of-ROW			Southern Edge-of-ROW		
		Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)	Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)
Vernon – Royalston	B-15191-NE Sh. 1	4.07	12.13	7.30	4.25	10.00	6.05
	B-15191-NE Sh. 2	4.07	13.45	8.13	4.25	10.83	6.58
	B-15191-NE Sh. 3	2.24	13.45	8.13	2.54	10.83	6.58
Royalston – Otter River	B-15191-NE Sh. 4	1.18	1.94	1.05	2.39	3.98	2.59
	B-15191-NE Sh. 5	1.11	1.94	1.05	2.91	3.98	2.59
	B-15191-NE Sh. 6	1.11	8.96	5.65	2.91	8.26	5.23
	B-15191-NE Sh. 7	1.11	9.65	5.31	2.91	8.56	4.87
	B-15191-NE Sh. 8	1.18	9.65	5.31	2.39	8.56	4.87
Otter River – Gardner	B-15191-NE Sh. 9	1.10	2.67	2.04	2.45	5.41	3.49
	B-15191-NE Sh. 10	2.24	1.62	1.27	3.13	2.99	2.09
	B-15191-NE Sh. 11	2.24	4.89	2.97	3.13	4.88	3.08
	B-15191-NE Sh. 12	2.24	4.02	2.52	3.13	4.19	2.73
Gardner – Westminster	B-15191-NE Sh. 13	0.68	2.40	1.06	0.43	1.04	0.25
Westminster – East Westminster	B-15191-NE Sh. 13	0.13	4.47	2.20	0.73	3.80	1.80
	B-15191-NE Sh. 14	0.13	0.97	0.57	0.73	1.51	0.58
East Westminster – Pratts Junction	B-15191-NE Sh. 14	0.74	2.95	1.50	1.20	3.98	1.97
	B-15191-NE Sh. 15	0.63	0.64	0.65	1.15	1.77	1.20
	B-15191-NE Sh. 16	0.63	0.70	0.68	1.15	2.35	1.30
	B-15191-NE Sh. 17	0.71	0.70	0.68	3.24	2.35	1.30
	B-15191-NE Sh. 18	0.92	0.90	0.88	5.15	6.41	4.08
	B-15191-NE Sh. 19	1.24	1.22	1.20	13.85	13.29	13.39
	B-15191-NE Sh. 20	1.24	1.22	1.20	13.85	13.29	13.39
	B-15191-NE Sh. 21	1.28	1.25	1.24	13.87	13.30	13.40
Royalston – Chestnut Hill	B-15192-NE Sh. 1	0.59	0.63	1.01	5.51	2.08	0.51
	B-15192-NE Sh. 2	0.59	0.29	0.62	5.51	1.20	0.24
Gardner – Crystal Lake	B-15193-NE Sh. 1	1.70	5.14	3.36	2.94	8.18	5.12

Notes:
kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way; Sh. = Sheet.

Table 1.3 Summary of Modeled Pre-Project and Post-Project Edge-of-ROW Electric Field Values for the Representative ROW Cross Sections

Line Segment	Cross Section	Loading Scenario	Electric Field (kV/m)					
			Northern Edge-of-ROW			Southern Edge-of-ROW		
			Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)	Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)
Vernon – Royalston	B-15191-NE Sh. 1	Ann. Avg.	0.13	0.14	0.23	0.12	0.09	0.15
		Sys. Pk.	0.12	0.08	0.14	0.13	0.05	0.09
	B-15191-NE Sh. 2	Ann. Avg.	0.13	0.16	0.27	0.12	0.10	0.17
		Sys. Pk.	0.12	0.10	0.17	0.13	0.08	0.13
	B-15191-NE Sh. 3	Ann. Avg.	0.08	0.15	0.26	0.07	0.09	0.16
		Sys. Pk.	0.08	0.10	0.17	0.08	0.08	0.13
Royalston – Otter River	B-15191-NE Sh. 4	Ann. Avg.	0.08	0.08	0.13	0.08	0.05	0.09
		Sys. Pk.	0.07	0.08	0.14	0.08	0.05	0.08
	B-15191-NE Sh. 5	Ann. Avg.	0.09	0.08	0.13	0.09	0.05	0.09
		Sys. Pk.	0.09	0.08	0.14	0.09	0.05	0.08
	B-15191-NE Sh. 6	Ann. Avg.	0.09	0.15	0.25	0.09	0.09	0.16
		Sys. Pk.	0.09	0.08	0.14	0.09	0.06	0.10
	B-15191-NE Sh. 7	Ann. Avg.	0.09	0.15	0.25	0.09	0.10	0.16
		Sys. Pk.	0.09	0.10	0.17	0.09	0.08	0.13
	B-15191-NE Sh. 8	Ann. Avg.	0.08	0.13	0.21	0.08	0.08	0.13
		Sys. Pk.	0.07	0.10	0.17	0.08	0.08	0.13
Otter River – Gardner	B-15191-NE Sh. 9	Ann. Avg.	0.10	0.09	0.14	0.10	0.05	0.09
		Sys. Pk.	0.10	0.08	0.13	0.10	0.05	0.07
	B-15191-NE Sh. 10	Ann. Avg.	0.13	0.09	0.14	0.13	0.05	0.09
		Sys. Pk.	0.13	0.08	0.13	0.13	0.05	0.07
	B-15191-NE Sh. 11	Ann. Avg.	0.13	0.15	0.24	0.13	0.09	0.15
		Sys. Pk.	0.13	0.15	0.24	0.13	0.09	0.15
	B-15191-NE Sh. 12	Ann. Avg.	0.13	0.13	0.22	0.13	0.08	0.14
		Sys. Pk.	0.13	0.13	0.22	0.13	0.08	0.14
Gardner – Westminster	B-15191-NE Sh. 13	Ann. Avg.	0.12	0.09	0.14	0.12	0.06	0.09
		Sys. Pk.	0.09	0.10	0.14	0.09	0.07	0.09
Westminster – East Westminster	B-15191-NE Sh. 13	Ann. Avg.	0.10	0.13	0.25	0.10	0.08	0.15
		Sys. Pk.	0.08	0.10	0.17	0.08	0.09	0.13
	B-15191-NE Sh. 14	Ann. Avg.	0.10	0.09	0.21	0.10	0.05	0.13
		Sys. Pk.	0.08	0.08	0.14	0.08	0.05	0.09
East Westminster – Pratts Junction	B-15191-NE Sh. 14	Ann. Avg.	0.12	0.10	0.15	0.12	0.06	0.09
		Sys. Pk.	0.10	0.07	0.13	0.10	0.04	0.07
	B-15191-NE Sh. 15	Ann. Avg.	0.04	0.03	0.03	0.10	0.02	0.02
		Sys. Pk.	0.03	0.03	0.03	0.11	0.03	0.05
	B-15191-NE Sh. 16	Ann. Avg.	0.04	0.05	0.05	0.10	0.05	0.08
		Sys. Pk.	0.03	0.03	0.03	0.11	0.06	0.09
	B-15191-NE Sh. 17	Ann. Avg.	0.04	0.05	0.06	0.15	0.04	0.07
		Sys. Pk.	0.03	0.03	0.03	0.14	0.06	0.09
	B-15191-NE Sh. 18	Ann. Avg.	0.04	0.05	0.05	0.15	0.13	0.20
		Sys. Pk.	0.03	0.03	0.03	0.16	0.08	0.13

Line Segment	Cross Section	Loading Scenario	Electric Field (kV/m)					
			Northern Edge-of-ROW			Southern Edge-of-ROW		
			Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)	Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)
East Westminster – Pratts Junction (continued)	B-15191-NE Sh. 19	Ann. Avg.	0.05	0.05	0.06	0.91	0.90	0.89
		Sys. Pk.	0.04	0.04	0.03	0.89	0.86	0.85
	B-15191-NE Sh. 20	Ann. Avg.	0.04	0.05	0.05	0.91	0.90	0.89
		Sys. Pk.	0.04	0.04	0.03	0.89	0.86	0.85
	B-15191-NE Sh. 21	Ann. Avg.	0.04	0.05	0.05	0.90	0.88	0.87
		Sys. Pk.	0.04	0.04	0.04	0.89	0.86	0.85
Royalston – Chestnut Hill	B-15192-NE Sh. 1	Ann. Avg.	0.09	0.25	0.42	0.18	0.25	0.43
		Sys. Pk.	0.08	0.26	0.44	0.18	0.31	0.53
	B-15192-NE Sh. 2	Ann. Avg.	0.09	0.03	0.05	0.18	0.04	0.07
		Sys. Pk.	0.08	0.04	0.06	0.18	0.04	0.07
Gardner – Crystal Lake	B-15193-NE Sh. 1	Ann. Avg.	0.07	0.11	0.19	0.07	0.12	0.20
		Sys. Pk.	0.15	0.04	0.06	0.15	0.04	0.06

Notes:
Ann. Avg. = Annual Average; kV = Kilovolt; kV/m = Kilovolts per Meter; ROW = Right-of-Way; Sh. = Sheet; Sys. Pk. = System Peak.

Section 2 of this report describes the nature of EMFs, provides values for EMF levels from common sources, and reports on EMF exposure guidelines. Section 3 outlines the EMF modeling procedures for calculating EMF strengths as a function of lateral distance from an electric transmission line (or distribution line) and provides tabular results for the modeled cross sections. Section 4 summarizes the conclusions, and the Reference list provides the references for published literature and exposure guidelines cited in this report. Appendix A provides cross section diagrams, showing both existing (pre-Project) and post-Project overhead conductor arrangements, for the representative cross sections in Massachusetts, while Appendices B and C provide graphical magnetic field and electric field profiles, respectively, for each modeled route segment and loading scenario. Appendix D provides a summary of the current status of scientific reports regarding potential health effects of power-frequency EMF exposures.

2 Nature of Electric and Magnetic Fields

All matter contains electrically charged particles. Most objects are electrically neutral because positive and negative charges are present in equal numbers. When the balance of electric charges is altered, we experience electrical effects. Common examples are the static electricity attraction between a comb and our hair or a static electricity spark after walking on a synthetic rug in the wintertime. Electrical effects occur both in nature and through our society's use of electric power (generation, transmission, and consumption).

2.1 Units for EMFs Are Kilovolts Per Meter (kV/m) and Milligauss (mG)

The electrical tension on utility power lines is expressed in volts or kilovolts (1 kV = 1,000 V). Voltage is the "pressure" of the electricity and can be envisioned as analogous to the pressure of water in a plumbing system. The existence of a voltage difference between power lines and ground results in an EF, usually expressed in units of kilovolts per meter (kV/m). The size of the EF depends on the line voltage, the separation distance between lines and ground, and other factors.

Power lines also carry an electric current that creates a MF. The units for electric current are amperes (A), which is a measure of the "flow" of electricity. Electric current is analogous to the flow of water in a plumbing system. The MF produced by an electric current is usually expressed in units of gauss (G) or milligauss (mG) (1 G = 1,000 mG).[2] The size of the MF depends on the electric current, the distance to the current-carrying conductor, and other factors.

2.2 There Are Many Natural and Man-made Sources of EMFs

Everyone experiences a variety of natural and man-made EMFs. EMF levels can be steady or slowly varying (often called direct current [DC] fields), or EMF levels can vary in time (often called alternating current [AC] fields). When the time variation corresponds to that of standard North American power line currents (*i.e.*, 60 cycles per second), the fields are called 60-Hz EMFs, or power-frequency EMFs.

Man-made MFs are common in everyday life. For example, many childhood toys contain magnets. Such permanent magnets generate strong, steady (DC) MFs. Typical toy magnets (*e.g.*, refrigerator door magnets) have fields of 100,000-500,000 mG. On a larger scale, Earth's core also creates a steady DC MF that can be easily demonstrated with a compass needle. The size of the Earth's MF in the northern US is about 550 mG (less than 1% of the levels generated by typical refrigerator door magnets).

2.3 Power-frequency EMFs Are Found Near Electric Lines and Appliances

In North America, electric power transmission lines, distribution lines, and electric wiring in buildings carry AC currents and voltages that change size and direction at a frequency of 60 Hz. These 60-Hz currents and voltages create 60-Hz EMFs nearby. The size of the MF is proportional to the line current, while the size of the EF is proportional to the line voltage. The EMFs associated with electrical wires and electrical equipment decrease rapidly with increasing distance away from the electrical wires. Specifically, EMFs

[2] Another unit for magnetic field (MF) levels is the microtesla (μT) (1 μT = 10 mG).

from three-phased, balanced conductors decrease in proportion to the square of the distance from the conductors (*i.e.*, $1/d^2$) (IEEE, 2014).

When EMF derives from different wires or conductors that are in close proximity, or adjacent to one another, the level of the net EMF produced will be somewhere in the range between the sum of EMF from the individual sources and the difference of the EMF from the individual sources. EMF may partially add, or partially cancel but, because adjacent wires are often carrying current in opposite directions, the EMF produced tends generally to cancel.

EMFs in the home arise from electric appliances, indoor wiring, grounding currents on pipes and ground wires, and outdoor distribution or transmission circuits. Inside residences, typical baseline 60-Hz MF levels (away from appliances) range from 0.5-5.0 mG.

Higher 60-Hz MF levels are found near operating appliances. For example, can openers, mixers, blenders, refrigerators, fluorescent lamps, electric ranges, clothes washers, toasters, portable heaters, vacuum cleaners, electric tools, and many other appliances generate MF levels in the range of 40-300 mG at distances of 1 foot (NIEHS, 2002). MF levels from personal care appliances held within half a foot (*e.g.*, shavers, hair dryers, massagers) can produce average fields of 600-700 mG. At school and in the workplace, lights, motors, copy machines, vending machines, video-display terminals, pencil sharpeners, electric tools, electric heaters, and building wiring are all sources of 60-Hz MFs.

Recognizing that magnetic resonance imaging (MRI) is a source of DC fields rather than 60-Hz fields, MRIs are a diagnostic procedure that puts humans in much larger, but steady, MF (*e.g.*, levels of 20,000,000 mG). The scanning MF superimposed on the large, steady static field (which is the source of the characteristic audio noise of MRI scans) exposes the body to time-varying MF similar to time-varying power-frequency MF.

2.4 State, National, and International Guidelines for Power-frequency EMFs

Table 2.1 shows guidelines for 60-Hz AC EMFs from national and world health and safety organizations that are designed to be protective against any adverse health effects. The limit values should not be viewed as demarcation lines between safe and dangerous levels of EMFs, but rather, levels that assure safety with an adequate margin to allow for uncertainties in the science. Appendix D provides more information on the health-effects science underlying the available exposure guidelines, as well as a summary of EMF health-effect conclusions from international scientific, health, and safety organizations, and governmental public health agencies. As part of its International EMF Project, the World Health Organization (WHO) has conducted comprehensive reviews of EMF health-effects research and existing standards and guidelines. The WHO website for the International EMF Project (WHO, 2023) notes: "*[T]he main conclusion from the WHO reviews is that EMF exposures below the limits recommended in the ICNIRP international guidelines do not appear to have any known consequence on health.*"

The US has no federal standards limiting either residential or occupational exposure to 60-Hz EMFs. Table 2.2 lists 60-Hz AC EMF guidelines that have been adopted by various states in the US, including by the MA EFSB. The MA EFSB has adopted, and long used, edge-of-ROW guideline levels of 85 mG and 1.8 kV/m for 60-Hz AC magnetic and electric fields, respectively. State guidelines such as those of the MA EFSB are not health-effect based and have typically been adopted to maintain the *status quo* for MFs on and near a transmission line ROW.

Table 2.1 60-Hz AC EMF Guidelines Established by International Health and Safety Organizations

Organization	Electric Field	Magnetic Field
American Conference of Governmental and Industrial Hygienists (ACGIH) (occupational)	25 kV/m(1)	10,000 mG(1) 1,000 mG(2)
International Commission on Non-Ionizing Radiation Protection (ICNIRP) (general public)	4.2 kV/m(3)	2,000 mG(3)
International Commission on Non-Ionizing Radiation Protection (ICNIRP) (occupational)	8.3 kV/m(3)	10,000 mG(3)
Institute of Electrical and Electronics Engineers (IEEE) Standard C95.1TM-2019 (general public)	5.0 kV/m(4)	9,040 mG(4)
Institute of Electrical and Electronics Engineers (IEEE) Standard C95.1TM-2019 (occupational)	20.0 kV/m(4)	27,100 mG(4)

Notes:
AC = Alternating Current; EMF = Electric and Magnetic Field; Hz = Hertz; kV/m = Kilovolts per Meter; mG = Milligauss.
(1) The ACGIH guidelines for the general worker (ACGIH, 2022).
(2) The ACGIH guideline for workers with cardiac pacemakers (ACGIH, 2022).
(3) ICNIRP (2010).
(4) IEEE (2019); developed by the IEEE International Committee on Electromagnetic Safety (ICES).

Table 2.2 State EMF Standards and Guidelines for Transmission Lines

State	Line Voltage (kV)	Electric Field (kV/m)		Magnetic Field (mG)	
		On ROW	Edge of ROW	On ROW	Edge of ROW
Florida(1)	69-230 >230-500 >500	8.0 10.0 15.0	2.0(2) 2.0(2) 5.5(2)		150(2) 200(2) 250(2,3)
Massachusetts			1.8		85
Minnesota		8.0			
Montana		7.0(4)	1.0(5)		
New Jersey			3.0		
New York(1)		11.8 11.0(6) 7.0(4)	1.6		200
Oregon		9.0			

Notes:
Blank = Not Applicable/Not Available; EMF = Electric and Magnetic Field; kV = Kilovolt; kV/m = Kilovolts per Meter; mG = Milligauss; ROW = Right-of-Way.
Sources: NIEHS (2002); FLDEP (2008); MA EFSB (2009).
(1) Magnetic fields for winter-normal (*i.e.*, at maximum current-carrying capability of the conductors).
(2) Includes the property boundary of a substation.
(3) Also applies to 500-kV double-circuit lines built on existing ROWs.
(4) Maximum for highway crossings.
(5) May be waived by the landowner.
(6) Maximum for private road crossings.

3 EMF Modeling

3.1 Software Program Used for Modeling EMFs for Overhead Line Cross Sections

The "EMF and Corona Effects Analysis" calculation program, designed by the Bonneville Power Administration (BPA) of the US Department of Energy, was used to calculate EMFs. This program operates using Maxwell's equations, which accurately apply the laws of physics as related to electricity and magnetism (EPRI, 1982, 1993). Modeled fields using this program are both precise and accurate for the input data used. The results of the model have been checked against results from other software (*e.g.*, Southern California Edison's FIELDS program), confirming that the implementation of the laws of physics in this program is consistent.

3.2 Power-line Loads

MFs produced by the three-phase overhead lines were modeled using line loadings and conductor phase angles provided by National Grid. The current per phase satisfies the relationship:

(Eq. 3.1)

$$S = \sqrt{3} \times V \times I_{phase}$$

where:

S	=	The power in kilovolt-amperes (kVA)
V	=	The line voltage in kilovolts (kV)
I_{phase}	=	The current per phase in amperes (A)

Thus, the current per phase conductor is:

(Eq. 3.2)

$$I_{phase} = \frac{S}{\sqrt{3} \times V}$$

Real power is typically expressed in megawatts (MW) (*P*), and apparent power in megavolt-amperes (MVA) (*S*).[3,4] To convert between power quoted in MW to MVA, one must divide MW by the power factor.

Both pre-Project and post-Project electric current and voltage values provided by National Grid are summarized by load scenario (annual average and system peak loadings) in Tables 3.1 and 3.2 for the A1 and B2 lines, as well as other existing overhead lines in the different segments of the Project route in Massachusetts.

[3] MVA is apparent power and is the vector sum of real (active) and imaginary (reactive) power. MW and MVA are not the same unless the power factor = 1.0, which, in a practical AC circuit, is generally not the case.

[4] 1 MVA=1,000 kVA

Table 3.1 Summary of Line Loadings for Modeled Loading Scenarios

Line	Line Segment	Pre-Project		Post-Project: 69-kV Operation		Post-Project: 115-kV Operation	
		Voltage (kV)	Current (A)	Voltage (kV)	Current (A)	Voltage (kV)	Current (A)
Annual Average Loading							
A1	Vernon – Royalston	74.45	108.66	70.10	132.26	118.57	84.85
	Royalston – Otter River	69.81	53.82	70.31	84.83	118.34	49.84
	Otter River – Gardner	70.33	37.38	70.73	49.15	118.45	25.44
	Gardner – Westminster	70.31	37.40	70.73	49.15	118.45	25.44
	Westminster – East Westminster	70.48	36.50	70.79	49.10	118.45	25.44
	East Westminster – Pratts Junction	71.21	55.85	71.00	39.28	118.68	11.28
B2	Vernon – Royalston	69.95	123.15	70.10	140.64	118.57	91.16
	Royalston – Otter River	69.65	123.15	70.24	119.24	118.57	79.75
	Otter River – Gardner	70.31	121.53	70.31	119.12	118.45	78.69
	Gardner – Westminster	69.85	48.96	70.59	34.94	118.57	18.33
	Westminster – East Westminster	70.10	64.85	70.73	51.45	118.57	13.56
	East Westminster – Pratts Junction	71.21	87.03	71.00	98.22	118.68	31.17
A1 Tap	Royalston – Chestnut Hill	69.69	56.24	70.10	37.88	118.57	22.48
A1N Tap	Royalston – Chestnut Hill	70.42	118.48	N/A	N/A	N/A	N/A
B2 Tap	Royalston – Chestnut Hill	N/A	N/A	70.10	31.31	118.57	17.64
B2N Tap	Gardner – Crystal Lake	69.85	123.15	70.24	119.24	118.57	78.78
B2S Tap	Gardner – Crystal Lake	69.65	48.96	70.59	34.94	118.57	18.33
I135S	East Westminster – Pratts Junction	118.51	61.39	118.34	62.94	118.68	63.02
J136S	East Westminster – Pratts Junction	118.51	131.05	118.34	132.69	118.68	132.44
U21S	East Westminster – Pratts Junction	71.21	170.89	71.00	239.24	71.48	170.23
V22S	East Westminster – Pratts Junction	71.21	142.64	71.00	208.06	71.48	142.09
E205	East Westminster – Pratts Junction	237.13	136.86	237.13	133.95	237.36	132.60
System Peak Loading							
A1	Vernon – Royalston	69.33	136.81	69.90	159.47	118.34	98.05
	Royalston – Otter River	69.48	62.83	70.04	99.97	117.99	57.89
	Otter River – Gardner	70.01	38.01	70.45	49.85	118.11	26.62
	Gardner – Westminster	70.01	38.01	70.45	49.85	118.11	26.62
	Westminster – East Westminster	70.17	37.13	70.52	49.80	118.22	25.92
	East Westminster – Pratts Junction	71.06	71.76	71.00	39.28	118.45	19.72
B2	Vernon – Royalston	70.33	161.96	69.90	169.48	118.34	104.68
	Royalston – Otter River	70.33	161.96	70.10	151.07	118.22	94.09
	Otter River – Gardner	70.29	161.39	70.24	151.03	118.22	93.98
	Gardner – Westminster	70.25	5.00	70.45	19.13	118.22	12.60
	Westminster – East Westminster	70.38	63.21	70.52	64.49	118.11	28.81
	East Westminster – Pratts Junction	71.06	98.33	71.00	98.22	118.45	48.90
A1 Tap	Royalston – Chestnut Hill	69.41	66.04	69.90	28.10	118.34	29.31
A1N Tap	Royalston – Chestnut Hill	70.76	137.93	N/A	N/A	N/A	N/A
B2 Tap	Royalston – Chestnut Hill	N/A	N/A	69.90	49.57	118.34	16.70
B2N Tap	Gardner – Crystal Lake	70.33	161.96	70.10	151.07	118.22	94.09
B2S Tap	Gardner – Crystal Lake	70.25	5.00	70.04	19.25	118.22	12.60
I135S	East Westminster – Pratts Junction	118.39	31.53	118.34	31.44	118.45	32.14
J136S	East Westminster – Pratts Junction	118.39	125.75	118.34	126.97	118.45	127.10

Line	Line Segment	Pre-Project		Post-Project: 69-kV Operation		Post-Project: 115-kV Operation	
		Voltage (kV)	Current (A)	Voltage (kV)	Current (A)	Voltage (kV)	Current (A)
U21S	East Westminster – Pratts Junction	71.06	239.05	71.00	235.99	71.14	238.77
V22S	East Westminster – Pratts Junction	71.06	207.90	71.00	208.06	71.14	207.65
E205	East Westminster – Pratts Junction	236.67	232.74	236.67	229.67	236.21	229.80

Notes:
A = Ampere; kV = Kilovolt; N/A = Not Applicable; N = North; S = South.

3.3 Modeled Project Cross Sections

Gradient modeled EMFs expected to exist 1 meter (3.28 feet) above the ground surface for 26 representative cross sections located in Massachusetts. These cross sections reflect differences in A1 and B2 conductor arrangements/locations/heights and the presence of other transmission/distribution lines within ROW segments (see Appendix A for the 24 unique cross section reference drawings of the overhead lines within the ROW segments), as well as changes in loadings within the ROW segments (see Table 3.1 above). ROW segments included the following:

- The A1 and B2 lines originate in Vernon, Vermont, and cross into Massachusetts at structure (STR) 99, continuing until STR 561 as the only transmission lines present in the ROW. There are 14 cross section reference drawings for the ROW segments between STR 99 and STR 561, each with a minimum ROW width of 100 feet, that differs with respect to either pre- or post-Project phasing arrangements and/or conductor heights (see Appendix A, B-15191-NE Sheets 1 through 14). Note that the relative horizontal locations of the A1 and B2 conductors for the post-Project conditions are the same for each ROW segment.
- From STR 561 to STR 642, the A1 and B2 lines are present in the southern portion of the 350-foot wide ROW (see Appendix A, B-15191-NE Sheets 15 through 17). As a result of the Project, the centerline of the double circuit A1/B2 structures will be moved closer to the ROW center, from a distance of approximately 50 feet away from the southern ROW edge to approximately 92 feet. The 115-kV overhead transmission lines I135 and J136 are present in the middle portion of the ROW, starting at STR 561 and continuing until the end of the Project at Pratts Junction, with the midpoint of the double-circuit structure located at the centerline of the ROW from STR 561 to STR 642.
- From STR 642 to STR 647 (Appendix A B15191-NE Sheet 18), the centerline of the double circuit A1/B2 structures are located between 50 feet (existing structure) and 54 feet (proposed structure) from the southern edge of the 350-foot wide ROW. The I135/J136 structure is present in the same location as described previously. Additionally, the 69-kV overhead U21 and V22 transmission lines are also present in this segment of the ROW through the end of the Project at Pratts Junction, between the A1/B2 and the I135/J136 structures.
- From STR 648 to STR 653 (Appendix A B15191-NE Sheet 19), the ROW in this portion of the Project route expands to a total width of 447.5 feet to accommodate the addition of the 230-kV E205 overhead transmission line, which is present through the end of the Project at Pratts Junction.[5] The centerline of the E205 structure is located 62.5 feet from the southern ROW edge. The centerline of the proposed A1/B2 structure is located approximately 89 feet north of the centerline

[5] For purposes of modeling, the centerline of the ROW (*i.e.*, x=0) remained set to the midpoint of the I135/J136 structure, as was done for the B-15191-NE Sheets 18 through 20 models. Thus, the southern edge of the ROW is located further away from x=0 than the northern edge.

of the E205 structure. All other existing overhead lines (*i.e*., I135, J136, U21, V22) are in the same locations relative to the A1/B2 structure as described above for B-15191-NE Sheet 18.

- In the segment of the Project route from STR 654 to STR 661 (Appendix A B15191-NE Sheet 20), the 13.8-kV 225W4 overhead distribution line, which is located between the A1/B2 and E205 structures, is present in the 447.5-foot ROW. The 225W4 line was not included in EMF modeling due to the lack of available loading information. However, since this line is relatively distant from the ROW edges (112.5 feet from the nearest ROW edge), the omission of this line from EMF modeling is not expected to significantly impact model-predicted EF or MF values at the ROW edges. Thus, for purposes of EMF modeling, other than minor differences in conductor midspan sag heights for the post-Project annual average loading scenarios (see Table 3.2), this segment of the Project route is identical to B-15191-NE Sheet 19.
- From STR 661 to Pratts Junction (Appendix A B15191-NE Sheet 21), the ROW is 437.5 feet wide due to a reduced separation distance (77.5 feet instead of 87.5 feet) between the I135/J136 structure and the V22 transmission line compared to B-15200-NE. The relative horizontal locations of the other overhead lines remain the same. For this cross section, conductor midspan sag heights for the post-Project annual average loading scenarios are reduced as compared to prior cross sections (see Table 3.2).
- The Athol tap line originates at Royalston station and runs southward to the Chestnut Hill station, and is represented by two cross section drawings (Appendix A B-15192-NE Sheets 1 and 2). The existing configuration consists of the A1 line in a loop (A1 Tap and A1N Tap). Post-Project, both A1 and B2 lines are to be tapped to Chestnut Hill (A1 Tap and B2 Tap). The first cross section, which represents the route segment between Royalston to Structures 72 (A1N/B2 Tap) and 71 (A1 Tap) utilizes two single circuit delta-configured 115-kV structures. The second cross section, which represents the route segment between Structures 72 (A1N/B2 Tap) and 71 (A1 Tap) to Chestnut Hill Station, is a cross-phased double circuit davit arm structure that resembles the main A1/B2 line configuration.
- The Gardner tap line originates at the Gardner Switch tower and runs southward to the Crystal Lake station (Appendix A B-15193-NE Sheet 1). Both existing and post-Project configurations consist of the looped B2 line (B2S Tap and B2N Tap).

National Grid provided cross section reference drawings showing both existing (pre-Project) and post-Project overhead conductor arrangements, which are attached to this report as Appendix A. Conductor phasing arrangements are shown on the cross section drawings.

EMF levels were modeled for both pre-Project and post-Project ROW conditions as a function of distance perpendicular to the direction of current flow for each route segment, assuming that the transmission lines run straight. Modeling was performed assuming the minimum ROW widths as discussed above and shown in each representative cross section drawing (Appendix A); this resulted in conservative estimates of edge-of-ROW EMF levels, as EMF levels will be lower at the ROW edges with a wider ROW. Variation in the height of the nearby grade along the ROW was not accounted for, given that the general National Grid policy is to model EMF for the most conservative location of lowest conductor sag (*i.e.*, closest to the ground surface). Table 3.2 summarizes the midspan heights corresponding to the locations of lowest conductor sag that were provided by National Grid and conservatively used in the EMF modeling. The EMF modeling was conducted out to 50 feet beyond both ROW edges, illustrating the continued decline in EMF levels beyond the ROW edges for the assumed ROW widths.

Table 3.2 Summary of Lowest Conductor Midspan Heights Used in EMF Modeling

Cross Section	Loading	Line	Height of Lowest Conductor Midspan Sag (ft)(1)		
			Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)
B-15191-NE Sheets 1 and 2: STR 99 – 201	Annual Average	A1	17.0	40.3	40.3
		B2	17.0	40.4	40.4
	System Peak	A1	17.0	22.0	23.0
		B2	17.0	22.0	23.0
B-15191-NE Sheets 3 and 4: STR 201 – 318	Annual Average	A1	17.0	38.2	38.2
		B2	17.0	37.6	37.6
	System Peak	A1	17.0	22.0	23.0
		B2	17.0	22.0	23.0
B-15191-NE Sheets 5 to 7: STR 318 – 346	Annual Average	A1	17.0	39.8	39.8
		B2	17.0	40.0	40.0
	System Peak	A1	17.0	22.0	23.0
		B2	17.0	22.0	23.0
B-15191-NE Sheets 8 and 9: STR 347 – 358	Annual Average	A1	17.0	31.4	31.4
		B2	17.0	32.1	32.1
	System Peak	A1	17.0	22.0	23.0
		B2	17.0	22.0	23.0
B-15191-NE Sheets 10 to 14: STR 358 – 561	Annual Average	A1	17.0	35.8	35.8
		B2	17.0	36.5	36.5
	System Peak	A1	17.0	22.0	23.0
		B2	17.0	22.0	23.0
B-15191-NE Sheets 15 and 16: STR 561 – 615	Annual Average	A1	17.0	28.9	28.9
		B2	17.0	29.1	29.1
		I135S	27.5	27.5	27.5
		J136S	30.3	30.3	30.3
	System Peak	A1	17.0	22.0	23.0
		B2	17.0	22.0	23.0
		I135S	23.0	23.0	23.0
		J136S	23.0	23.0	23.0
B-15191-NE Sheet 17: STR 615 – 642	Annual Average	A1	17.0	29.5	29.5
		B2	17.0	32.2	32.2
		I135S	33.8	33.8	33.8
		J136S	37.6	37.6	37.6
	System Peak	A1	17.0	22.0	23.0
		B2	17.0	22.0	23.0
		I135S	23.0	23.0	23.0
		J136S	23.0	23.0	23.0

Cross Section	Loading	Line	Height of Lowest Conductor Midspan Sag (ft)[1]		
			Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)
B-15191-NE Sheet 18: STR 642 – 647	Annual Average	A1	17.0	44.5	44.5
		B2	17.0	45.5	45.5
		I135S	31.0	31.0	31.0
		J136S	34.9	34.9	34.9
		U21S	28.0	28.0	28.0
		V22S	29.2	29.2	29.2
	System Peak	A1	17.0	22.0	23.0
		B2	17.0	22.0	23.0
		I135S	23.0	23.0	23.0
		J136S	23.0	23.0	23.0
		U21S	22.0	22.0	22.0
		V22S	22.0	22.0	22.0
B-15191-NE Sheet 19: STR 648 – 653	Annual Average	A1	17.0	44.7	44.7
		B2	17.0	45.9	45.9
		I135S	37.7	37.7	37.7
		J136S	41.5	41.5	41.5
		U21S	28.9	28.9	28.9
		V22S	29.6	29.6	29.6
		E205	32.2	32.2	32.2
	System Peak	A1	17.0	22.0	23.0
		B2	17.0	22.0	23.0
		I135S	23.0	23.0	23.0
		J136S	23.0	23.0	23.0
		U21S	22.0	22.0	22.0
		V22S	22.0	22.0	22.0
		E205	25.0	25.0	25.0
B-15191-NE Sheet 20: STR 654 – 661	Annual Average	A1	17.0	45.3	45.3
		B2	17.0	47.9	47.9
		I135S	32.3	32.3	32.3
		J136S	33.3	33.3	33.3
		U21S	25.7	25.7	25.7
		V22S	26.2	26.2	26.2
		E205	30.3	30.3	30.3
	System Peak	A1	17.0	22.0	23.0
		B2	17.0	22.0	23.0
		I135S	23.0	23.0	23.0
		J136S	23.0	23.0	23.0
		U21S	22.0	22.0	22.0
		V22S	22.0	22.0	22.0
		E205	25.0	25.0	25.0

Cross Section	Loading	Line	Height of Lowest Conductor Midspan Sag (ft)(1)		
			Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)
B-15191-NE Sheet 21: STR 661 – Pratts Junction	Annual Average	A1	17.0	34.3	34.3
		B2	17.0	33.9	33.9
		I135S	31.7	31.7	31.7
		J136S	30.9	30.9	30.9
		U21S	31.7	31.7	31.7
		V22S	32.5	32.5	32.5
		E205	36.2	36.2	36.2
	System Peak	A1	17.0	22.0	23.0
		B2	17.0	22.0	23.0
		I135S	23.0	23.0	23.0
		J136S	23.0	23.0	23.0
		U21S	22.0	22.0	22.0
		V22S	22.0	22.0	22.0
		E205	25.0	25.0	25.0
B-15192-NE Sheets 1 and 2: Athol Tap	Annual Average	A1 Tap	17.0	25.7	25.7
		A1N Tap	17.0	N/A	N/A
		B2 Tap	N/A	32.9	32.9
	System Peak	A1 Tap	17.0	22.0	23.0
		A1N Tap	17.0	N/A	N/A
		B2 Tap	N/A	22.0	23.0
B-15193-NE Sheet 1: Gardner Tap	Annual Average	B2S Tap	17.0	34.5	34.5
		B2N Tap	17.0	36.2	36.2
	System Peak	B2S Tap	17.0	22.0	23.0
		B2N Tap	17.0	22.0	23.0

Notes:
EMF = Electric and Magnetic Field; ft = Feet; kV = Kilovolt; N/A = Not Applicable; STR = Structure.
(1) Pre-Project conductor elevation values reflect the minimum required elevation under governing code. Post-Project conductor elevations for the annual average loading scenarios assume ambient and conductor temperatures of 60°F. Post-Project conductor elevations for the system peak loading scenario reflect the minimum required elevation under governing code.

3.4 EMF Modeling Results

3.4.1 Magnetic Field Results

Results of the MF modeling for the representative cross sections are summarized in Tables 3.3 and 3.4, as well as the figures in Appendix B. In the Appendix B figures, panel (a) shows the pre- and post-Project modeling results for the annual average loading scenario, and panel (b) shows the pre- and post-Project modeling results for the system peak loading scenario. For the annual average and system peak modeling scenarios (panels a and b), both post-Project 69-kV and post-Project 115-kV MF results are shown.

The MF modeling results show that all model-predicted MF values, including those within the ROWs, remain well below the ICNIRP health-based guideline of 2,000 mG for allowable public exposure to 60-Hz MF. The Project will frequently result in increased edge-of-ROW MF levels; however, the magnitudes of the increases are small (often <1 mG, and nearly all <5 mG and <10 mG for annual average and system peak loading scenarios, respectively). For the annual average loading results, the largest edge-of-ROW MF increases are 6.29 mG and 3.49 mG for the post-Project 69-kV and 115-kV operating cases for the A1 and B2 lines, respectively; for the system peak loading results, slightly higher maximum edge-of-ROW MF increases of 11.21 mG and 5.89 mG were obtained for the post-Project 69-kV and 115-kV operating cases for the A1 and B2 lines, respectively.[6] In all cases, MF values drop off rapidly with increased lateral distance from the overhead lines, such that MF levels decrease to negligible levels at short distances beyond the ROW edges.

Table 3.3 Summary of Modeled Pre-Project and Post-Project Magnetic Fields for the Representative ROW Cross Sections for Annual Average Loading Scenarios

Line Segment	Cross Section	Scenario	Magnetic Field (mG)				
			50 ft from Northern ROW Edge	Northern ROW Edge	Maximum Within ROW	Southern ROW Edge	50 ft from Southern ROW Edge
Vernon – Royalston	B-15191-NE Sheet 1	Pre-Project	0.80	3.18	24.50	3.28	0.82
		Post-Project (69-kV)	2.70	6.71	11.65	5.88	2.42
		Post-Project (115-kV)	1.74	4.31	7.48	3.79	1.56
	B-15191-NE Sheet 2	Pre-Project	0.80	3.18	24.50	3.28	0.82
		Post-Project (69-kV)	2.83	7.52	14.36	6.47	2.52
		Post-Project (115-kV)	1.83	4.85	9.28	4.19	1.63
	B-15191-NE Sheet 3	Pre-Project	0.42	1.62	14.68	1.81	0.45
		Post-Project (69-kV)	2.88	7.91	15.92	6.80	2.57
		Post-Project (115-kV)	1.86	5.11	10.29	4.40	1.66
Royalston – Otter River	B-15191-NE Sheet 4	Pre-Project	0.23	0.65	19.33	1.67	0.36
		Post-Project (69-kV)	0.21	1.11	5.32	2.07	0.67
		Post-Project (115-kV)	0.23	0.68	3.66	1.54	0.53
	B-15191-NE Sheet 5	Pre-Project	0.23	0.58	22.40	2.07	0.42
		Post-Project (69-kV)	0.20	1.02	4.61	1.94	0.66
		Post-Project (115-kV)	0.22	0.62	3.18	1.44	0.51
	B-15191-NE Sheet 6	Pre-Project	0.23	0.58	22.40	2.07	0.42
		Post-Project (69-kV)	2.11	5.26	9.72	4.88	1.97
		Post-Project (115-kV)	1.36	3.39	6.40	3.21	1.29
	B-15191-NE Sheet 7	Pre-Project	0.23	0.58	22.40	2.07	0.42
		Post-Project (69-kV)	1.96	5.25	10.53	4.79	1.83
		Post-Project (115-kV)	1.20	3.21	6.59	3.02	1.15

[6] MF levels for the post-Project modeling cases with current loadings for the 115-kV operating voltage for the A1 and B2 lines are generally lower than the results for the corresponding 69-kV operating voltage due to reduced currents for the higher operating voltage.

Line Segment	Cross Section	Scenario	Magnetic Field (mG)				
			50 ft from Northern ROW Edge	Northern ROW Edge	Maximum Within ROW	Southern ROW Edge	50 ft from Southern ROW Edge
Royalston – Otter River (continued)	B-15191-NE Sheet 8	Pre-Project	0.23	0.65	19.33	1.67	0.36
		Post-Project (69-kV)	2.08	6.26	15.15	5.58	1.94
		Post-Project (115-kV)	1.27	3.82	9.51	3.53	1.22
Otter River – Gardner	B-15191-NE Sheet 9	Pre-Project	0.23	0.73	22.12	1.77	0.38
		Post-Project (69-kV)	0.76	1.69	8.58	3.30	1.11
		Post-Project (115-kV)	0.55	1.33	5.93	2.31	0.78
	B-15191-NE Sheet 10	Pre-Project	0.49	1.84	22.97	2.44	0.57
		Post-Project (69-kV)	0.74	1.62	6.60	2.99	1.07
		Post-Project (115-kV)	0.54	1.27	4.61	2.09	0.75
	B-15191-NE Sheet 11	Pre-Project	0.49	1.84	22.97	2.44	0.57
		Post-Project (69-kV)	1.87	4.89	10.61	4.88	1.85
		Post-Project (115-kV)	1.14	2.97	6.67	3.08	1.16
	B-15191-NE Sheet 12	Pre-Project	0.49	1.84	22.97	2.44	0.57
		Post-Project (69-kV)	1.43	4.02	9.77	4.19	1.51
		Post-Project (115-kV)	0.91	2.52	6.28	2.73	0.98
Gardner – Westminster	B-15191-NE Sheet 13	Pre-Project	0.20	0.82	11.55	0.93	0.21
		Post-Project (69-kV)	0.38	1.28	2.77	0.64	0.20
		Post-Project (115-kV)	0.18	0.57	1.26	0.19	0.07
Westminster – East Westminster	B-15191-NE Sheet 13	Pre-Project	0.10	0.41	13.24	0.86	0.17
		Post-Project (69-kV)	0.89	2.60	5.53	2.19	0.79
		Post-Project (115-kV)	0.49	1.35	2.53	1.01	0.40
	B-15191-NE Sheet 14	Pre-Project	0.10	0.41	13.24	0.86	0.17
		Post-Project (69-kV)	0.32	0.93	2.44	0.85	0.31
		Post-Project (115-kV)	0.36	1.06	2.11	0.72	0.26
East Westminster – Pratts Junction	B-15191-NE Sheet 14	Pre-Project	0.23	0.97	19.30	1.35	0.29
		Post-Project (69-kV)	0.96	2.29	6.13	2.94	1.10
		Post-Project (115-kV)	0.22	0.50	1.80	0.83	0.30

Line Segment	Cross Section	Scenario	Magnetic Field (mG)				
			50 ft from Northern ROW Edge	Northern ROW Edge	Maximum Within ROW	Southern ROW Edge	50 ft from Southern ROW Edge
East Westminster – Pratts Junction (continued)	B-15191-NE Sheet 15	Pre-Project	0.51	0.84	20.82	1.22	0.32
		Post-Project (69-kV)	0.52	0.86	20.56	1.63	0.71
		Post-Project (115-kV)	0.53	0.88	20.83	1.10	0.61
	B-15191-NE Sheet 16	Pre-Project	0.51	0.84	20.82	1.22	0.32
		Post-Project (69-kV)	0.57	0.93	22.00	2.47	1.14
		Post-Project (115-kV)	0.54	0.89	21.12	1.30	0.70
	B-15191-NE Sheet 17	Pre-Project	0.55	0.89	15.92	2.87	1.06
		Post-Project (69-kV)	0.57	0.92	15.75	2.39	1.11
		Post-Project (115-kV)	0.54	0.88	14.79	1.26	0.69
	B-15191-NE Sheet 18	Pre-Project	0.66	1.05	15.12	4.05	1.58
		Post-Project (69-kV)	0.71	1.12	20.76	5.45	2.27
		Post-Project (115-kV)	0.65	1.03	14.79	2.95	1.38
	B-15191-NE Sheet 19	Pre-Project	0.82	1.24	23.92	7.69	2.92
		Post-Project (69-kV)	0.86	1.30	22.05	7.45	2.93
		Post-Project (115-kV)	0.80	1.22	22.87	7.26	2.76
	B-15191-NE Sheet 20	Pre-Project	0.83	1.26	26.29	7.89	2.94
		Post-Project (69-kV)	0.86	1.31	24.35	7.69	2.97
		Post-Project (115-kV)	0.80	1.23	25.15	7.46	2.78
	B-15191-NE Sheet 21	Pre-Project	0.84	1.28	19.61	7.26	2.88
		Post-Project (69-kV)	0.89	1.35	18.22	6.89	2.84
		Post-Project (115-kV)	0.82	1.26	18.69	6.80	2.71
Royalston – Chestnut Hill	B-15192-NE Sheet 1	Pre-Project	0.31	0.66	46.76	4.76	1.01
		Post-Project (69-kV)	0.25	1.11	5.61	0.89	0.17
		Post-Project (115-kV)	0.15	0.67	3.31	0.50	0.09
	B-15192-NE Sheet 2	Pre-Project	0.31	0.66	46.76	4.76	1.01
		Post-Project (69-kV)	0.16	0.60	4.02	0.41	0.08
		Post-Project (115-kV)	0.10	0.37	2.40	0.24	0.05

Line Segment	Cross Section	Scenario	Magnetic Field (mG)				
			50 ft from Northern ROW Edge	Northern ROW Edge	Maximum Within ROW	Southern ROW Edge	50 ft from Southern ROW Edge
Gardner – Crystal Lake	B-15193-NE Sheet 1	Pre-Project	0.30	0.93	18.91	1.91	0.43
		Post-Project (69-kV)	1.50	3.95	10.04	5.07	1.81
		Post-Project (115-kV)	1.00	2.61	6.62	3.38	1.22

Notes:
ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way.

Table 3.4 Summary of Modeled Pre-Project and Post-Project Magnetic Fields for the Representative ROW Cross Sections for System Peak Loading Scenarios

Line Segment	Cross Section	Scenario	Magnetic Field (mG)				
			50 ft from Northern ROW Edge	Northern ROW Edge	Maximum Within ROW	Southern ROW Edge	50 ft from Southern ROW Edge
Vernon – Royalston	B-15191-NE Sheet 1	Pre-Project	1.03	4.07	32.66	4.25	1.05
		Post-Project (69-kV)	3.76	12.13	32.70	10.00	3.32
		Post-Project (115-kV)	2.30	7.30	18.91	6.05	2.03
	B-15191-NE Sheet 2	Pre-Project	1.03	4.07	32.66	4.25	1.05
		Post-Project (69-kV)	3.88	13.45	42.05	10.83	3.40
		Post-Project (115-kV)	2.38	8.13	24.53	6.58	2.09
	B-15191-NE Sheet 3	Pre-Project	0.59	2.24	19.28	2.54	0.63
		Post-Project (69-kV)	3.88	13.45	42.05	10.83	3.40
		Post-Project (115-kV)	2.38	8.13	24.53	6.58	2.09
Royalston – Otter River	B-15191-NE Sheet 4	Pre-Project	0.38	1.18	24.65	2.39	0.54
		Post-Project (69-kV)	0.26	1.94	23.47	3.98	1.02
		Post-Project (115-kV)	0.31	1.05	13.16	2.59	0.71
	B-15191-NE Sheet 5	Pre-Project	0.38	1.11	28.44	2.91	0.61
		Post-Project (69-kV)	0.26	1.94	23.47	3.98	1.02
		Post-Project (115-kV)	0.31	1.05	13.16	2.59	0.71
	B-15191-NE Sheet 6	Pre-Project	0.38	1.11	28.44	2.91	0.61
		Post-Project (69-kV)	2.85	8.96	28.31	8.26	2.68
		Post-Project (115-kV)	1.81	5.65	17.28	5.23	1.71

Line Segment	Cross Section	Scenario	Magnetic Field (mG)				
			50 ft from Northern ROW Edge	Northern ROW Edge	Maximum Within ROW	Southern ROW Edge	50 ft from Southern ROW Edge
Royalston – Otter River (continued)	B-15191-NE Sheet 7	Pre-Project	0.38	1.11	28.44	2.91	0.61
		Post-Project (69-kV)	2.82	9.65	33.16	8.56	2.64
		Post-Project (115-kV)	1.56	5.31	18.35	4.87	1.50
	B-15191-NE Sheet 8	Pre-Project	0.38	1.18	24.65	2.39	0.54
		Post-Project (69-kV)	2.82	9.65	33.16	8.56	2.64
		Post-Project (115-kV)	1.56	5.31	18.35	4.87	1.50
Otter River – Gardner	B-15191-NE Sheet 9	Pre-Project	0.35	1.10	28.77	2.45	0.53
		Post-Project (69-kV)	1.07	2.67	23.94	5.41	1.57
		Post-Project (115-kV)	0.78	2.04	13.85	3.49	1.05
	B-15191-NE Sheet 10	Pre-Project	0.61	2.24	29.93	3.13	0.73
		Post-Project (69-kV)	0.74	1.62	6.60	2.99	1.07
		Post-Project (115-kV)	0.54	1.27	4.61	2.09	0.75
	B-15191-NE Sheet 11	Pre-Project	0.61	2.24	29.93	3.13	0.73
		Post-Project (69-kV)	1.87	4.89	10.61	4.88	1.85
		Post-Project (115-kV)	1.14	2.97	6.67	3.08	1.16
	B-15191-NE Sheet 12	Pre-Project	0.61	2.24	29.93	3.13	0.73
		Post-Project (69-kV)	1.43	4.02	9.77	4.19	1.51
		Post-Project (115-kV)	0.91	2.52	6.28	2.73	0.98
Gardner – Westminster	B-15191-NE Sheet 13	Pre-Project	0.16	0.68	6.28	0.43	0.12
		Post-Project (69-kV)	0.61	2.40	8.29	1.04	0.34
		Post-Project (115-kV)	0.27	1.06	3.78	0.25	0.10
Westminster – East Westminster	B-15191-NE Sheet 13	Pre-Project	0.07	0.13	10.70	0.73	0.15
		Post-Project (69-kV)	1.30	4.47	14.76	3.80	1.18
		Post-Project (115-kV)	0.65	2.20	6.68	1.80	0.57
	B-15191-NE Sheet 14	Pre-Project	0.07	0.13	10.70	0.73	0.15
		Post-Project (69-kV)	0.13	0.97	10.19	1.51	0.36
		Post-Project (115-kV)	0.08	0.57	4.26	0.58	0.13

Line Segment	Cross Section	Scenario	Magnetic Field (mG)				
			50 ft from Northern ROW Edge	Northern ROW Edge	Maximum Within ROW	Southern ROW Edge	50 ft from Southern ROW Edge
East Westminster – Pratts Junction	B-15191-NE Sheet 14	Pre-Project	0.15	0.74	21.57	1.20	0.23
		Post-Project (69-kV)	1.06	2.95	15.76	3.98	1.22
		Post-Project (115-kV)	0.54	1.50	7.24	1.97	0.62
	B-15191-NE Sheet 15	Pre-Project	0.39	0.63	32.39	1.15	0.42
		Post-Project (69-kV)	0.39	0.64	32.44	1.77	0.75
		Post-Project (115-kV)	0.40	0.65	32.67	1.20	0.57
	B-15191-NE Sheet 16	Pre-Project	0.39	0.63	32.39	1.15	0.42
		Post-Project (69-kV)	0.43	0.70	33.47	2.35	1.03
		Post-Project (115-kV)	0.42	0.68	32.71	1.30	0.63
	B-15191-NE Sheet 17	Pre-Project	0.45	0.71	31.74	3.24	1.08
		Post-Project (69-kV)	0.43	0.70	33.47	2.35	1.03
		Post-Project (115-kV)	0.42	0.68	32.71	1.30	0.63
	B-15191-NE Sheet 18	Pre-Project	0.59	0.92	29.73	5.15	1.87
		Post-Project (69-kV)	0.58	0.90	34.86	6.41	2.15
		Post-Project (115-kV)	0.57	0.88	30.50	4.08	1.59
	B-15191-NE Sheet 19	Pre-Project	0.85	1.24	60.46	13.85	4.71
		Post-Project (69-kV)	0.83	1.22	58.22	13.29	4.55
		Post-Project (115-kV)	0.82	1.20	59.09	13.39	4.54
	B-15191-NE Sheet 20	Pre-Project	0.85	1.24	60.46	13.85	4.71
		Post-Project (69-kV)	0.83	1.22	58.22	13.29	4.55
		Post-Project (115-kV)	0.82	1.20	59.09	13.39	4.54
	B-15191-NE Sheet 21	Pre-Project	0.88	1.28	60.44	13.87	4.72
		Post-Project (69-kV)	0.85	1.25	58.19	13.30	4.56
		Post-Project (115-kV)	0.84	1.24	59.06	13.40	4.55
Royalston – Chestnut Hill	B-15192-NE Sheet 1	Pre-Project	0.32	0.59	54.63	5.51	1.16
		Post-Project (69-kV)	0.06	0.63	9.81	2.08	0.44
		Post-Project (115-kV)	0.23	1.01	5.45	0.51	0.06

Line Segment	Cross Section	Scenario	Magnetic Field (mG)				
			50 ft from Northern ROW Edge	Northern ROW Edge	Maximum Within ROW	Southern ROW Edge	50 ft from Southern ROW Edge
Royalston – Chestnut Hill (continued)	B-15192-NE Sheet 2	Pre-Project	0.32	0.59	54.63	5.51	1.16
		Post-Project (69-kV)	0.11	0.29	7.88	1.20	0.34
		Post-Project (115-kV)	0.19	0.62	4.26	0.24	0.07
Gardner – Crystal Lake	B-15193-NE Sheet 1	Pre-Project	0.49	1.70	28.27	2.94	0.66
		Post-Project (69-kV)	1.73	5.14	26.87	8.18	2.33
		Post-Project (115-kV)	1.14	3.36	15.75	5.12	1.49

Notes:
ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way.

3.4.2 Electric Field Results

Pre- and post-Project EF modeling results for the representative cross sections are shown in Table 3.5 and the figures in Appendix C. In the Appendix C figures, panel (a) shows the pre- and post-Project modeling results for the annual average loading scenario, and panel (b) shows the pre- and post-Project modeling results for the system peak loading scenario; both panels show results for the post-Project 69-kV and 115-kV operating cases for the A1 and B2 lines. Although electric fields are not dependent on conductor loading (*i.e.*, current), separate results are provided for the annual average and system peak loading scenarios due to the differences in the midspan heights of the Project conductors at the location of lowest conductor sag that were modeled for the two loading scenarios. In all cases, the modeled edge-of-ROW EFs are well below the ICNIRP health-based guideline of 4.2 kV/m, and the Project will result in little change to EFs at the ROW edges (*i.e.*, all edge-of-ROW EF changes were <0.4 kV/m), including for the higher 115-kV operating case. This is because the increased EF levels associated with the higher voltage are generally offset by the proposed conductor arrangements and phasing configurations that help promote EMF cancellation, as well as the greater midspan heights of the Project conductors at the location of lowest conductor sag that was modeled.

Table 3.5 Summary of Modeled Pre-Project and Post-Project Electric Fields for the Representative ROW Cross Sections

Line Segment	Cross Section	Loading	Scenario	Electric Field (kV/m)				
				50 ft from Northern ROW Edge	Northern ROW Edge	Maximum Within ROW	Southern ROW Edge	50 ft from Southern ROW Edge
Vernon – Royalston	B-15191-NE Sheet 1	Annual Average	Pre-Project	0.03	0.13	1.16	0.12	0.03
			Post (69-kV)	0.02	0.14	0.56	0.09	0.02
			Post (115-kV)	0.03	0.23	0.95	0.15	0.04
		System Peak	Pre-Project	0.03	0.12	1.16	0.13	0.03
			Post (69-kV)	0.05	0.08	1.26	0.05	0.04
			Post (115-kV)	0.08	0.14	2.01	0.09	0.07

Line Segment	Cross Section	Loading	Scenario	Electric Field (kV/m)				
				50 ft from Northern ROW Edge	Northern ROW Edge	Maximum Within ROW	Southern ROW Edge	50 ft from Southern ROW Edge
Vernon – Royalston (continued)	B-15191-NE Sheet 2	Annual Average	Pre-Project	0.03	0.13	1.16	0.12	0.03
			Post (69-kV)	0.02	0.16	0.77	0.10	0.02
			Post (115-kV)	0.04	0.27	1.30	0.17	0.04
		System Peak	Pre-Project	0.03	0.12	1.16	0.13	0.03
			Post (69-kV)	0.05	0.10	1.83	0.08	0.05
			Post (115-kV)	0.09	0.17	2.93	0.13	0.08
	B-15191-NE Sheet 3	Annual Average	Pre-Project	0.01	0.08	0.77	0.07	0.01
			Post (69-kV)	0.03	0.15	0.85	0.09	0.03
			Post (115-kV)	0.05	0.26	1.44	0.16	0.05
		System Peak	Pre-Project	0.01	0.08	0.74	0.08	0.01
			Post (69-kV)	0.05	0.10	1.83	0.08	0.05
			Post (115-kV)	0.09	0.17	2.93	0.13	0.08
Royalston – Otter River	B-15191-NE Sheet 4	Annual Average	Pre-Project	0.01	0.08	0.67	0.08	0.01
			Post (69-kV)	<0.01	0.08	0.23	0.05	<0.01
			Post (115-kV)	0.01	0.13	0.38	0.09	0.01
		System Peak	Pre-Project	0.01	0.07	0.69	0.08	0.01
			Post (69-kV)	0.02	0.08	0.81	0.05	0.01
			Post (115-kV)	0.03	0.14	1.16	0.08	0.02
	B-15191-NE Sheet 5	Annual Average	Pre-Project	0.01	0.09	0.71	0.09	0.01
			Post (69-kV)	<0.01	0.08	0.20	0.05	<0.01
			Post (115-kV)	0.01	0.13	0.32	0.09	<0.01
		System Peak	Pre-Project	0.01	0.09	0.73	0.09	0.01
			Post (69-kV)	0.02	0.08	0.81	0.05	0.01
			Post (115-kV)	0.03	0.14	1.16	0.08	0.02
	B-15191-NE Sheet 6	Annual Average	Pre-Project	0.01	0.09	0.71	0.09	0.01
			Post (69-kV)	0.02	0.15	0.63	0.09	0.02
			Post (115-kV)	0.04	0.25	1.10	0.16	0.04
		System Peak	Pre-Project	0.01	0.09	0.73	0.09	0.01
			Post (69-kV)	0.05	0.08	1.31	0.06	0.05
			Post (115-kV)	0.09	0.14	2.33	0.10	0.08
	B-15191-NE Sheet 7	Annual Average	Pre-Project	0.01	0.09	0.71	0.09	0.01
			Post (69-kV)	0.02	0.15	0.76	0.10	0.02
			Post (115-kV)	0.04	0.25	1.25	0.16	0.04
		System Peak	Pre-Project	0.01	0.09	0.73	0.09	0.01
			Post (69-kV)	0.05	0.10	1.82	0.08	0.05
			Post (115-kV)	0.08	0.17	2.79	0.13	0.07
	B-15191-NE Sheet 8	Annual Average	Pre-Project	0.01	0.08	0.67	0.08	0.01
			Post (69-kV)	0.04	0.13	1.08	0.08	0.03
			Post (115-kV)	0.06	0.21	1.78	0.13	0.05
		System Peak	Pre-Project	0.01	0.07	0.69	0.08	0.01
			Post (69-kV)	0.05	0.10	1.82	0.08	0.05
			Post (115-kV)	0.08	0.17	2.79	0.13	0.07

Line Segment	Cross Section	Loading	Scenario	Electric Field (kV/m)				
				50 ft from Northern ROW Edge	Northern ROW Edge	Maximum Within ROW	Southern ROW Edge	50 ft from Southern ROW Edge
Otter River – Gardner	B-15191-NE Sheet 9	Annual Average	Pre-Project	0.02	0.10	0.92	0.10	0.02
			Post (69-kV)	0.01	0.09	0.34	0.05	0.01
			Post (115-kV)	0.02	0.14	0.57	0.09	0.02
		System Peak	Pre-Project	0.02	0.10	0.90	0.10	0.02
			Post (69-kV)	0.02	0.08	0.75	0.05	0.02
			Post (115-kV)	0.04	0.13	1.15	0.07	0.03
	B-15191-NE Sheet 10	Annual Average	Pre-Project	0.03	0.13	1.30	0.13	0.03
			Post (69-kV)	<0.01	0.09	0.25	0.05	<0.01
			Post (115-kV)	0.01	0.14	0.42	0.09	0.02
		System Peak	Pre-Project	0.03	0.13	1.30	0.13	0.03
			Post (69-kV)	<0.01	0.09	0.25	0.05	<0.01
			Post (115-kV)	0.01	0.14	0.42	0.09	0.02
	B-15191-NE Sheet 11	Annual Average	Pre-Project	0.03	0.13	1.30	0.13	0.03
			Post (69-kV)	0.03	0.15	0.83	0.09	0.03
			Post (115-kV)	0.05	0.24	1.39	0.15	0.05
		System Peak	Pre-Project	0.03	0.13	1.30	0.13	0.03
			Post (69-kV)	0.03	0.15	0.83	0.09	0.03
			Post (115-kV)	0.05	0.24	1.39	0.15	0.05
	B-15191-NE Sheet 12	Annual Average	Pre-Project	0.03	0.13	1.30	0.13	0.03
			Post (69-kV)	0.03	0.13	0.81	0.08	0.02
			Post (115-kV)	0.04	0.22	1.37	0.14	0.04
		System Peak	Pre-Project	0.03	0.13	1.30	0.13	0.03
			Post (69-kV)	0.03	0.13	0.81	0.08	0.02
			Post (115-kV)	0.04	0.22	1.37	0.14	0.04
Gardner – Westminster	B-15191-NE Sheet 13	Annual Average	Pre-Project	0.03	0.12	1.29	0.12	0.03
			Post (69-kV)	0.01	0.09	0.42	0.06	0.01
			Post (115-kV)	0.01	0.14	0.42	0.09	0.01
		System Peak	Pre-Project	0.02	0.09	0.88	0.09	0.02
			Post (69-kV)	0.03	0.10	1.13	0.07	0.02
			Post (115-kV)	0.03	0.14	1.21	0.09	0.02
Westminster – East Westminster	B-15191-NE Sheet 13	Annual Average	Pre-Project	0.02	0.10	1.02	0.10	0.02
			Post (69-kV)	0.03	0.13	0.83	0.08	0.03
			Post (115-kV)	0.05	0.25	1.46	0.15	0.05
		System Peak	Pre-Project	0.01	0.08	0.66	0.08	0.01
			Post (69-kV)	0.05	0.10	1.83	0.09	0.05
			Post (115-kV)	0.09	0.17	2.94	0.13	0.08
	B-15191-NE Sheet 14	Annual Average	Pre-Project	0.02	0.10	1.02	0.10	0.02
			Post (69-kV)	<0.01	0.09	0.25	0.05	<0.01
			Post (115-kV)	0.04	0.21	1.28	0.13	0.04
		System Peak	Pre-Project	0.01	0.08	0.66	0.08	0.01
			Post (69-kV)	0.02	0.08	0.81	0.05	0.01
			Post (115-kV)	0.03	0.14	1.30	0.09	0.02

Line Segment	Cross Section	Loading	Scenario	Electric Field (kV/m)				
				50 ft from Northern ROW Edge	Northern ROW Edge	Maximum Within ROW	Southern ROW Edge	50 ft from Southern ROW Edge
East Westminster – Pratts Junction	B-15191-NE Sheet 14	Annual Average	Pre-Project	0.03	0.12	1.20	0.12	0.03
			Post (69-kV)	0.02	0.10	0.36	0.06	0.02
			Post (115-kV)	0.02	0.15	0.43	0.09	0.02
		System Peak	Pre-Project	0.02	0.10	1.02	0.10	0.02
			Post (69-kV)	0.03	0.07	0.87	0.04	0.03
			Post (115-kV)	0.05	0.13	1.37	0.07	0.05
	B-15191-NE Sheet 15	Annual Average	Pre-Project	0.02	0.04	1.48	0.10	0.03
			Post (69-kV)	0.02	0.03	1.48	0.02	0.02
			Post (115-kV)	0.01	0.03	1.48	0.02	0.02
		System Peak	Pre-Project	0.01	0.03	1.94	0.11	0.03
			Post (69-kV)	0.01	0.03	1.94	0.03	0.02
			Post (115-kV)	0.02	0.03	1.95	0.05	0.03
	B-15191-NE Sheet 16	Annual Average	Pre-Project	0.02	0.04	1.48	0.10	0.03
			Post (69-kV)	0.02	0.05	1.49	0.05	0.03
			Post (115-kV)	0.03	0.05	2.03	0.08	0.05
		System Peak	Pre-Project	0.01	0.03	1.94	0.11	0.03
			Post (69-kV)	0.02	0.03	1.95	0.06	0.03
			Post (115-kV)	0.02	0.03	2.54	0.09	0.05
	B-15191-NE Sheet 17	Annual Average	Pre-Project	0.02	0.04	1.14	0.15	0.04
			Post (69-kV)	0.03	0.05	1.27	0.04	0.03
			Post (115-kV)	0.03	0.06	1.91	0.07	0.05
		System Peak	Pre-Project	0.01	0.03	1.94	0.14	0.04
			Post (69-kV)	0.02	0.03	1.95	0.06	0.03
			Post (115-kV)	0.02	0.03	2.54	0.09	0.05
	B-15191-NE Sheet 18	Annual Average	Pre-Project	0.02	0.04	1.22	0.15	0.05
			Post (69-kV)	0.03	0.05	1.23	0.13	0.02
			Post (115-kV)	0.03	0.05	1.24	0.20	0.03
		System Peak	Pre-Project	0.02	0.03	1.95	0.16	0.05
			Post (69-kV)	0.02	0.03	1.95	0.08	0.05
			Post (115-kV)	0.02	0.03	2.93	0.13	0.08
	B-15191-NE Sheet 19	Annual Average	Pre-Project	0.02	0.05	2.50	0.91	0.21
			Post (69-kV)	0.03	0.05	2.49	0.90	0.20
			Post (115-kV)	0.03	0.06	2.49	0.89	0.19
		System Peak	Pre-Project	0.02	0.04	3.80	0.89	0.18
			Post (69-kV)	0.02	0.04	3.78	0.86	0.16
			Post (115-kV)	0.02	0.03	3.76	0.85	0.16
	B-15191-NE Sheet 20	Annual Average	Pre-Project	0.02	0.04	2.77	0.91	0.21
			Post (69-kV)	0.02	0.05	2.76	0.90	0.19
			Post (115-kV)	0.03	0.05	2.76	0.89	0.19
		System Peak	Pre-Project	0.02	0.04	3.80	0.89	0.18
			Post (69-kV)	0.02	0.04	3.78	0.86	0.16
			Post (115-kV)	0.02	0.03	3.76	0.85	0.16

Line Segment	Cross Section	Loading	Scenario	Electric Field (kV/m)				
				50 ft from Northern ROW Edge	Northern ROW Edge	Maximum Within ROW	Southern ROW Edge	50 ft from Southern ROW Edge
East Westminster – Pratts Junction (continued)	B-15191-NE Sheet 21	Annual Average	Pre-Project	0.02	0.04	2.04	0.90	0.23
			Post (69-kV)	0.02	0.05	2.02	0.88	0.21
			Post (115-kV)	0.03	0.05	2.02	0.87	0.21
		System Peak	Pre-Project	0.02	0.04	3.80	0.89	0.18
			Post (69-kV)	0.02	0.04	3.78	0.86	0.16
			Post (115-kV)	0.02	0.04	3.76	0.85	0.16
Royalston – Chestnut Hill	B-15192-NE Sheet 1	Annual Average	Pre-Project	0.01	0.09	1.73	0.18	0.02
			Post (69-kV)	0.05	0.25	0.70	0.25	0.07
			Post (115-kV)	0.09	0.42	1.19	0.43	0.11
		System Peak	Pre-Project	0.01	0.08	1.76	0.18	0.02
			Post (69-kV)	0.05	0.26	0.99	0.31	0.06
			Post (115-kV)	0.09	0.44	1.60	0.53	0.10
	B-15192-NE Sheet 2	Annual Average	Pre-Project	0.01	0.09	1.73	0.18	0.02
			Post (69-kV)	<0.01	0.03	0.70	0.04	0.01
			Post (115-kV)	0.01	0.05	1.19	0.07	0.02
		System Peak	Pre-Project	0.01	0.08	1.76	0.18	0.02
			Post (69-kV)	0.01	0.04	0.84	0.04	0.01
			Post (115-kV)	0.02	0.06	1.35	0.07	0.02
Gardner – Crystal Lake	B-15193-NE Sheet 1	Annual Average	Pre-Project	0.01	0.07	0.67	0.07	0.01
			Post (69-kV)	0.02	0.11	0.94	0.12	0.02
			Post (115-kV)	0.05	0.19	1.59	0.20	0.05
		System Peak	Pre-Project	0.04	0.15	1.31	0.15	0.04
			Post (69-kV)	0.04	0.04	1.68	0.04	0.04
			Post (115-kV)	0.08	0.06	2.80	0.06	0.08

Notes:
ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter; ROW = Right-of-Way.

4 Conclusions

Gradient performed an independent EMF assessment for the National Grid A1 and B2 Line ACR Project, which involves replacing the structures for the existing 69-kV overhead A1 and B2 double circuit lines between the Vernon No. 13 Substation in Vernon, Vermont, and the Pratts Junction No. 225 Substation in Sterling, Massachusetts. The total Project route is approximately 61 miles in length (including tap lines to be refurbished), with approximately 2.5 miles in Vermont, 4.3 miles in New Hampshire, and 54.3 miles in Massachusetts. As discussed in this report, EMF modeling was conducted at a height of 1 meter (3.28 feet) above the ground surface for 26 representative ROW cross sections in the Commonwealth of Massachusetts. EMF modeling was performed for a pre-Project case, as well as two post-Project cases, namely for an in-service year case assuming the A1 and B2 lines operate at 69-kV and for an in-service year case assuming the lines operate at 115-kV. For each case, EMF modeling was conducted for both annual average and system peak load levels.

As described in this report, our EMF modeling analysis demonstrated that all model-predicted, post-Project MF levels for the representative cross sections in Massachusetts, including for annual average and system peak loading scenarios, are well below the ICNIRP health-based guideline for allowable public exposure to 60-Hz MF (2,000 mG; ICNIRP, 2010). The Project will frequently result in small increases to edge-of-ROW MF levels for the representative cross sections (often <1 mG, and nearly all <5 mG and <10 mG for annual average and system peak loading scenarios, respectively).

The EMF modeling analysis also showed that, for the representative cross sections in Massachusetts, all modeled edge-of-ROW EF levels are well below the ICNIRP health-based guideline for allowable public exposure to 60-Hz EF (4.2 kV/m; ICNIRP, 2010). Our modeling analysis indicates that the Project will result in little change to EFs at the ROW edges (*i.e.*, all edge-of-ROW EF changes were <0.4 kV/m) across the modeling results.

References

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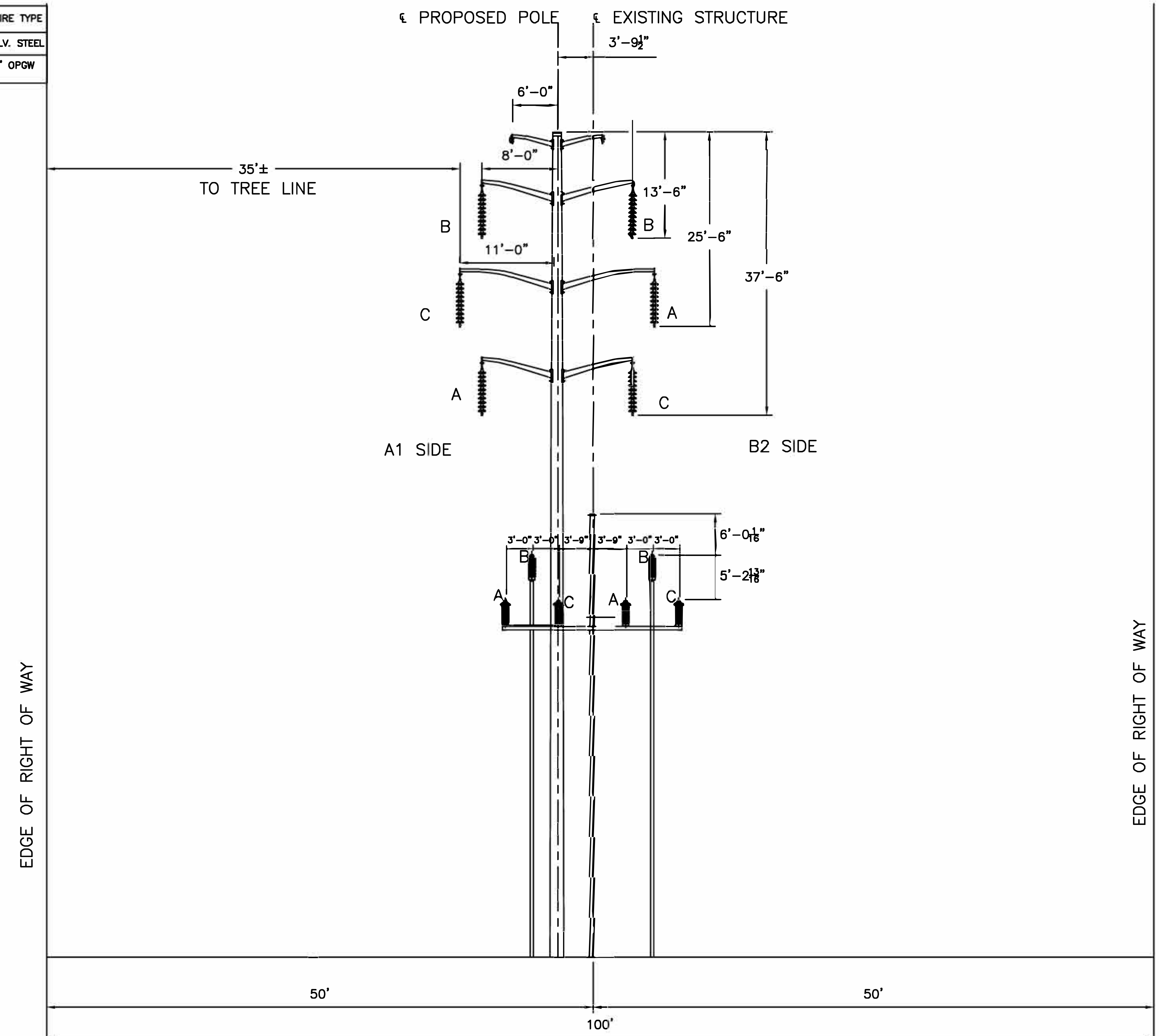
Appendix A

Representative Pre-Project and Post-Project ROW Overhead Line Cross Sections in the Commonwealth of Massachusetts

B-15191-NE
SHEET 1

LINE NAME	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2-1/2" OPGW

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



PROPOSED TYPICAL DOUBLE CIRCUIT STRUCTURES
LOOKING TOWARDS PRATTS JUNCTION
EXISTING STRUCTURE 94 TO EXISTING STRUCTURE 186
STATE OF NEW HAMPSHIRE - EXISTING STRUCTURE 94-98
COMMONWEALTH OF MASSACHUSETTS - EXISTING STRUCTURE 99-186

INCHES ON ORIGINAL

VER	DATE	VERSION DESCRIPTION	PREPARED/REVIEWED/APPROVED
1	2/22	INITIAL ISSUE	EEG LRG GAP

nationalgrid

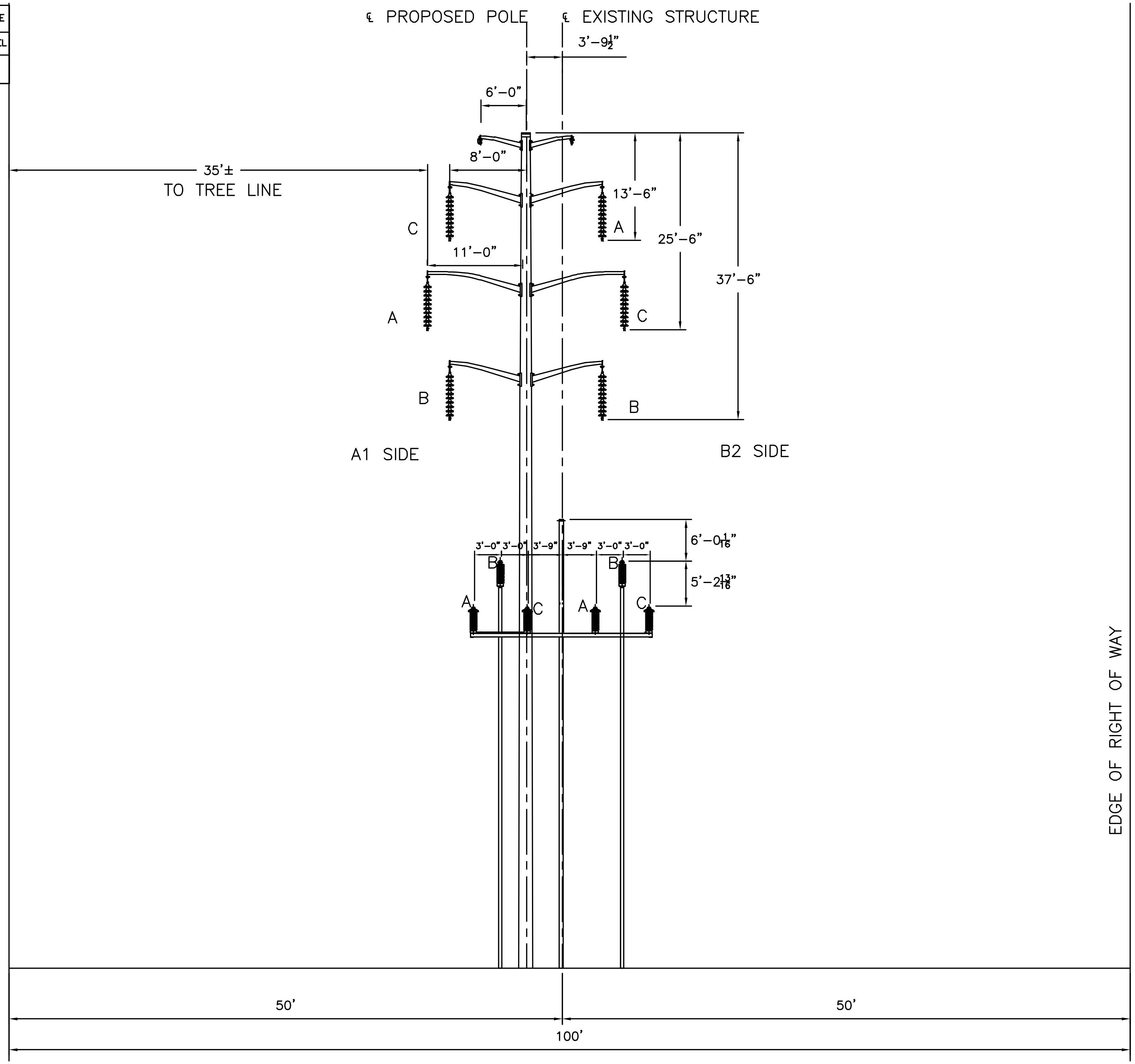
PREPARED BY	EEG	2/22
REVIEWED BY	LRG	2/22
APPROVED BY	GAP	2/22
SCALE	AS NOTED	
SHEET	2 OF 22	
INDEX	400739	

CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION)
PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION
PROPOSED DOUBLE CIRCUIT STRUCTURES

VERSION 1

LINE NAME	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2-1/2" OPGW

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



PROPOSED TYPICAL DOUBLE CIRCUIT STRUCTURES
LOOKING TOWARDS PRATTS JUNCTION
EXISTING STRUCTURE 186 TO EXISTING STRUCTURE 201
COMMONWEALTH OF MASSACHUSETTS

INCHES ON ORIGINAL

CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION) PROJECT (A1/B2 REBUILD PROJECT) FACING PRATTS JUNCTION PROPOSED DOUBLE CIRCUIT STRUCTURES

PREPARED BY EEG 2/22 | REVIEWED BY LRG 2/22 | APPROVED BY GAP 2/22 | SCALE AS NOTED | SHEET 3 OF 22 | INDEX 400739

nationalgrid

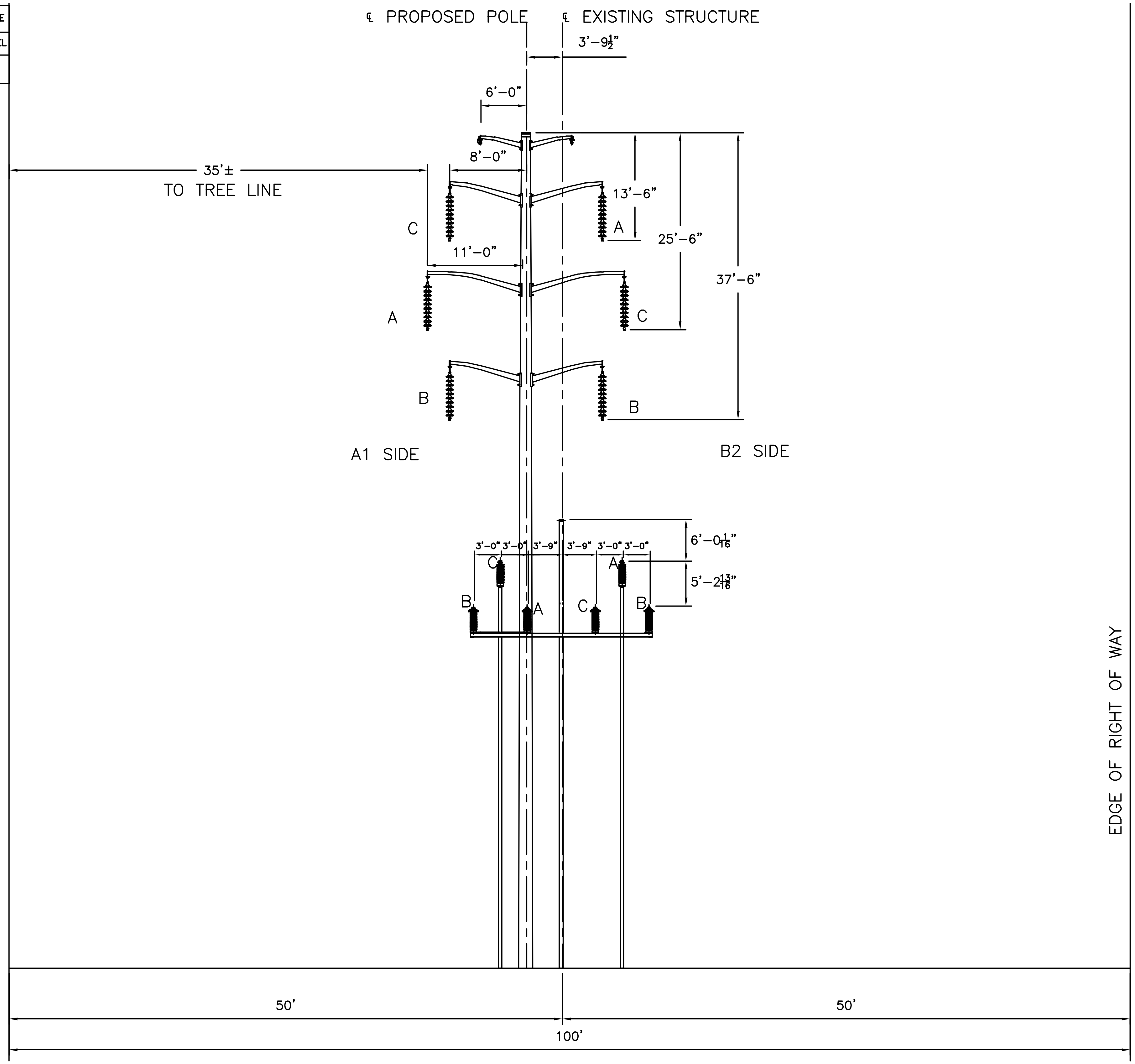
VER 1 | DATE 2/22 | INITIAL ISSUE | EEG LRG GAP

VERSION 1

B-15191-NE
SHEET 3

LINE NAME	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2-1/2" OPGW

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



PROPOSED TYPICAL DOUBLE CIRCUIT STRUCTURES
LOOKING TOWARDS PRATTS JUNCTION
EXISTING STRUCTURE 201 TO ROYALSTON STATION
COMMONWEALTH OF MASSACHUSETTS

VER	DATE	VERSION DESCRIPTION	PREPARED	REVIEWED	APPROVED
1	2/22	INITIAL ISSUE	EEG	LRG	GAP

nationalgrid

PREPARED BY EEG 2/22
REVIEWED BY LRG 2/22
APPROVED BY GAP 2/22
SCALE AS NOTED
SHEET 4 OF 22
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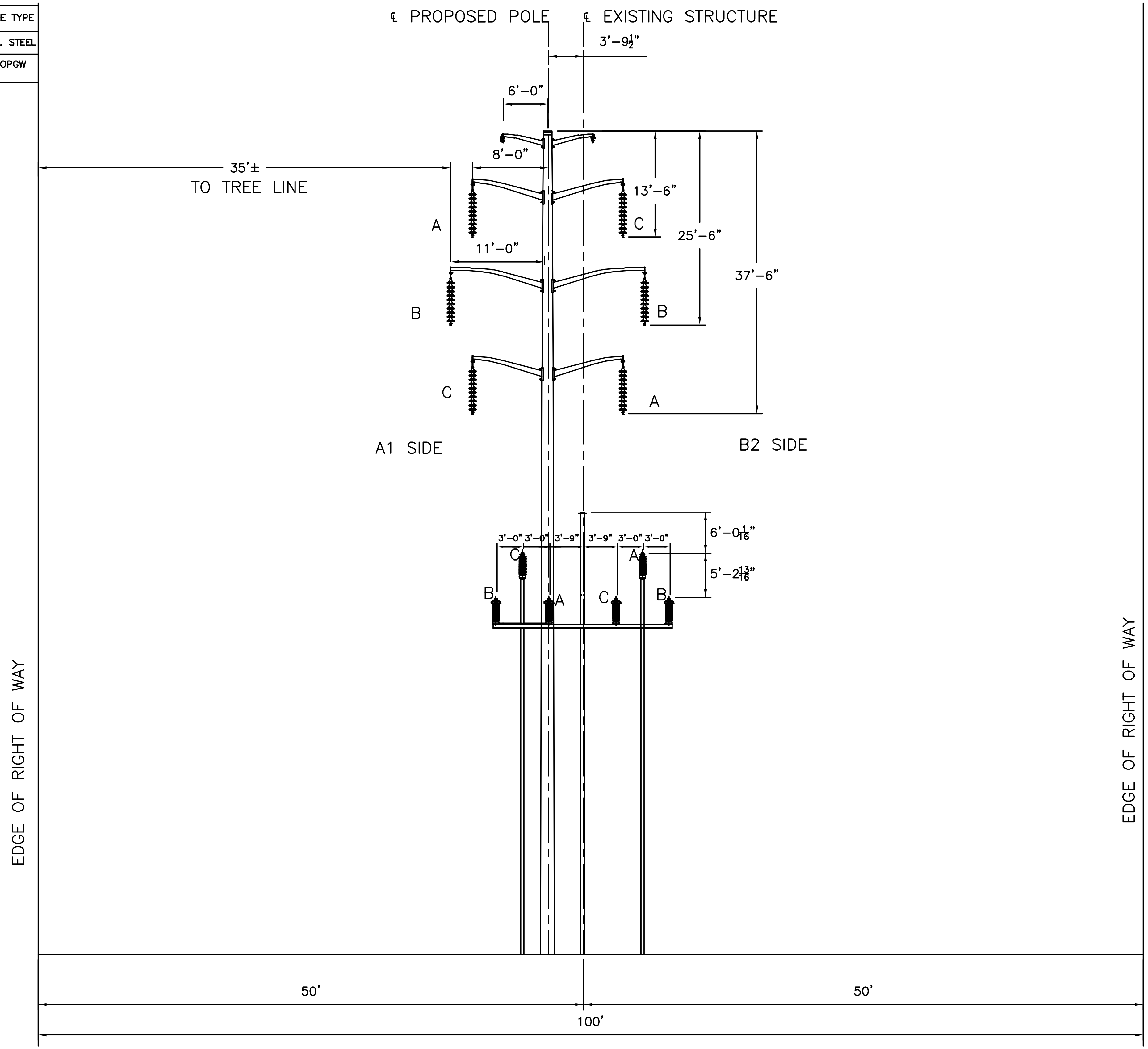
CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION)
PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION
PROPOSED DOUBLE CIRCUIT STRUCTURES

VERSION 1

INCHES ON ORIGINAL

LINE NAME	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2-1/2" OPGW

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



PROPOSED TYPICAL DOUBLE CIRCUIT STRUCTURES
LOOKING TOWARDS PRATTS JUNCTION
ROYALSTON STATION TO EXISTING STRUCTURE 318
COMMONWEALTH OF MASSACHUSETTS

INCHES ON ORIGINAL

VER	DATE	VERSION DESCRIPTION	PREPARED	REVIEWED	APPROVED
1	2/22	INITIAL ISSUE	EEG	LRG	GAP

VERSION 1

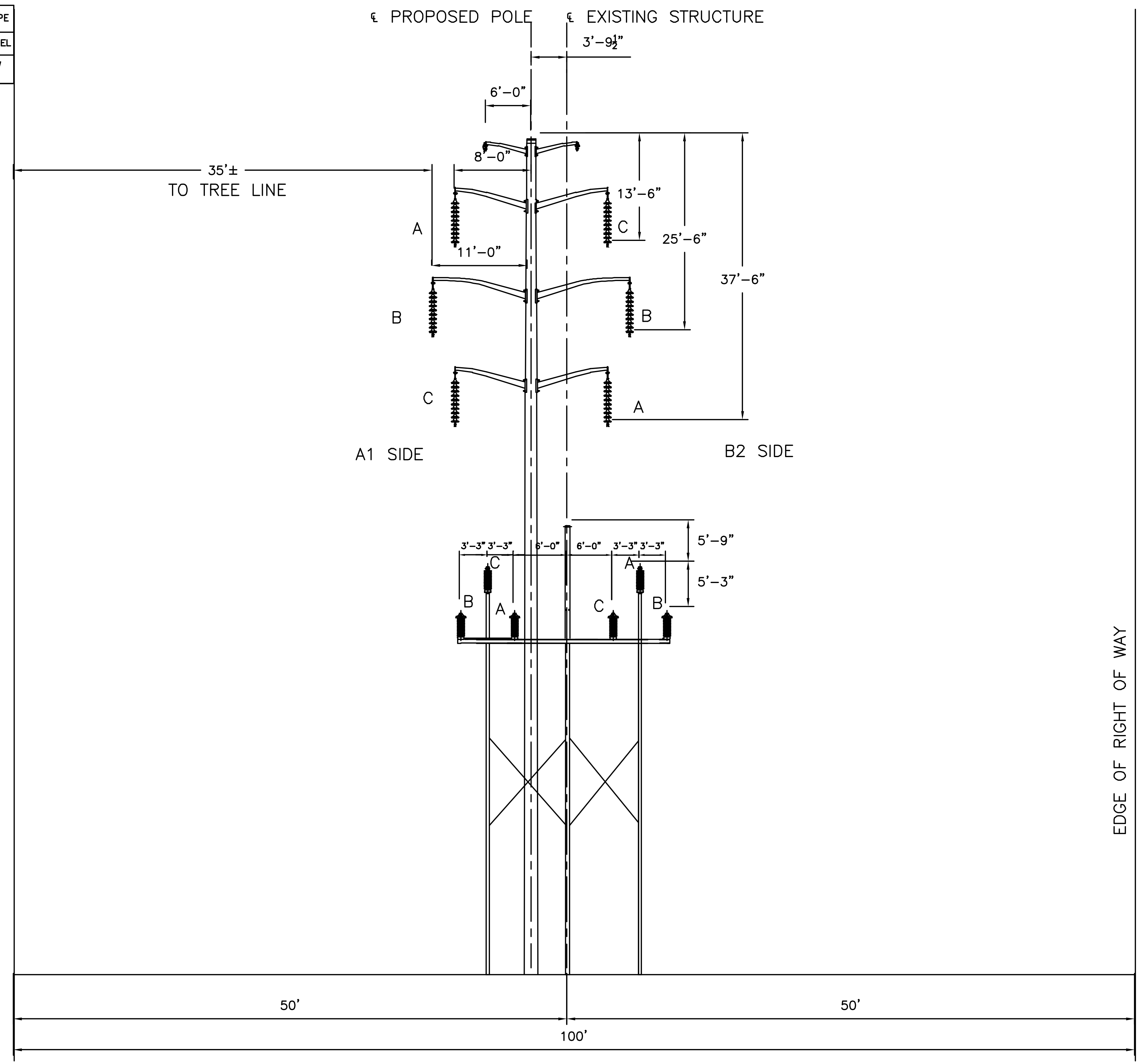
nationalgrid

PREPARED BY	EEG	2/22
REVIEWED BY	LRG	2/22
APPROVED BY	GAP	2/22
SCALE	AS NOTED	
SHEET	5 OF 22	
INDEX	400739	

CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION) PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION
PROPOSED DOUBLE CIRCUIT STRUCTURES

LINE NAME	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2-1/2" OPGW

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



PROPOSED TYPICAL DOUBLE CIRCUIT STRUCTURES
LOOKING TOWARDS PRATTS JUNCTION
EXISTING STRUCTURE 318 TO EXISTING STRUCTURE 319
COMMONWEALTH OF MASSACHUSETTS

CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION)
PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION
PROPOSED DOUBLE CIRCUIT STRUCTURES

PREPARED BY	EEG	2/22
REVIEWED BY	LRG	2/22
APPROVED BY	GAP	2/22
SCALE	AS NOTED	
SHEET	6 OF 22	
INDEX	400739	

nationalgrid

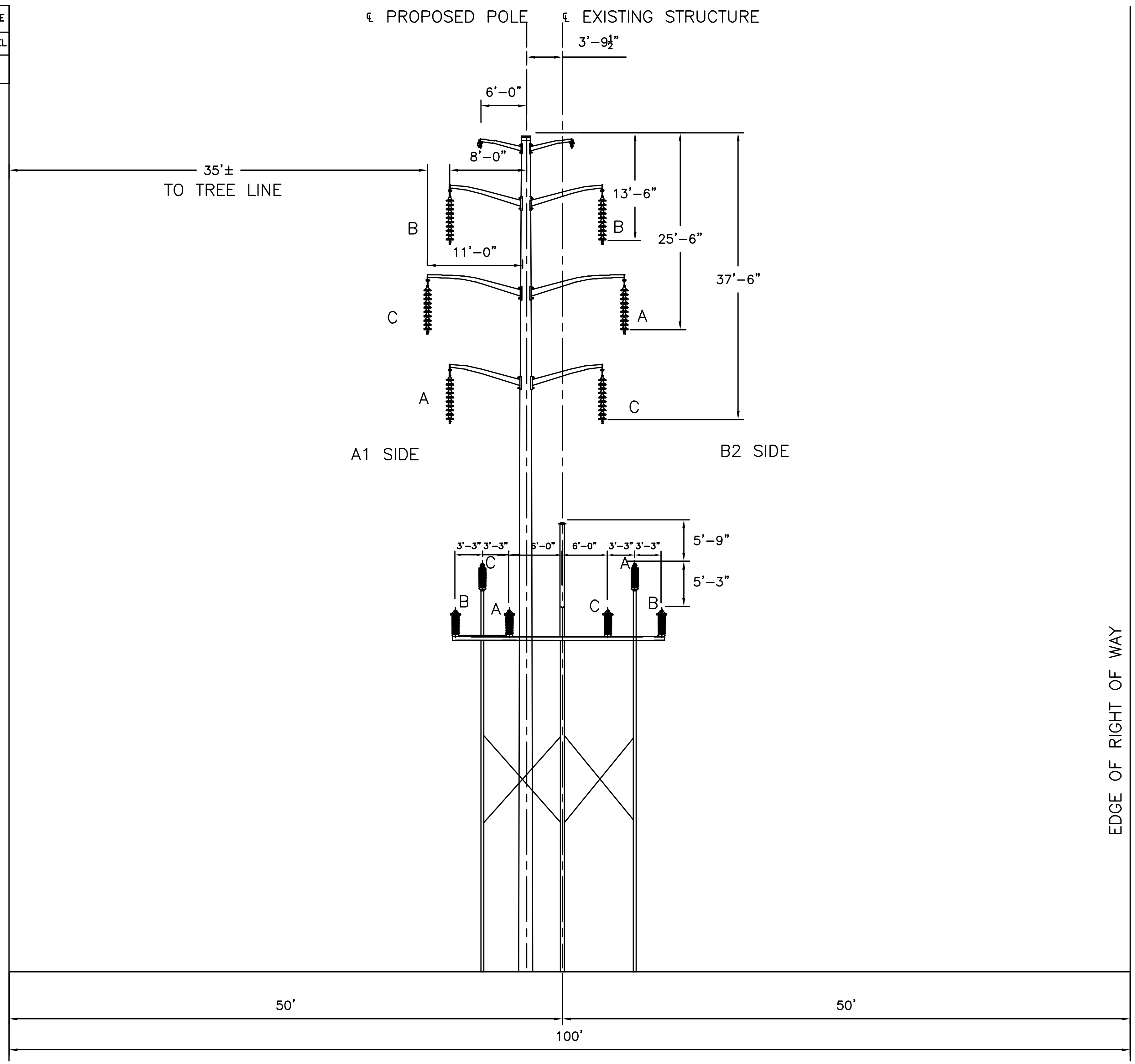
VER	DATE	VERSION DESCRIPTION	PREPARED	REVIEWED	APPROVED
1	2/22	INITIAL ISSUE	EEG	LRG	GAP

VERSION 1

INCHES ON ORIGINAL

LINE NAME	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2-1/2" OPGW

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



PROPOSED TYPICAL DOUBLE CIRCUIT STRUCTURES
LOOKING TOWARDS PRATTS JUNCTION
EXISTING STRUCTURE 319 TO EXISTING STRUCTURE 343-1
COMMONWEALTH OF MASSACHUSETTS

nationalgrid

CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION)
PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION
PROPOSED DOUBLE CIRCUIT STRUCTURES

PREPARED BY	EEG	2/22
REVIEWED BY	LRG	2/22
APPROVED BY	GAP	2/22
SCALE	AS NOTED	
SHEET	7 OF 22	
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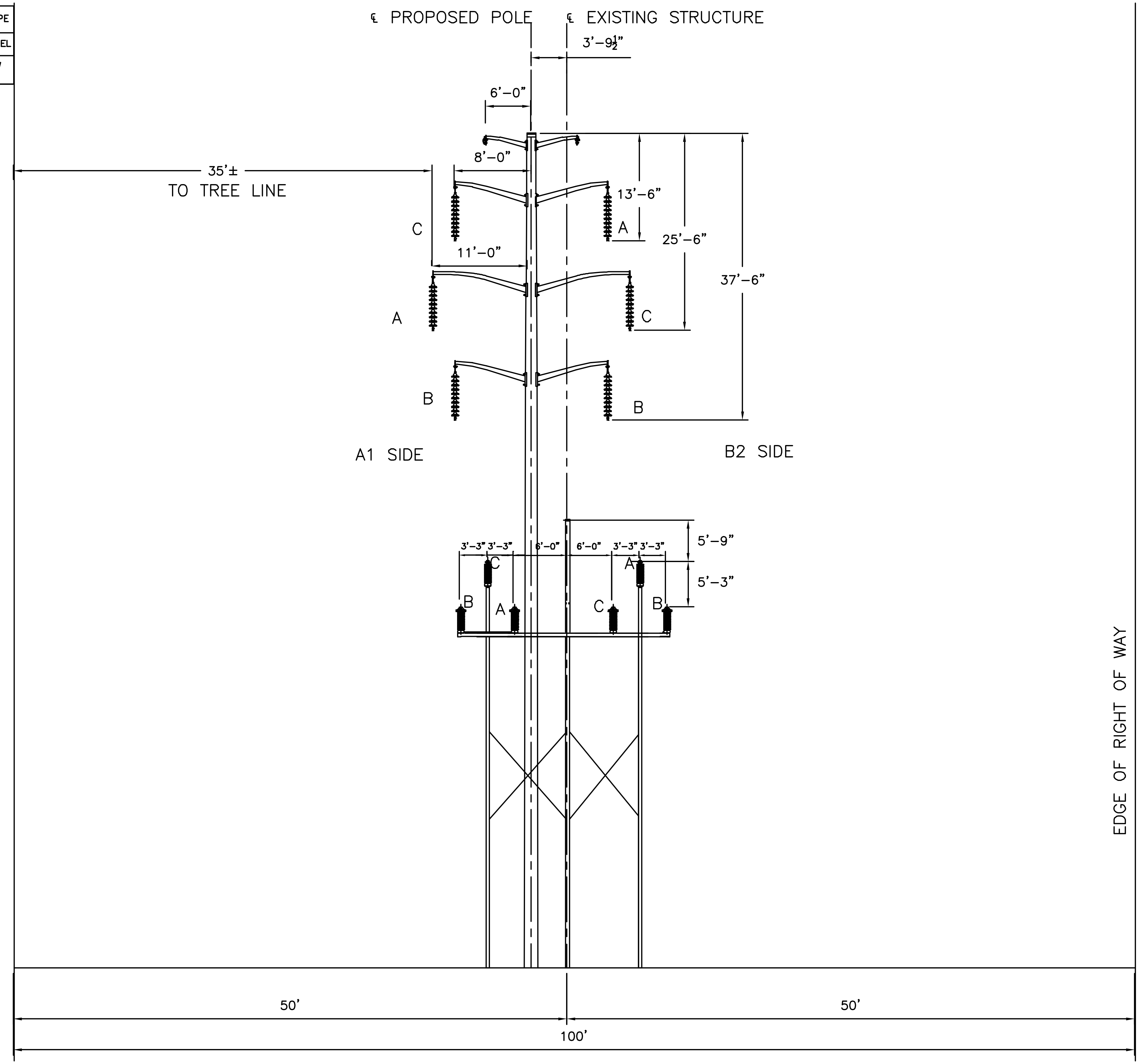
VER	DATE	VERSION DESCRIPTION	PREPARED	REVIEWED	APPROVED
1	2/22	INITIAL ISSUE	EEG	LRG	GAP

VERSION 1

INCHES ON ORIGINAL

LINE NAME	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2-1/2" OPGW

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



PROPOSED TYPICAL DOUBLE CIRCUIT STRUCTURES
LOOKING TOWARDS PRATTS JUNCTION
EXISTING STRUCTURE 343-1 TO EXISTING STRUCTURE 346
COMMONWEALTH OF MASSACHUSETTS

CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION)
PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION
PROPOSED DOUBLE CIRCUIT STRUCTURES

nationalgrid

VER	DATE	VERSION DESCRIPTION	PREPARED	REVIEWED	APPROVED
1	2/22	INITIAL ISSUE	EEG	LRG	GAP

PREPARED BY EEG 2/22
REVIEWED BY LRG 2/22
APPROVED BY GAP 2/22
SCALE AS NOTED
SHEET B OF 22
INDEX 400739

VERSION 1

INCHES ON ORIGINAL

B-15191-NE

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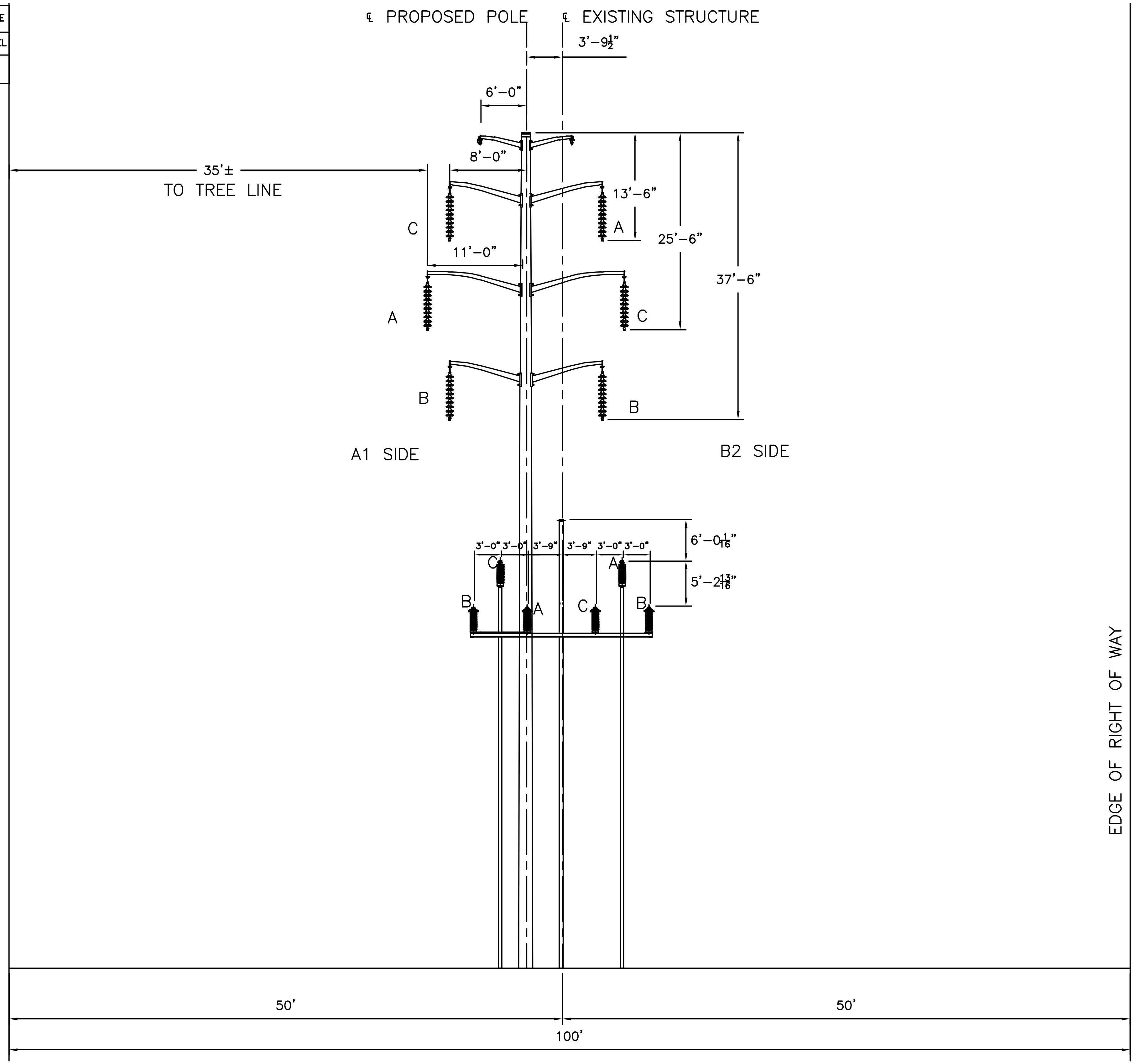
SHEET 8

LINE NAME	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2-1/2" OPGW

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



PROPOSED TYPICAL DOUBLE CIRCUIT STRUCTURES
LOOKING TOWARDS PRATTS JUNCTION
EXISTING STRUCTURE 347 TO OTTER RIVER
COMMONWEALTH OF MASSACHUSETTS

VERSION 1

VER	DATE	VERSION DESCRIPTION	PREPARED	REVIEWED	APPROVED
1	2/22	INITIAL ISSUE	EEG	LRG	GAP

nationalgrid

PREPARED BY EEG 2/22
REVIEWED BY LRG 2/22
APPROVED BY GAP 2/22
SCALE AS NOTED
SHEET 9 OF 22
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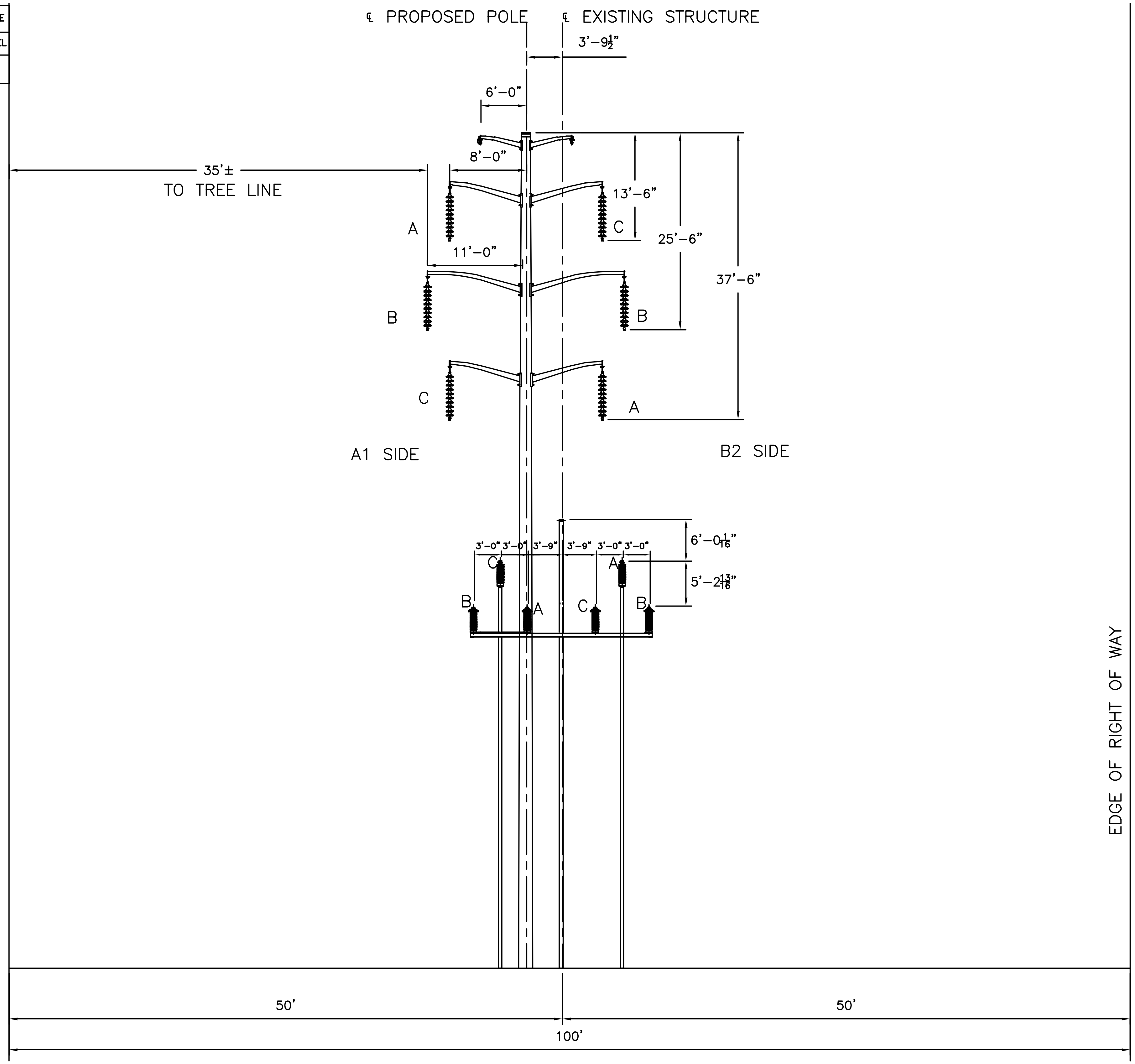
CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION) PROJECT (A1/B2 REBUILD PROJECT) FACING PRATTS JUNCTION
PROPOSED DOUBLE CIRCUIT STRUCTURES

INCHES ON ORIGINAL

LINE NAME	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2-1/2" OPGW

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



PROPOSED TYPICAL DOUBLE CIRCUIT STRUCTURES
LOOKING TOWARDS PRATTS JUNCTION
OTTER RIVER TO EXISTING STRUCTURE 358
COMMONWEALTH OF MASSACHUSETTS

INCHES ON ORIGINAL

nationalgrid

CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION) PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION
PROPOSED DOUBLE CIRCUIT STRUCTURES

PREPARED BY	EEG	2/22
REVIEWED BY	LRG	2/22
APPROVED BY	GAP	2/22
SCALE	AS NOTED	
SHEET	10 OF 22	
INDEX	400739	

VER	DATE	VERSION DESCRIPTION	PREPARED	REVIEWED	APPROVED
1	2/22	INITIAL ISSUE	EEG	LRG	GAP
2					
3					
4					
5					
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7					

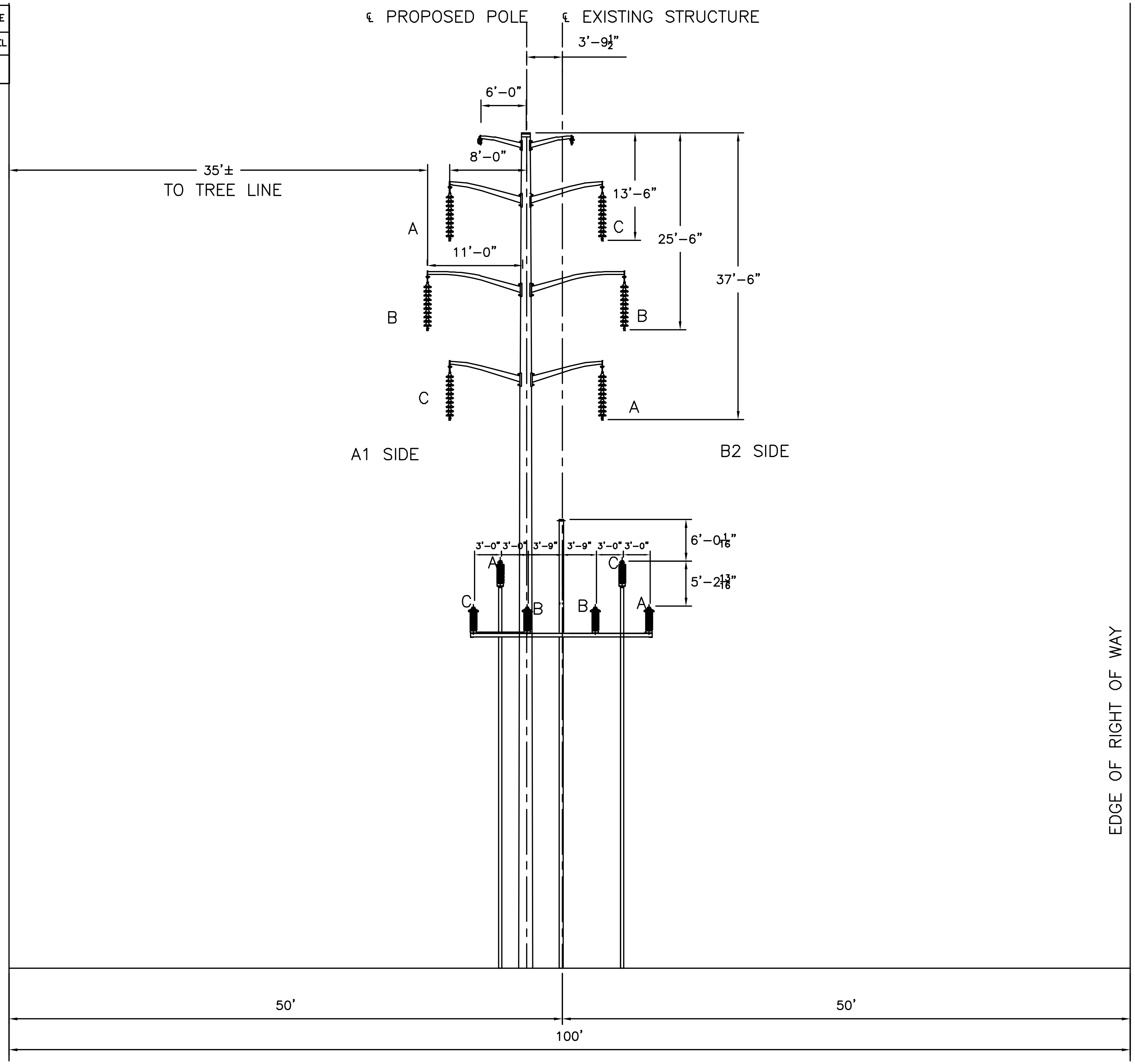
VERSION 1

B-15191-NE

B-15191-NE
SHEET 10

LINE NAME	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2-1/2" OPGW

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



PROPOSED TYPICAL DOUBLE CIRCUIT STRUCTURES
LOOKING TOWARDS PRATTS JUNCTION
EXISTING STRUCTURE 358 TO EXISTING STRUCTURE 377
COMMONWEALTH OF MASSACHUSETTS

VER	DATE	VERSION DESCRIPTION	PREPARED	REVIEWED	APPROVED
1	2/22	INITIAL ISSUE	EEG	LRG	GAP

VERSION 1

nationalgrid

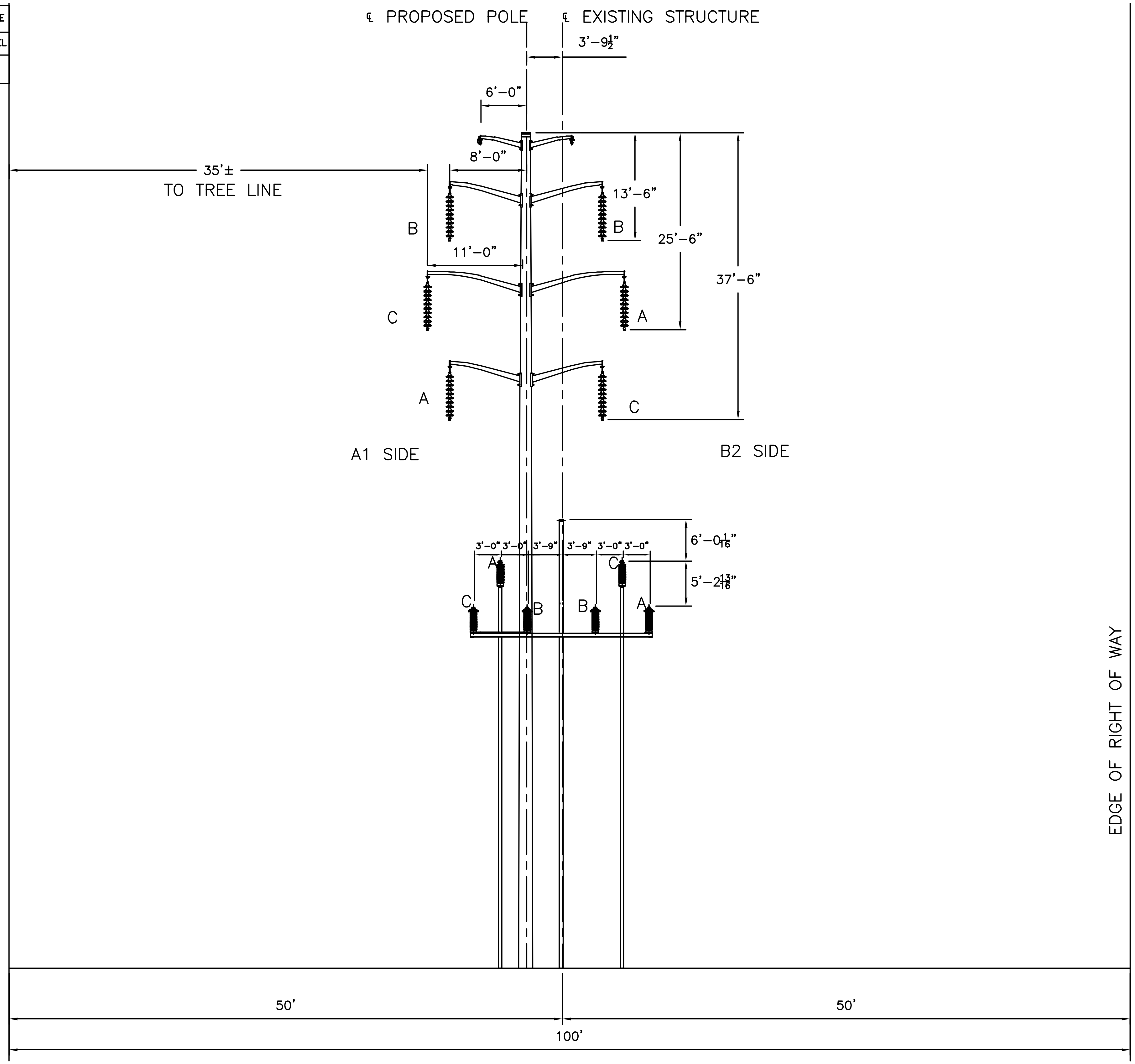
PREPARED BY EEG 2/22
REVIEWED BY LRG 2/22
APPROVED BY GAP 2/22
SCALE AS NOTED
SHEET 11 OF 22
INDEX 400739

CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION)
PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION
PROPOSED DOUBLE CIRCUIT STRUCTURES

INCHES ON ORIGINAL

LINE NAME	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2-1/2" OPGW

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



PROPOSED TYPICAL DOUBLE CIRCUIT STRUCTURES
LOOKING TOWARDS PRATTS JUNCTION
EXISTING STRUCTURE 377 TO EXISTING STRUCTURE 400
COMMONWEALTH OF MASSACHUSETTS

nationalgrid

CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION) PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION
PROPOSED DOUBLE CIRCUIT STRUCTURES

PREPARED BY EEG 2/22 | REVIEWED BY LRG 2/22 | APPROVED BY GAP 2/22 | SCALE AS NOTED | SHEET 12 OF 22 | INDEX 400739

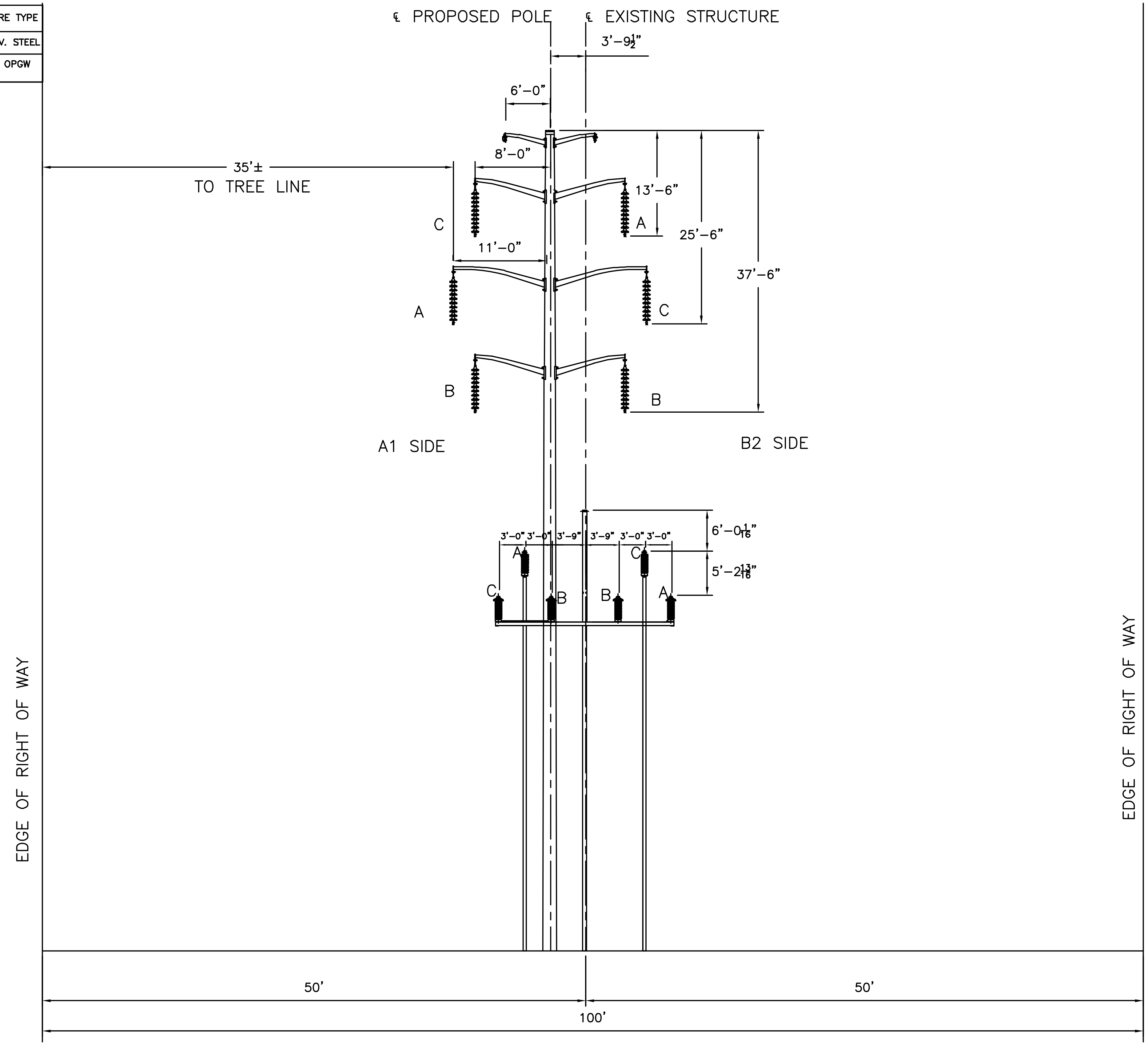
VERSION 1 | DATE 2/22 | INITIAL ISSUE | EEG LRG GAP

INCHES ON ORIGINAL

B-15191-NE
SHEET 12

LINE NAME	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2-1/2" OPGW

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



PROPOSED TYPICAL DOUBLE CIRCUIT STRUCTURES
LOOKING TOWARDS PRATTS JUNCTION
EXISTING STRUCTURE 400 TO GARDNER SWITCH TOWER
COMMONWEALTH OF MASSACHUSETTS

INCHES ON ORIGINAL

VER	DATE	VERSION DESCRIPTION	PREPARED	REVIEWED	APPROVED
1	2/22	INITIAL ISSUE	EEG	LRG	GAP

VERSION 1

nationalgrid

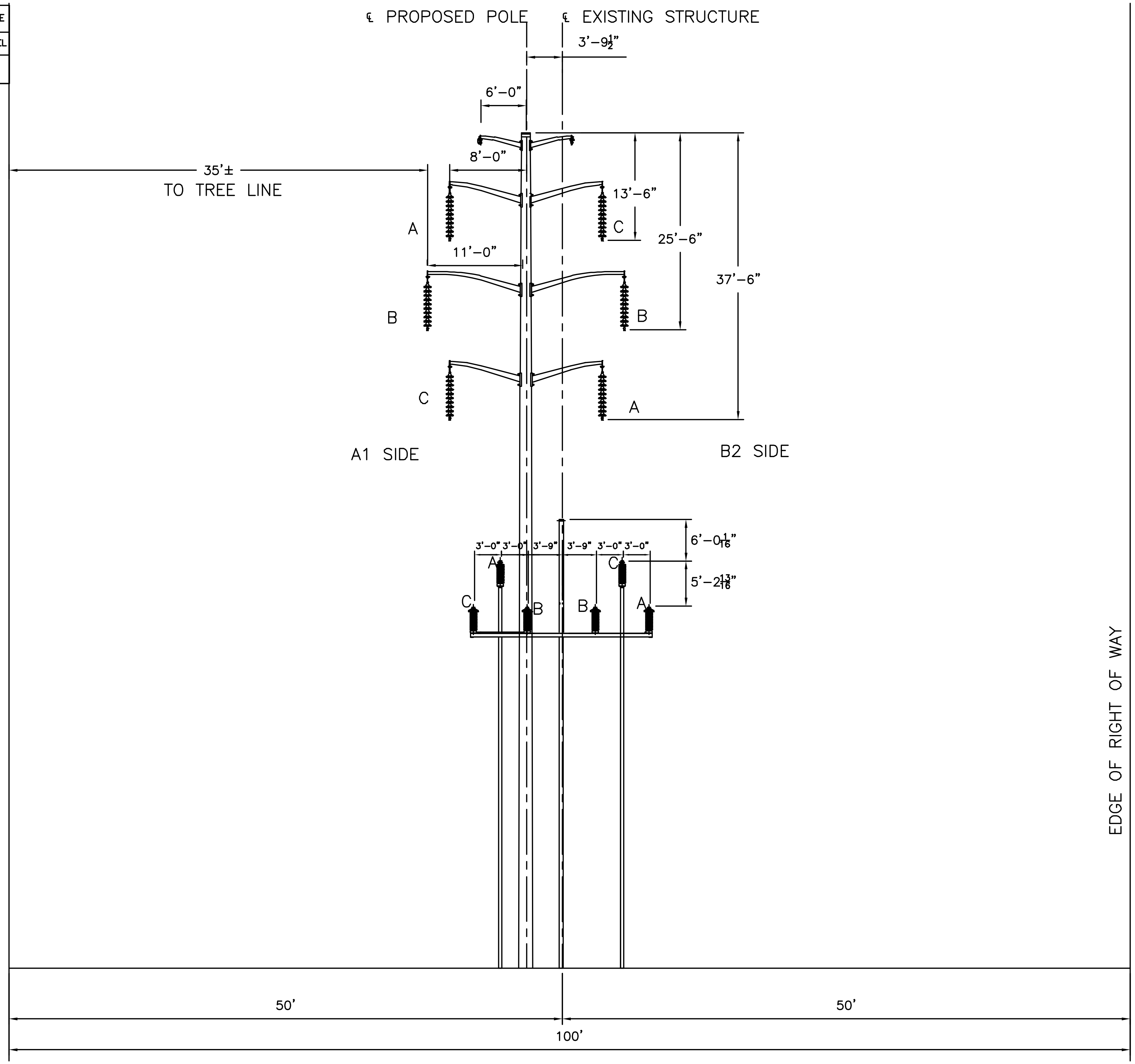
PREPARED BY	EEG	2/22
REVIEWED BY	LRG	2/22
APPROVED BY	GAP	2/22
SCALE	AS NOTED	
SHEET	13 OF 22	
INDEX	400739	

CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION)
PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION
PROPOSED DOUBLE CIRCUIT STRUCTURES

PRINTED 2/13/2023 11:32 AM

LINE NAME	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2-1/2" OPGW

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



PROPOSED TYPICAL DOUBLE CIRCUIT STRUCTURES
LOOKING TOWARDS PRATTS JUNCTION
GARDNER SWITCH TOWER TO EXISTING STRUCTURE 499
COMMONWEALTH OF MASSACHUSETTS

INCHES ON ORIGINAL

CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION)
PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION
PROPOSED DOUBLE CIRCUIT STRUCTURES

PREPARED BY	EEG	2/22
REVIEWED BY	LRG	2/22
APPROVED BY	GAP	2/22
SCALE	AS NOTED	
SHEET	14 OF 22	
INDEX	400739	

nationalgrid

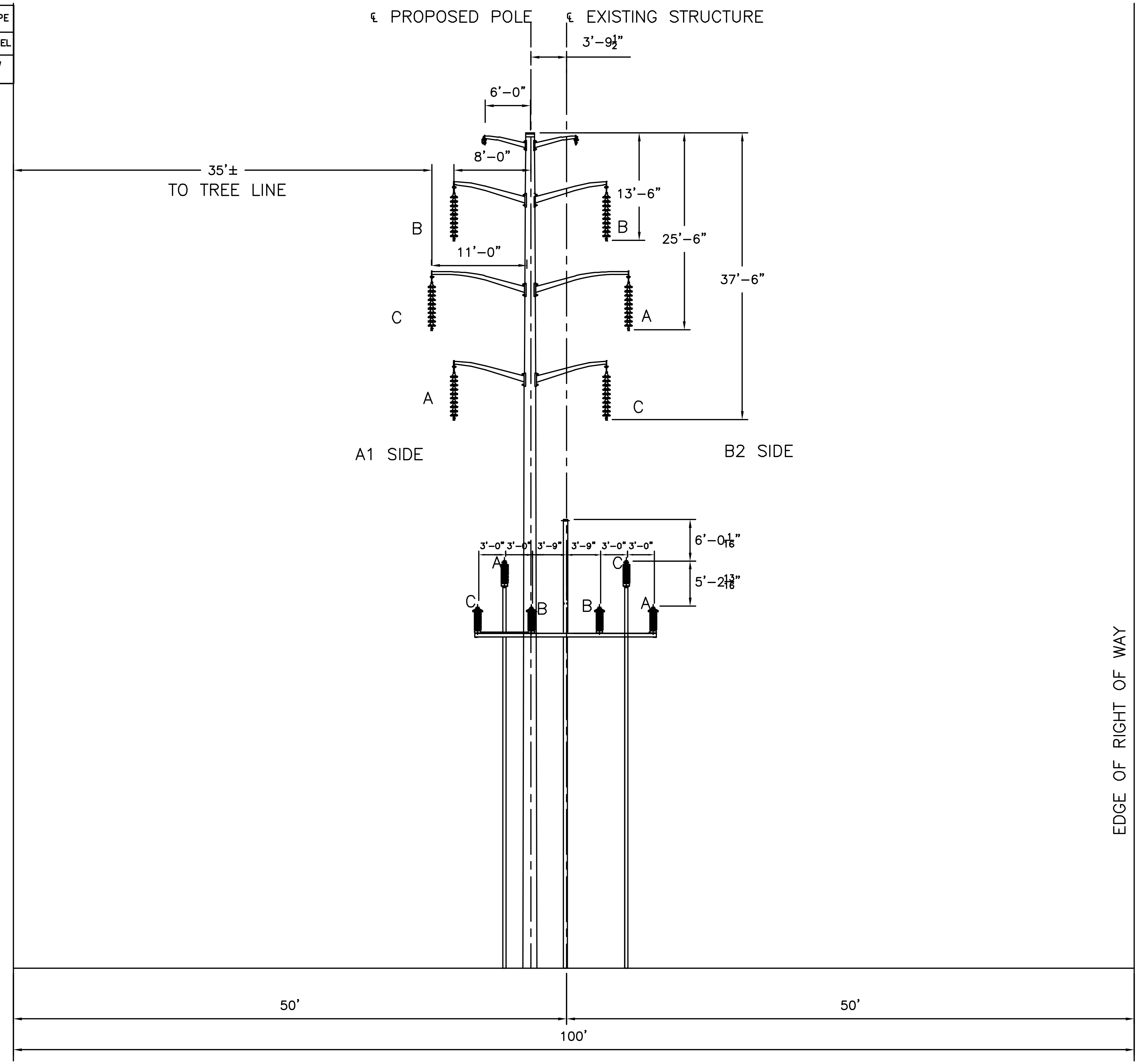
VER	DATE	VERSION DESCRIPTION	PREPARED	REVIEWED	APPROVED
1	2/22	INITIAL ISSUE	EEG	LRG	GAP
2					
3					
4					
5					
6					
7					

VERSION 1

B-15191-NE
SHEET 14

LINE NAME	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2-1/2" OPGW

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



PROPOSED TYPICAL DOUBLE CIRCUIT STRUCTURES
LOOKING TOWARDS PRATTS JUNCTION
EXISTING STRUCTURE 499 TO EXISTING STRUCTURE 561
COMMONWEALTH OF MASSACHUSETTS

VER	DATE	VERSION DESCRIPTION	PREPARED	REVIEWED	APPROVED
1	2/22	INITIAL ISSUE	EEG	LRG	GAP
2					
3					
4					
5					
6					
7					

VERSION 1

nationalgrid

PREPARED BY	EEG	2/22
REVIEWED BY	LRG	2/22
APPROVED BY	GAP	2/22
SCALE	AS NOTED	
SHEET	15 OF 22	
INDEX	400739	

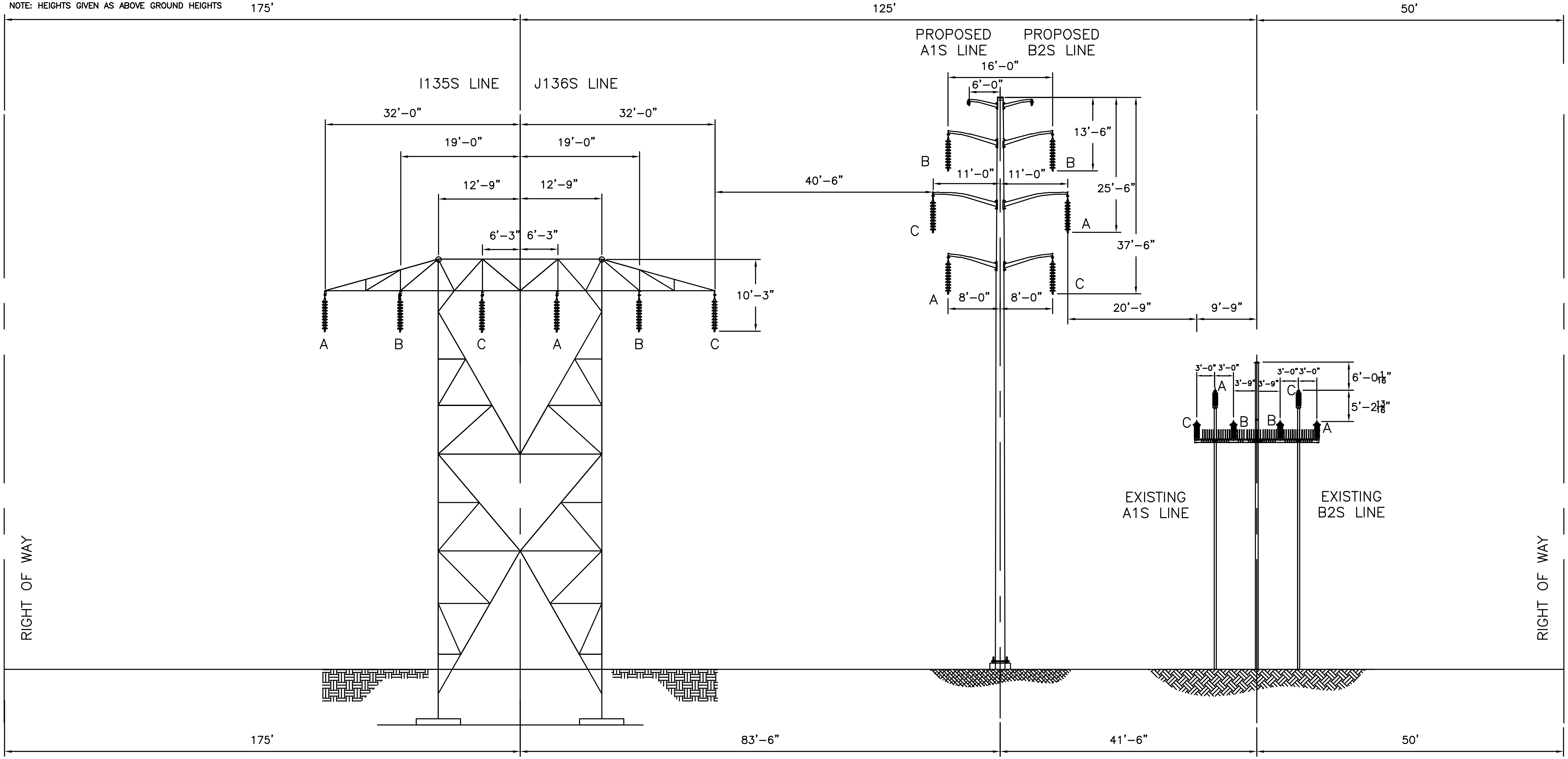
CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION)
PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION
PROPOSED DOUBLE CIRCUIT STRUCTURES

INCHES ON ORIGINAL

B-15191-NE
SHEET 15

LINE NAME/ VOLTAGE	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2 – 1/2" OPGW
I135S 115KV	70' STEEL LATTICE	795 ACSS "DRAKE"	1 – 7/16" EHS STEEL
J136S 115KV	70' STEEL LATTICE	795 ACSS "DRAKE"	1 – 7/16" EHS STEEL

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



CROSS-SECTION FACING PRATTS JUNCTION SUBSTATION
EXISTING STRUCTURE 561 TO EXISTING STRUCTURE 575
COMMONWEALTH OF MASSACHUSETTS

INCHES ON ORIGINAL

VER	DATE	VERSION DESCRIPTION	PREPARED	REVIEWED	APPROVED
1	2/22	INITIAL ISSUE	TY	LRG	GAP

VERSION 1

nationalgrid

PREPARED BY	TY	2/22
REVIEWED BY	LRG	2/22
APPROVED BY	GAP	2/22
SCALE	AS NOTED	
SHEET	16 OF 22	
INDEX	400739	

CROSS-SECTION
ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION)
PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION
PROPOSED DOUBLE CIRCUIT STRUCTURES

LINE NAME/ VOLTAGE	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2 – 1/2" OPGW
I135S 115KV	70' STEEL LATTICE	795 ACSS "DRAKE"	1 – 7/16" EHS STEEL
J136S 115KV	70' STEEL LATTICE	795 ACSS "DRAKE"	1 – 7/16" EHS STEEL

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS

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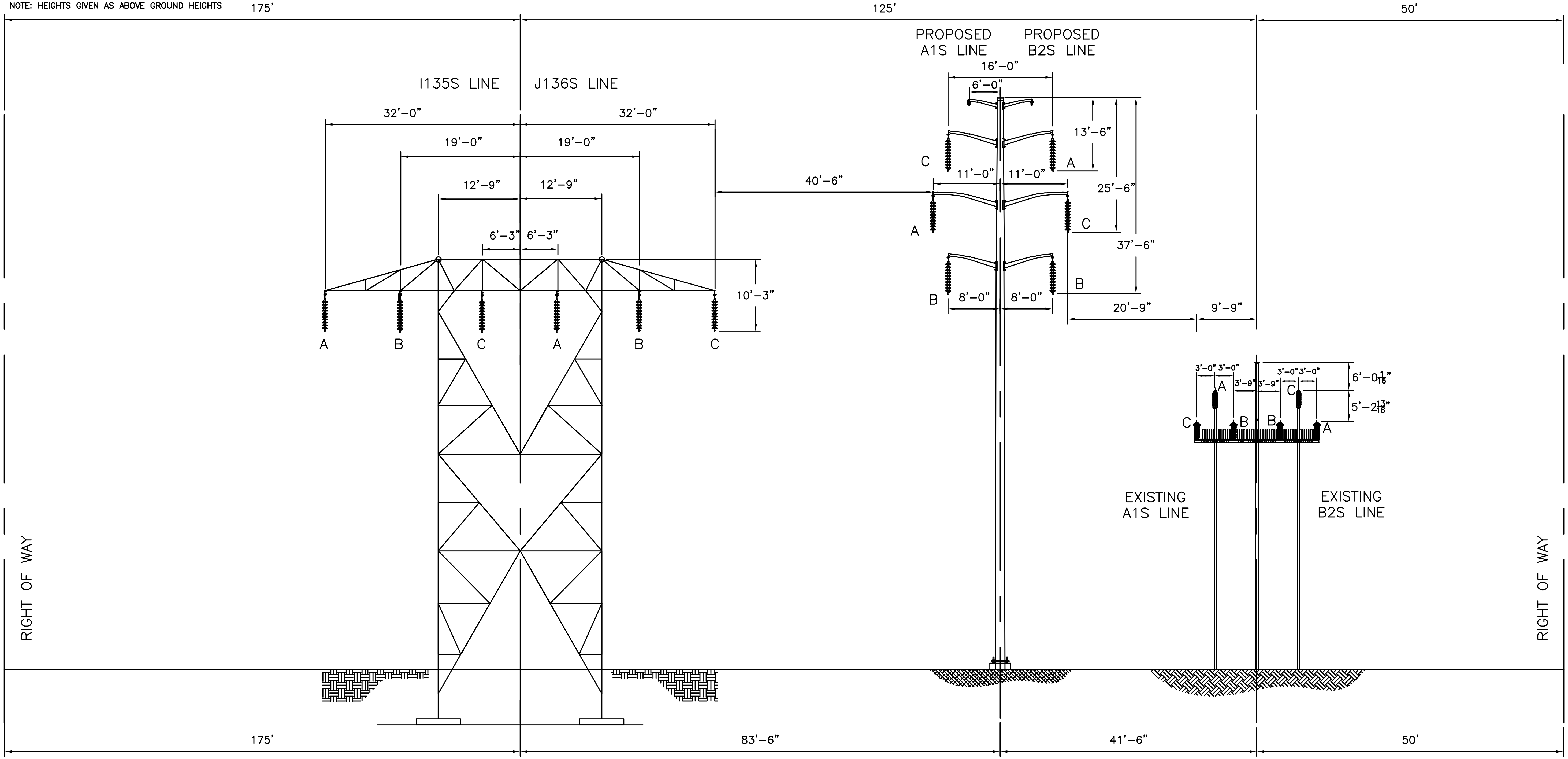

CROSS–SECTION FACING PRATTS JUNCTION SUBSTATION
EXISTING STRUCTURE 575 TO EXISTING STRUCTURE 615
COMMONWEALTH OF MASSACHUSETTS

CROSS–SECTION
ROW (A1/B2 MAIN LINE – VERNON TO PRATTS JUNCTION) PROJECT (A1/B2 REBUILD PROJECT) FACING PRATTS JUNCTION PROPOSED DOUBLE CIRCUIT STRUCTURES

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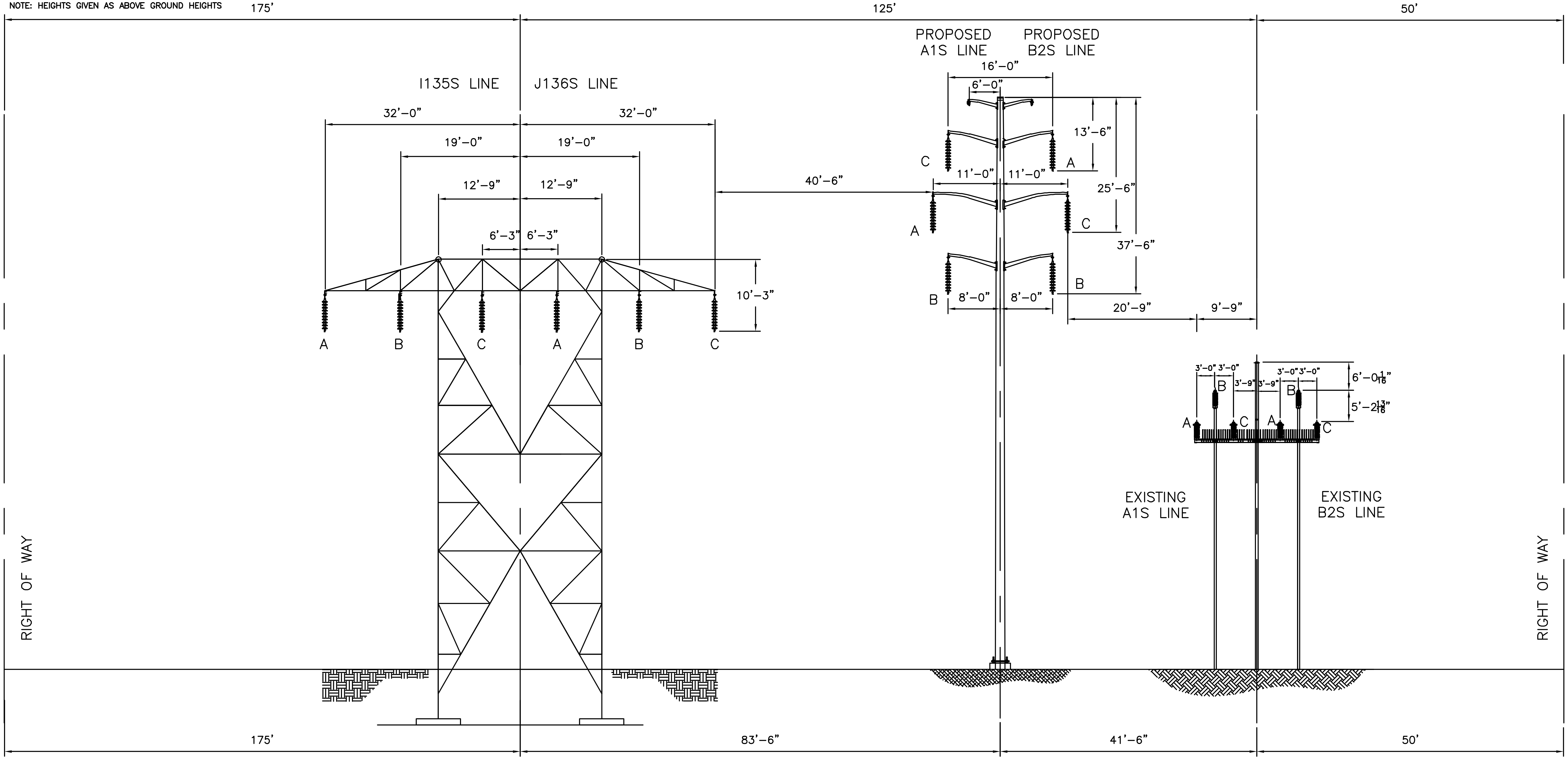
LINE NAME/ VOLTAGE	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2 – 1/2" OPGW
I135S 115KV	70' STEEL LATTICE	795 ACSS "DRAKE"	1 – 7/16" EHS STEEL
J136S 115KV	70' STEEL LATTICE	795 ACSS "DRAKE"	1 – 7/16" EHS STEEL

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



CROSS–SECTION FACING PRATTS JUNCTION SUBSTATION
EXISTING STRUCTURE 615 TO EXISTING STRUCTURE 642
COMMONWEALTH OF MASSACHUSETTS

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CROSS–SECTION
ROW (A1/B2 MAIN LINE – VERNON TO PRATTS JUNCTION) PROJECT (A1/B2 REBUILD PROJECT) FACING PRATTS JUNCTION PROPOSED DOUBLE CIRCUIT STRUCTURES

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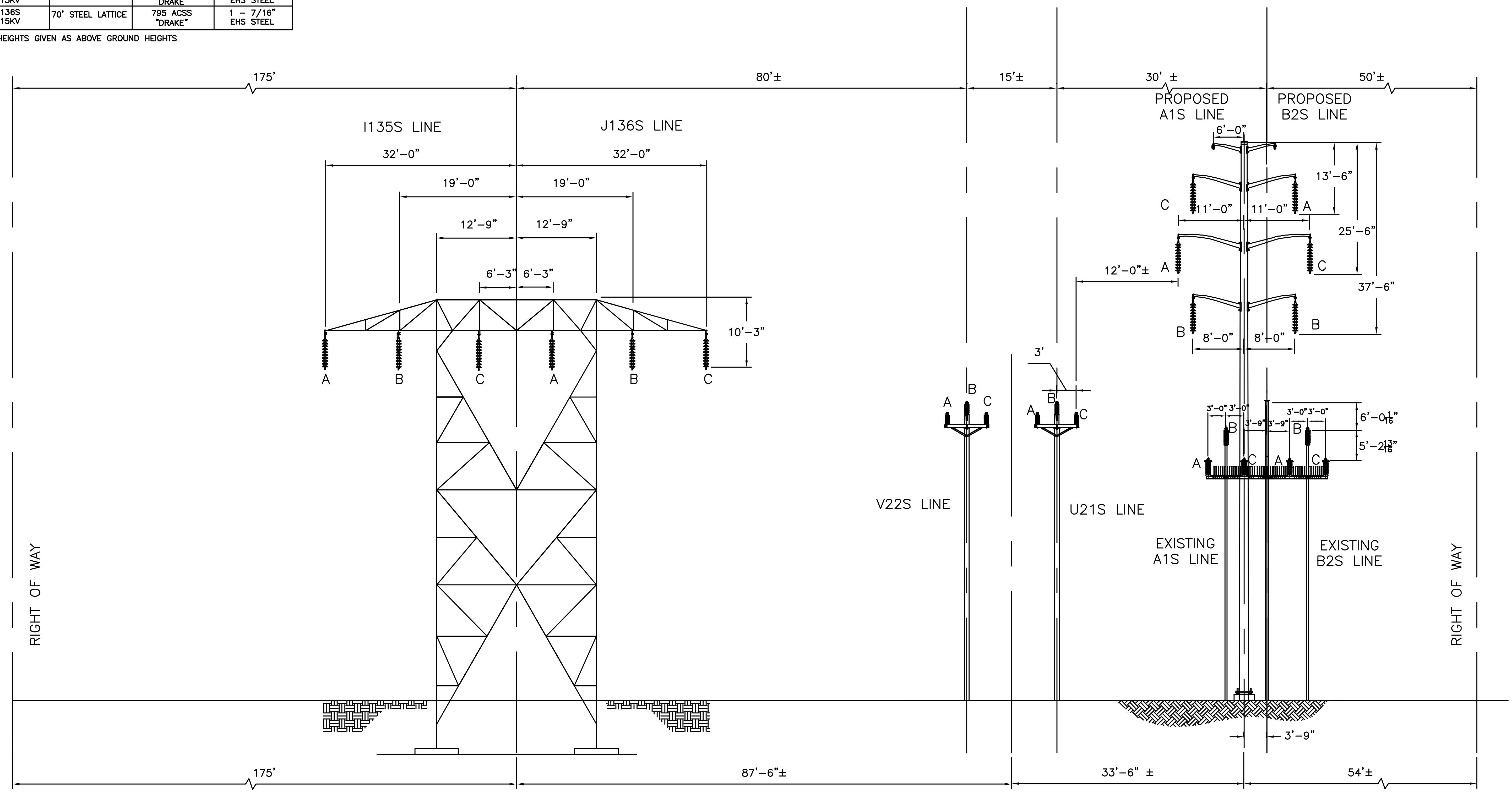
LINE NAME/ VOLTAGE	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2 – 1/2" OPGW
I135S 115KV	70' STEEL LATTICE	795 ACSS "DRAKE"	1 – 7/16" EHS STEEL
J136S 115KV	70' STEEL LATTICE	795 ACSS "DRAKE"	1 – 7/16" EHS STEEL

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS

LINE NAME/ VOLTAGE	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
U21S 69KV	43' WOOD POLE	795 ACSR "CONDOR"	–
V22S 69KV	43' WOOD POLE	477 ACSR "HAWK"	–



CROSS-SECTION FACING PRATTS JUNCTION SUBSTATION
EXISTING STRUCTURE 642 TO EXISTING STRUCTURE 647
COMMONWEALTH OF MASSACHUSETTS

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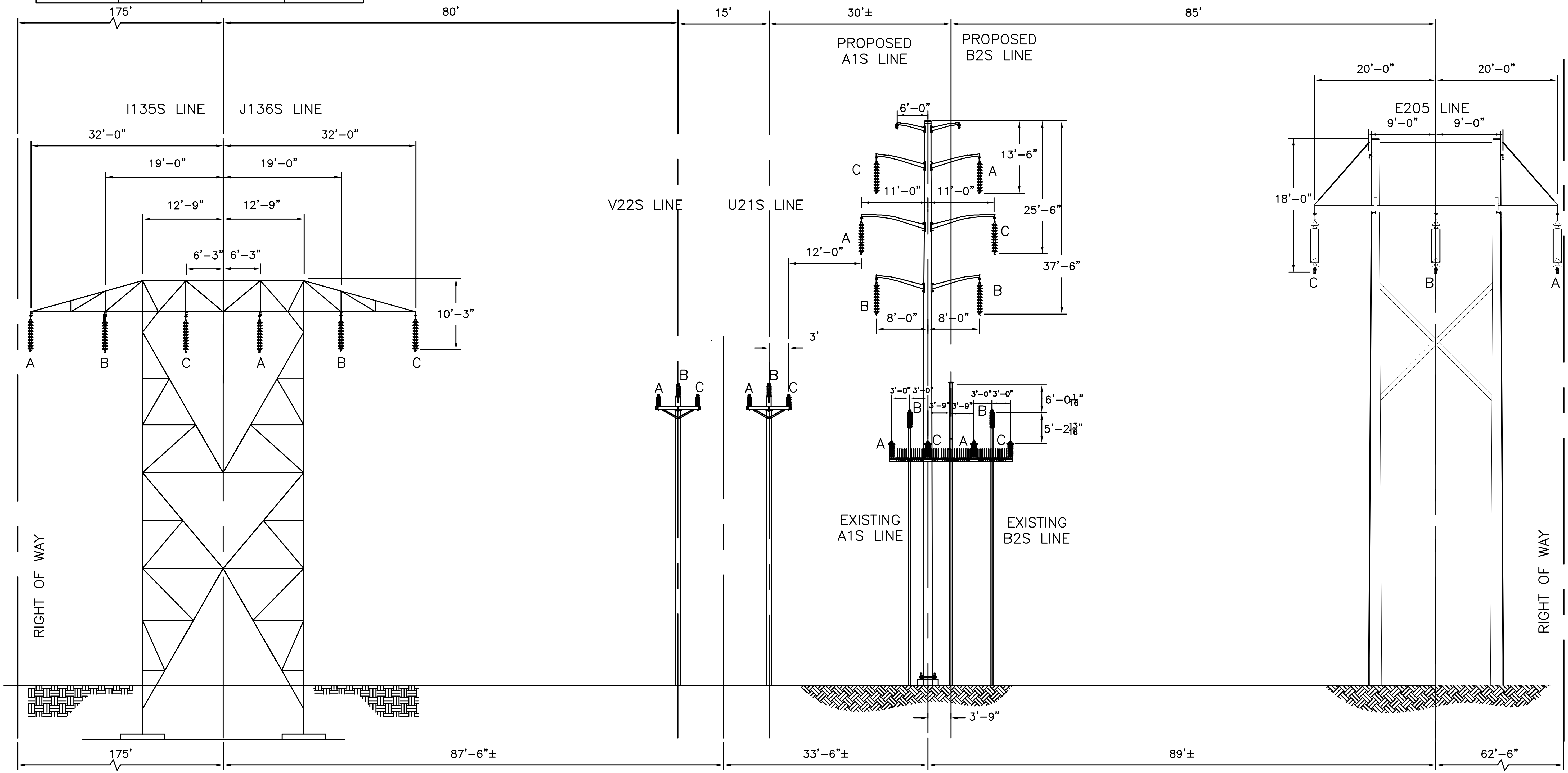
LINE NAME/ VOLTAGE	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2 – 1/2" OPGW
I135S 115KV	70' STEEL LATTICE	795 ACSS "DRAKE"	1 – 7/16" EHS STEEL
J136S 115KV	70' STEEL LATTICE	795 ACSS "DRAKE"	1 – 7/16" EHS STEEL

LINE NAME/ VOLTAGE	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
U21S 69KV	43' WOOD POLE	795 ACSR "CONDOR"	–
V22S 69KV	43' WOOD POLE	477 ACSR "HAWK"	–
E205 230KV	65.5' WOOD H-FRAME	795 AAC "ARBUTUS"	2 – 3/8" EHS STEEL

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



CROSS–SECTION FACING PRATTS JUNCTION SUBSTATION
EXISTING STRUCTURE 648 TO EXISTING STRUCTURE 653
COMMONWEALTH OF MASSACHUSETTS

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CROSS–SECTION
ROW (A1/B2 MAIN LINE – VERNON TO PRATTS JUNCTION)
PROJECT (A1/B2 REBUILD PROJECT)
FACING TOWARD PRATTS JUNCTION
PROPOSED DOUBLE CIRCUIT STRUCTURES

LINE NAME/ VOLTAGE	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	93' STEEL POLE	795 ACSS "DRAKE"	2 – 1/2" OPGW
I135S 115KV	70' STEEL LATTICE	795 ACSS "DRAKE"	1 – 7/16" EHS STEEL
J136S 115KV	70' STEEL LATTICE	795 ACSS "DRAKE"	1 – 7/16" EHS STEEL

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS

LINE NAME/ VOLTAGE	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
U21S 69KV	43' WOOD POLE	795 ACSR "CONDOR"	–
V22S 69KV	43' WOOD POLE	477 ACSR "HAWK"	–
E205 230KV	65.5' WOOD H-FRAME	795 AAC "ARBUTUS"	2 – 3/8" EHS STEEL
225W4 13.8KV	38.5' WOOD POLE	477 ACSR "HAWK"	–

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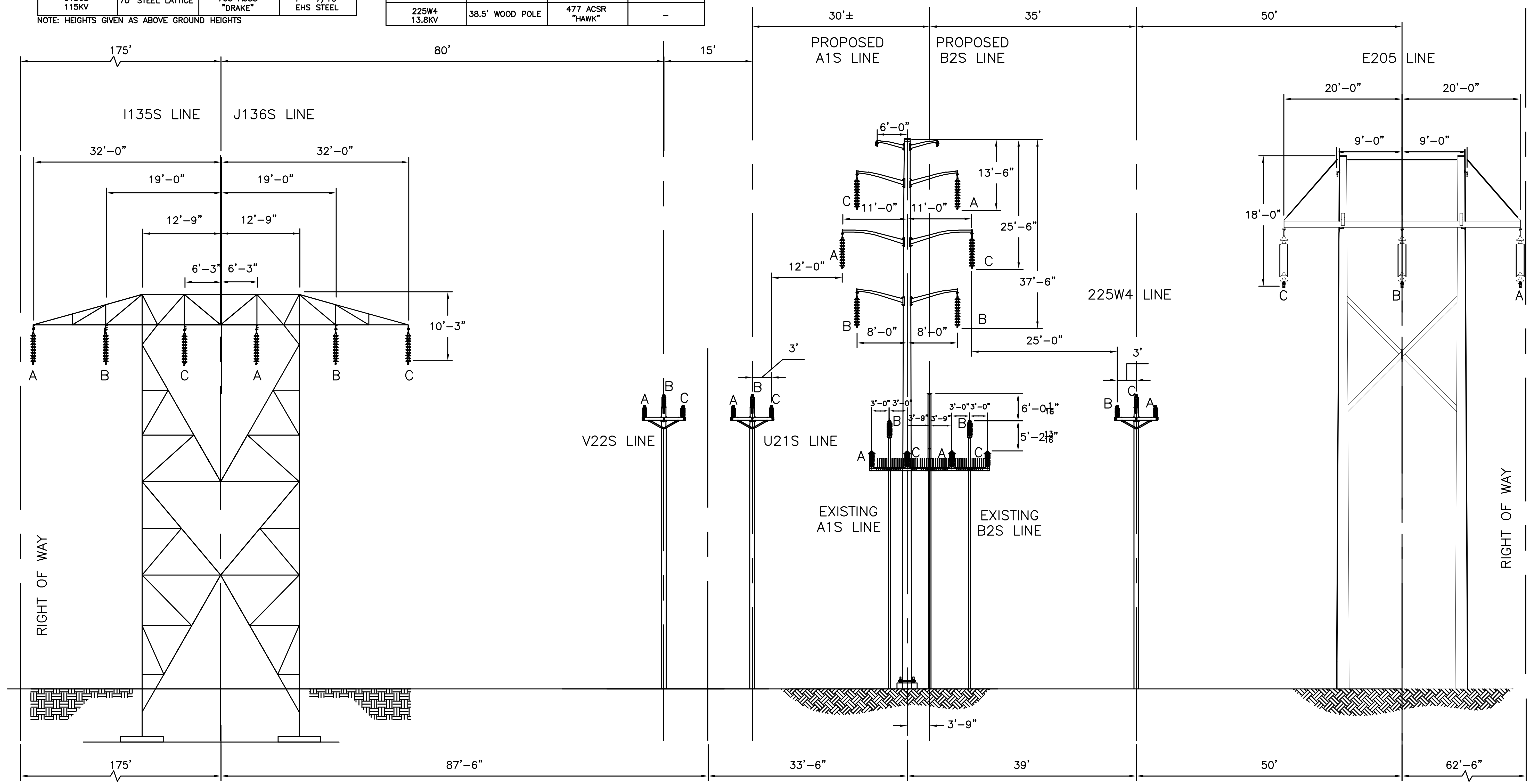

CROSS-SECTION FACING PRATTS JUNCTION SUBSTATION
EXISTING STRUCTURE 654 TO EXISTING STRUCTURE 661
COMMONWEALTH OF MASSACHUSETTS

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CROSS-SECTION
ROW (A1/B2 MAIN LINE – VERNON TO PRATTS JUNCTION)
PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION
PROPOSED DOUBLE CIRCUIT STRUCTURES

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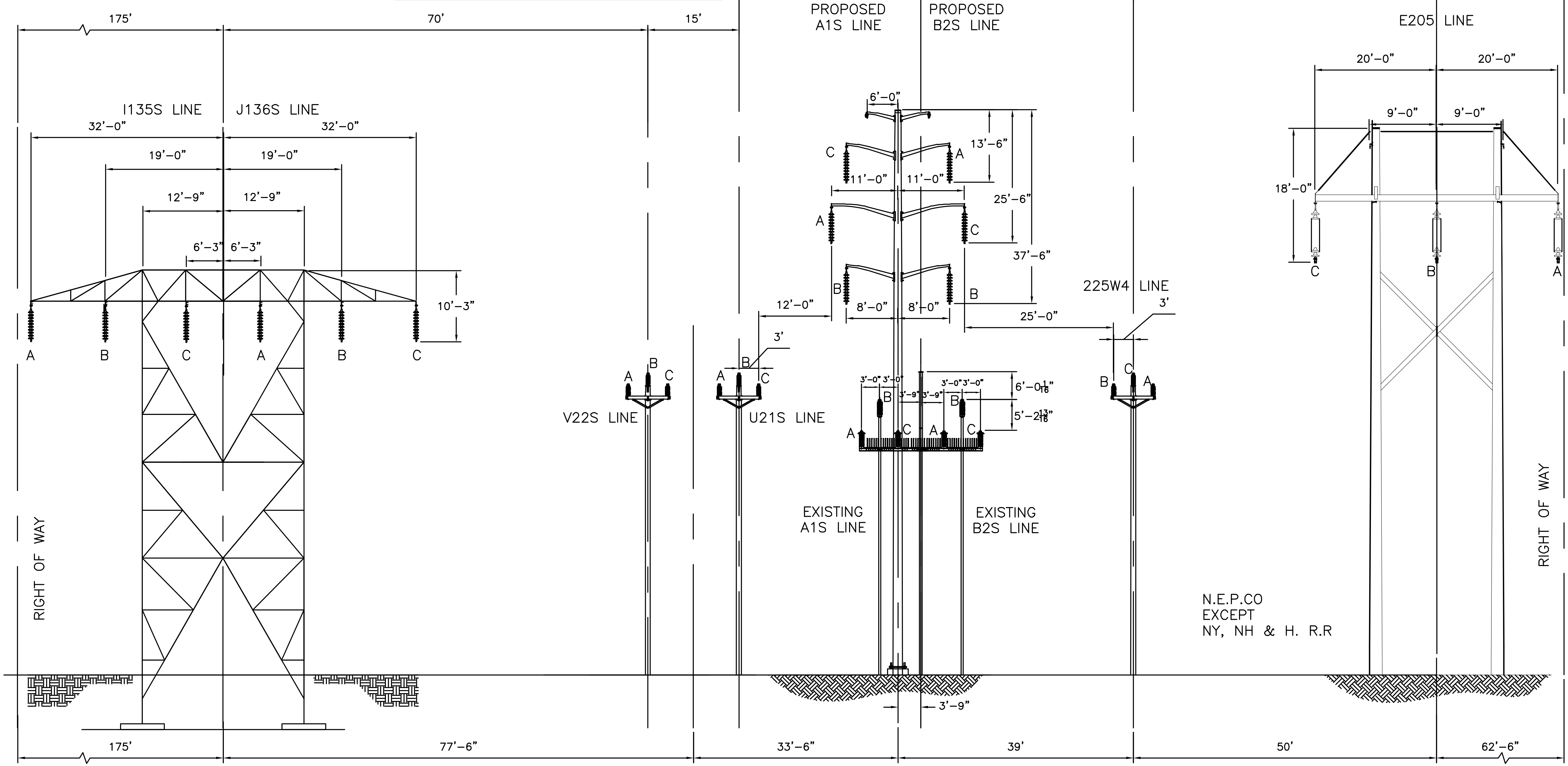
LINE NAME/ VOLTAGE	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING A1/B2 69KV	51' LATTICE STR.	2/0 COPPER	3#11 GALV. STEEL
PROPOSED A1/B2 69KV	105' STEEL POLE	795 ACSS "DRAKE"	2 – 1/2" OPGW
I135S 115KV	70' STEEL LATTICE	795 ACSS "DRAKE"	1 – 7/16" EHS STEEL
J136S 115KV	70' STEEL LATTICE	795 ACSS "DRAKE"	1 – 7/16" EHS STEEL

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS

LINE NAME/ VOLTAGE	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
U21S 69KV	43' WOOD POLE	795 ACSR "CONDOR"	–
V22S 69KV	43' WOOD POLE	477 ACSR "HAWK"	–
E205 230KV	65.5' WOOD H-FRAME	795 AAC "ARBUTUS"	2 – 3/8" EHS STEEL
225W4 13.8KV	38.5' WOOD POLE	477 ACSR "HAWK"	–



CROSS-SECTION FACING PRATTS JUNCTION SUBSTATION
EXISTING STRUCTURE 661 TO PRATTS JUNCTION SUBSTATION
COMMONWEALTH OF MASSACHUSETTS

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ROW (A1/B2 MAIN LINE - VERNON TO PRATTS JUNCTION)
PROJECT (A1/B2 REBUILD PROJECT)
FACING PRATTS JUNCTION
PROPOSED DOUBLE CIRCUIT STRUCTURES

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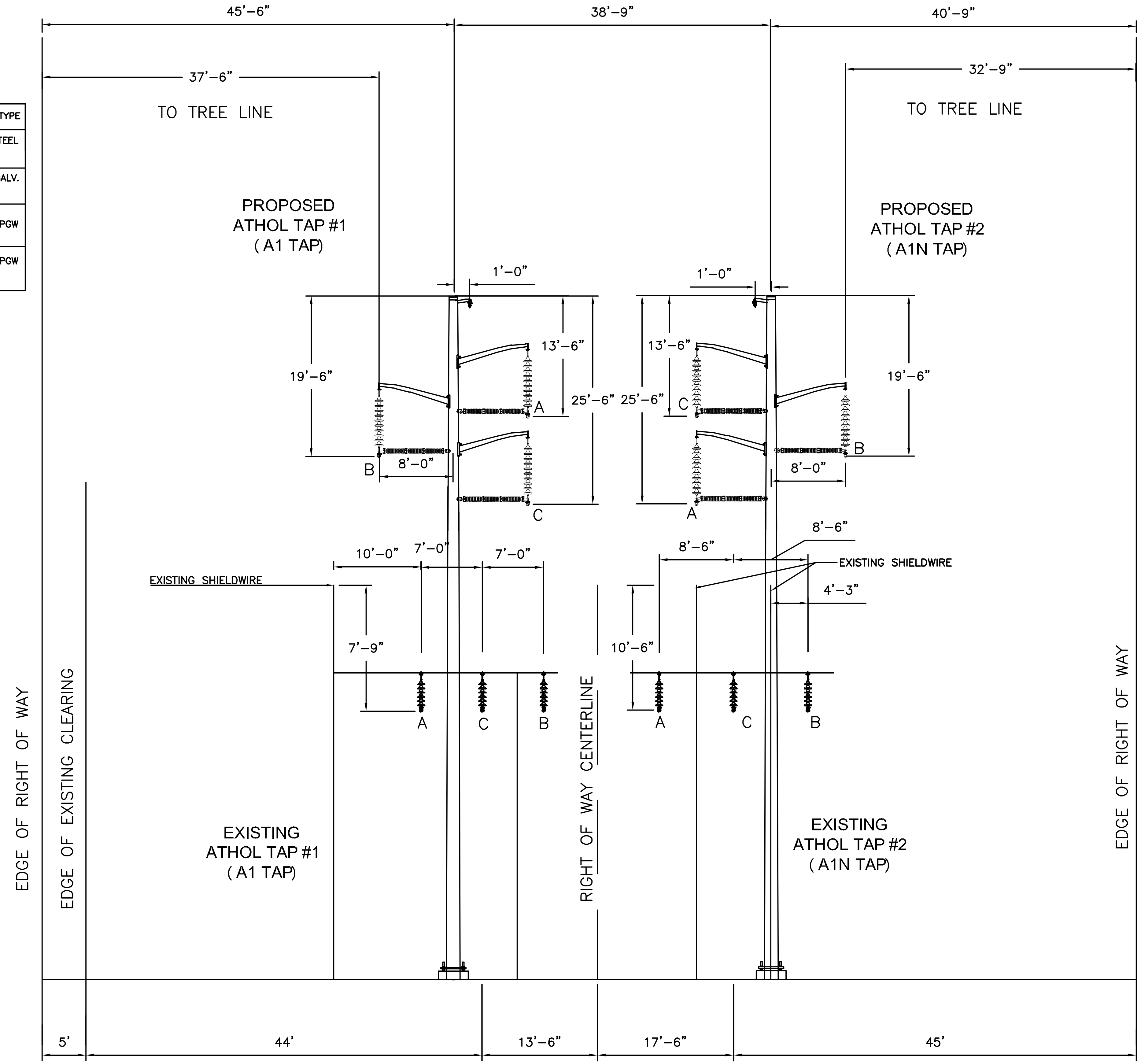
LINE NAME	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING ATHOL TAP #1 69KV	43' WOOD POLARM	2/0 COPPER	3/8" EHS STEEL
EXISTING ATHOL TAP #2 69KV	43' WOOD H-FRAME	2/0 COPPER	2 – 3#11 GALV. STEEL
PROPOSED ATHOL TAP #1 69KV	95' STEEL DELTA SINGLE POLE	795 ACSS "DRAKE"	1 – 1/2" OPGW
PROPOSED ATHOL TAP #2 69KV	95' STEEL DELTA SINGLE POLE	795 ACSS "DRAKE"	1 – 1/2" OPGW

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



PROPOSED SINGLE CIRCUIT VERTICAL DAVIT ARM STRUCTURES
LOOKING TOWARDS CHESTNUT HILL STATION
ROYALSTON TO STRUCTURES 72 (TAP 2) & 71 (TAP 1)
STATE OF MASSACHUSETTS

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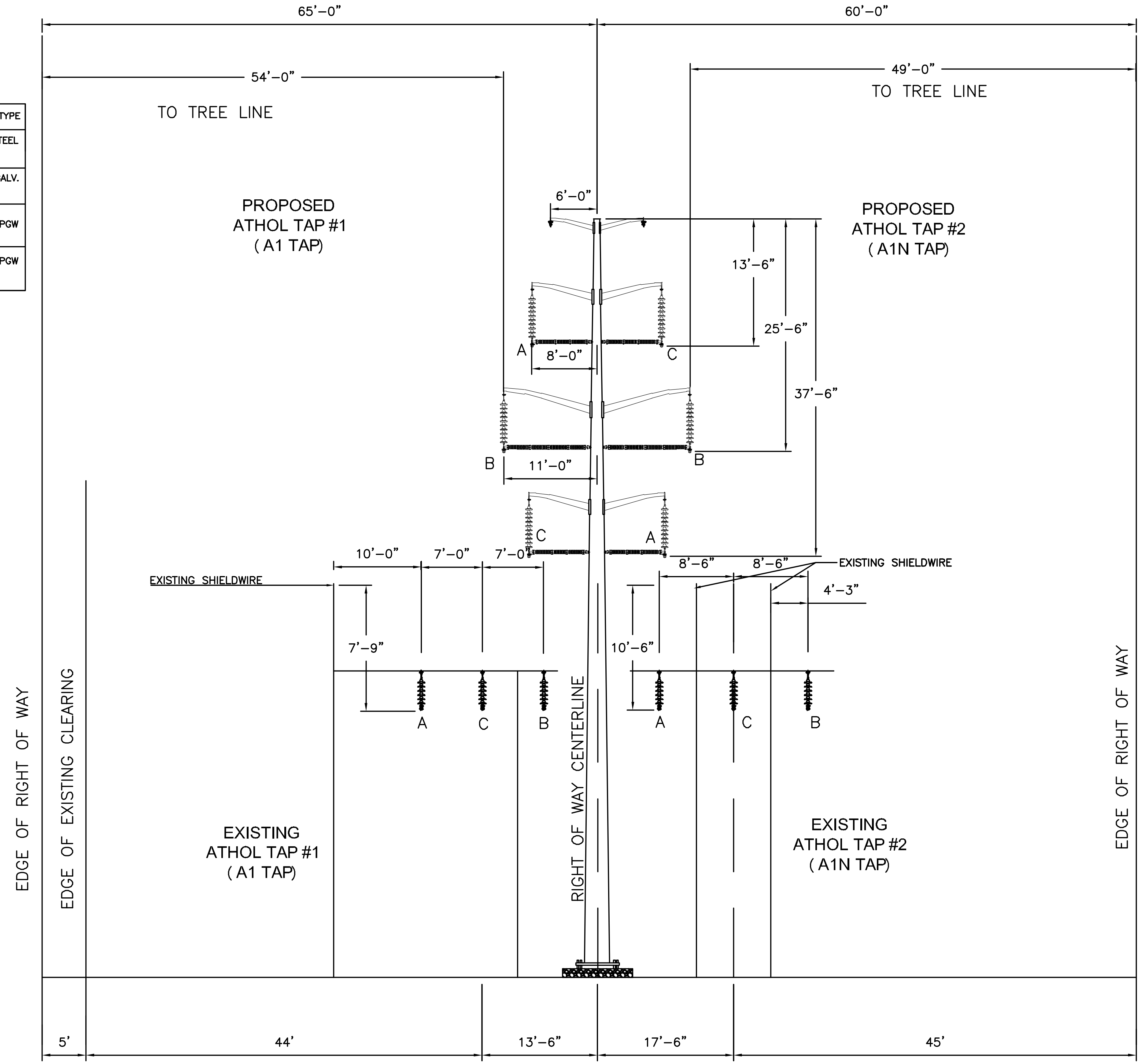
CROSS-SECTION
ROW (A1/B2 TAP TO CHESTNUT HILL)
PROJECT (A1/B2 REBUILD PROJECT)
FACING CHESTNUT HILL STATION
VERTICAL DAVIT ARM STRUCTURES

VERSION 1

LINE NAME	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING ATHOL TAP #1 69KV	43' WOOD POLARM	2/0 COPPER	3/8" EHS STEEL
EXISTING ATHOL TAP #2 69KV	43' WOOD H-FRAME	2/0 COPPER	2 - 3#11 GALV. STEEL
PROPOSED ATHOL TAP #1 69KV	95' STEEL DOUBLE CIRCUIT SINGLE POLE	795 ACSS "DRAKE"	1 - 1/2" OPGW
PROPOSED ATHOL TAP #2 69KV	95' STEEL DOUBLE CIRCUIT SINGLE POLE	795 ACSS "DRAKE"	1 - 1/2" OPGW

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



PROPOSED SINGLE CIRCUIT VERTICAL DAVIT ARM STRUCTURES
LOOKING TOWARDS CHESTNUT HILL STATION
STRUCTURES 72 (TAP 2) & 71 (TAP 1) TO CHESTNUT HILL STATION
STATE OF MASSACHUSETTS

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CROSS-SECTION
ROW (A1/B2 TAP TO CHESTNUT HILL)
PROJECT (A1/B2 REBUILD PROJECT)
FACING CHESTNUT HILL STATION
VERTICAL DAVIT ARM STRUCTURES

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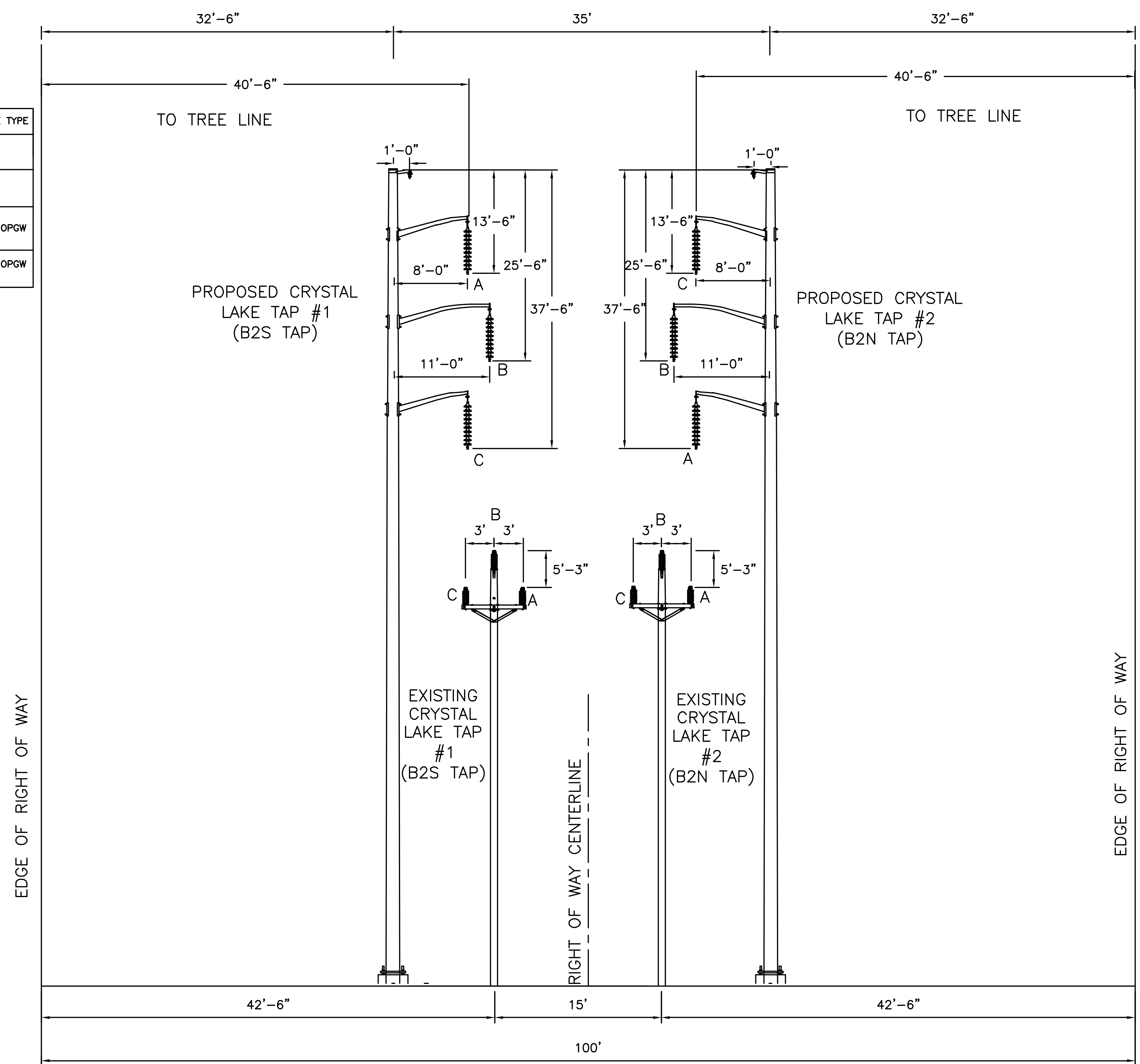
LINE NAME	STRUCTURE TYPE TYP.	CONDUCTOR TYPE	SHIELDWIRE TYPE
EXISTING CRYSTAL LAKE TAP #1 69KV	43' WOOD SINGLE POLE	2/0 COPPER	–
EXISTING CRYSTAL LAKE TAP #2 69KV	43' WOOD SINGLE POLE	2/0 COPPER	–
PROPOSED CRYSTAL LAKE TAP #1 69KV	95' STEEL SINGLE POLE	795 ACSS "DRAKE"	1 – 1/2" OPGW
PROPOSED CRYSTAL LAKE TAP #2 69KV	95' STEEL SINGLE POLE	795 ACSS "DRAKE"	1 – 1/2" OPGW

NOTE: HEIGHTS GIVEN AS ABOVE GROUND HEIGHTS



PROPOSED SINGLE CIRCUIT VERTICAL DAVIT ARM STRUCTURES
LOOKING TOWARD CRYSTAL LAKE STATION
TYPICAL
STATE OF MASSACHUSETTS

INCHES ON ORIGINAL

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CROSS–SECTION
ROW (A1/B2 TAP TO CRYSTAL LAKE STATION) PROJECT (A1/B2 REBUILD PROJECT)
FACING CRYSTAL LAKE STATION
SINGLE CIRCUIT VERTICAL DAVIT ARM STRUCTURES

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Appendix B

Magnetic Field Profiles for Each Route Segment and Loading Scenario

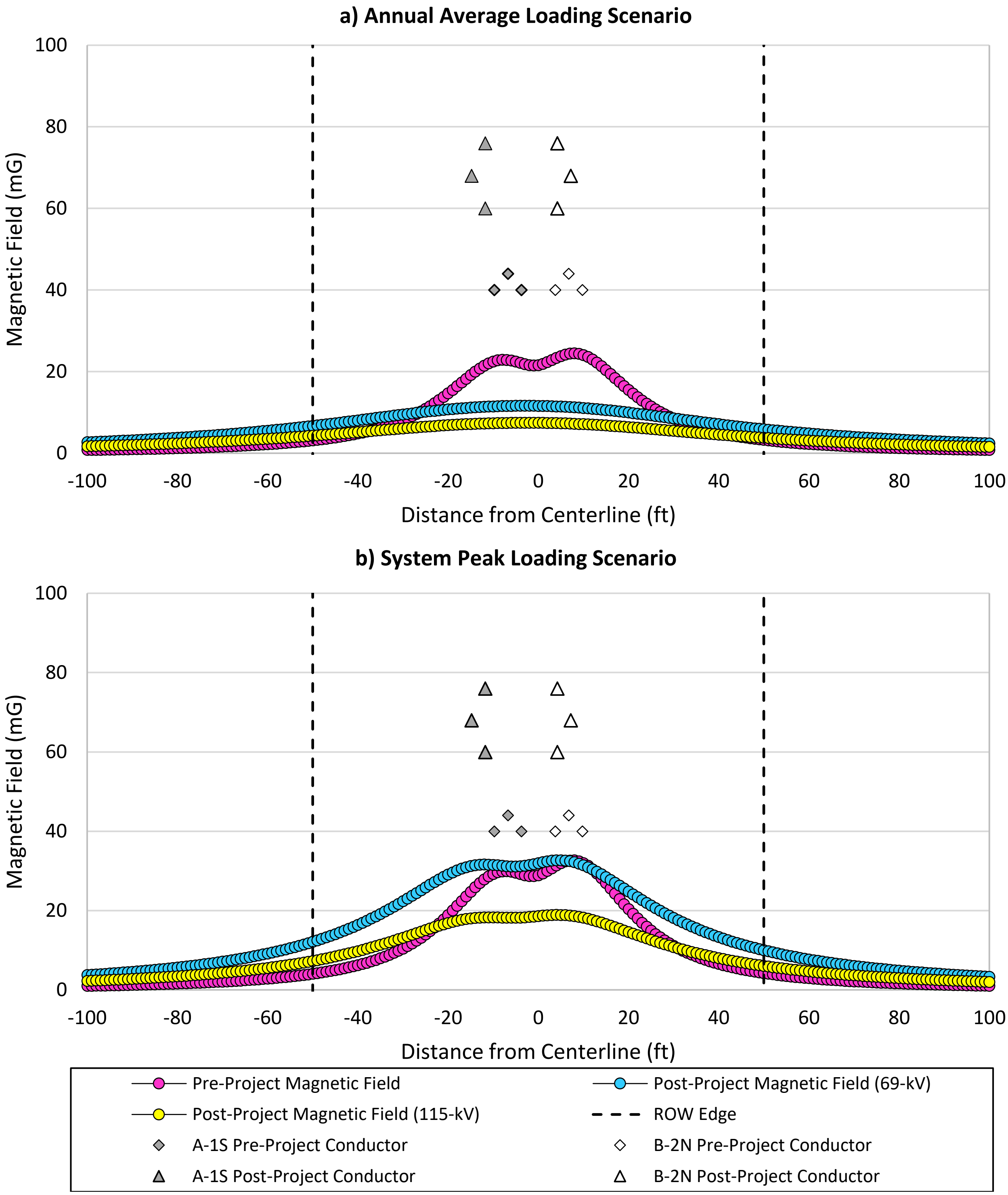

Figure B.1 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 1 Cross Section (Structures 99–186). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

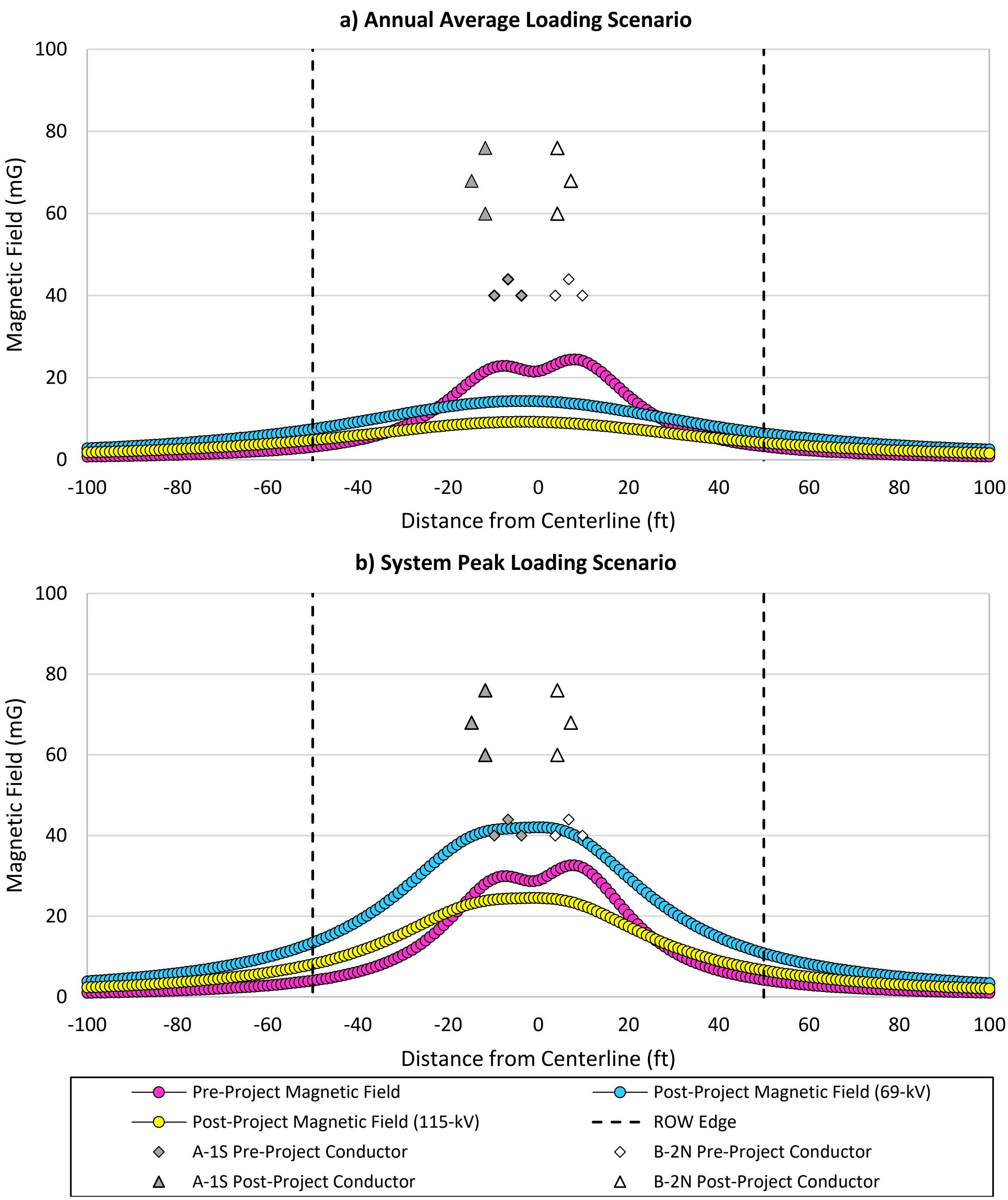

Figure B.2 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 2 Cross Section (Structures 186–201). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

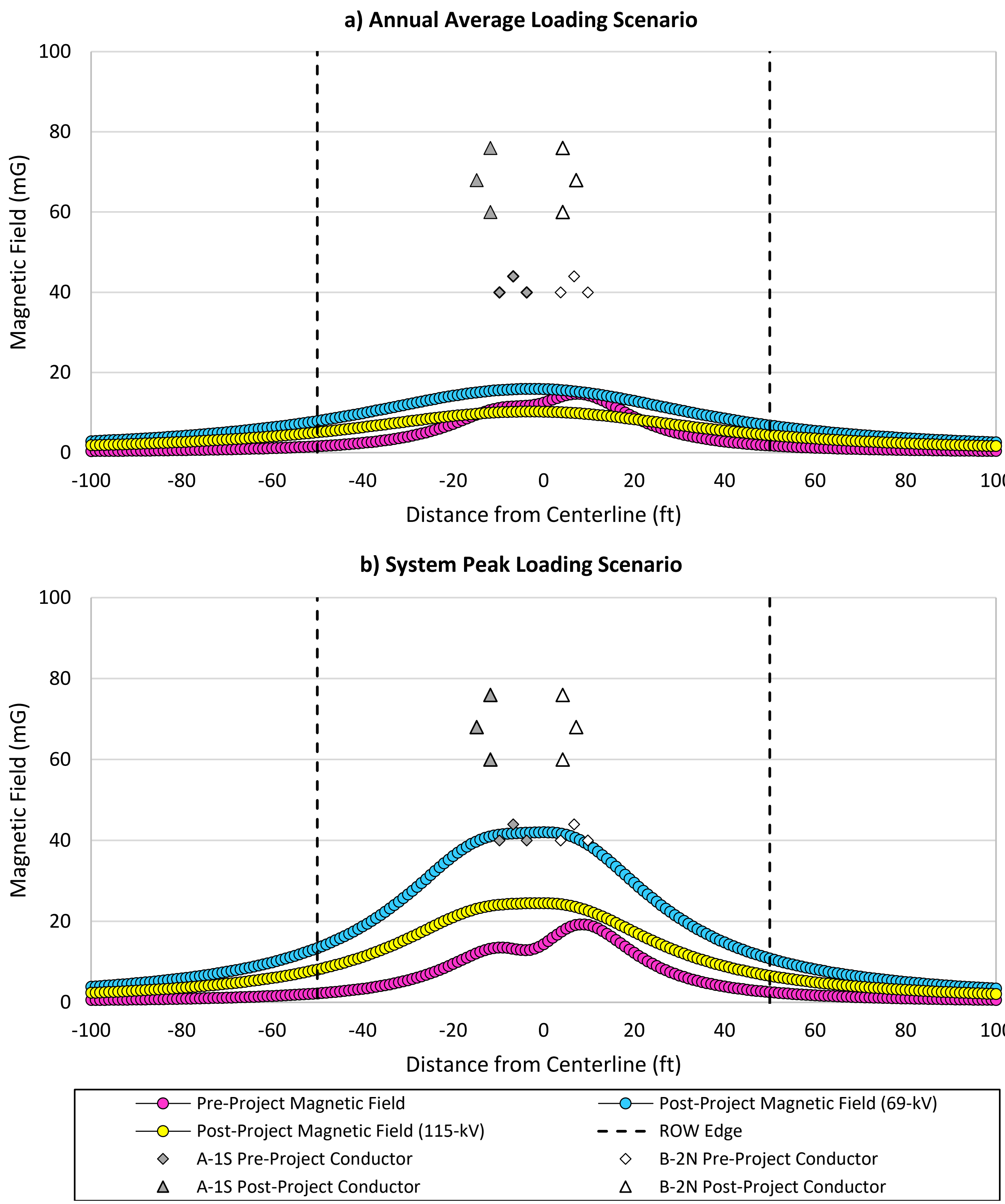

Figure B.3 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 3 Cross Section (Structure 201–Royalston Station). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

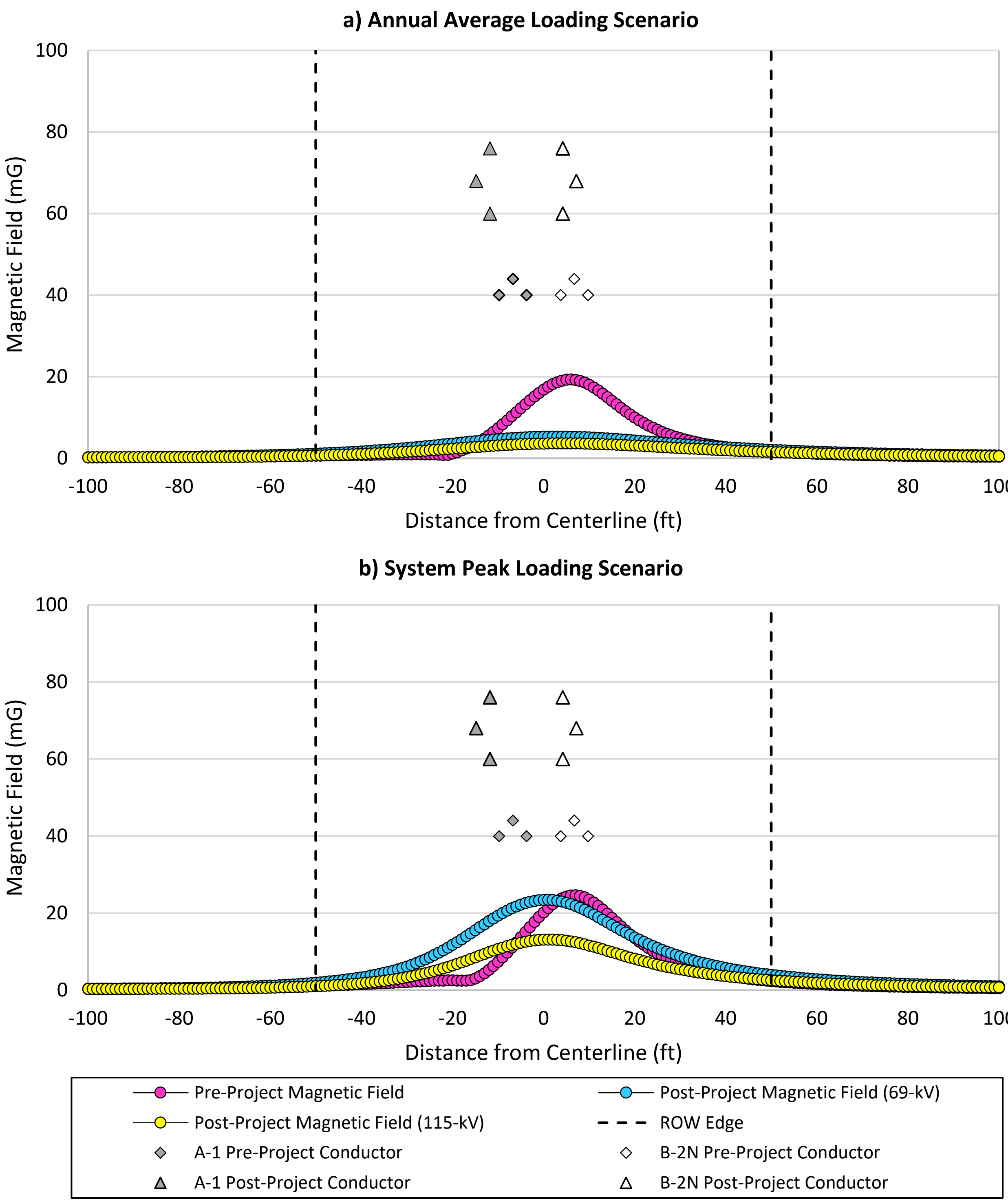

Figure B.4 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 4 Cross Section (Royalston Station–Structure 318). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

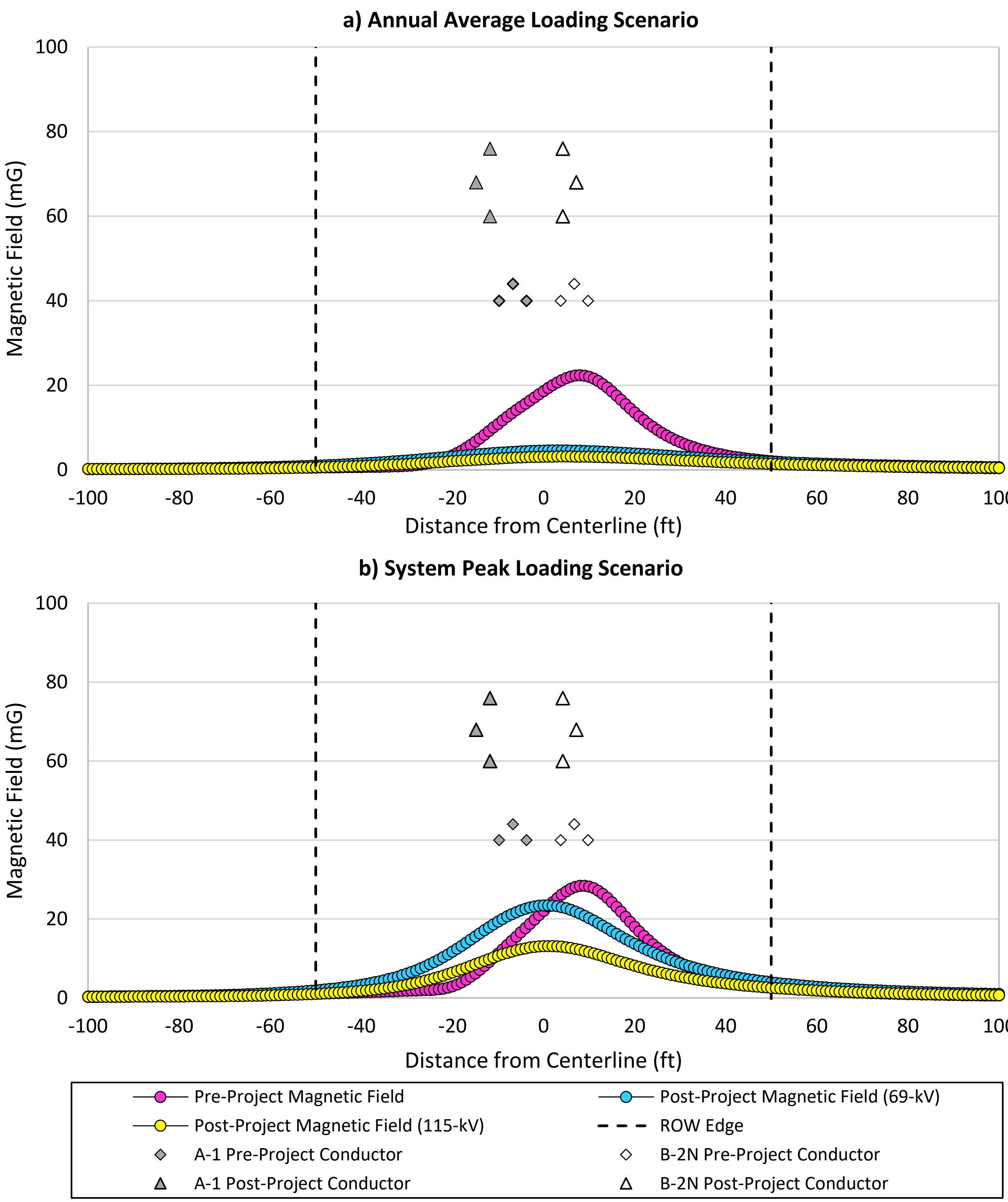

Figure B.5 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 5 Cross Section (Structures 318–319). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

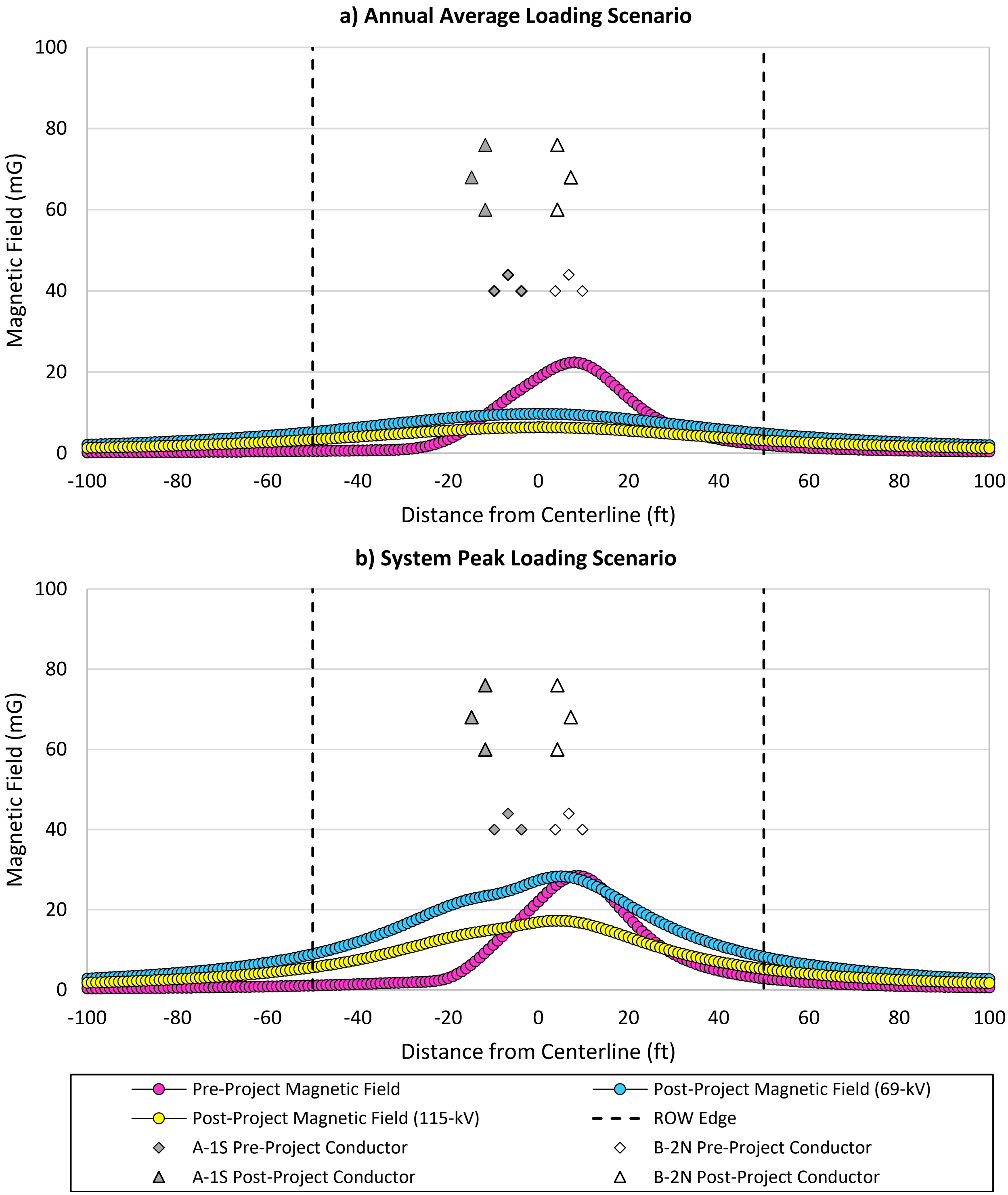

Figure B.6 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 6 Cross Section (Structures 319–343-1). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

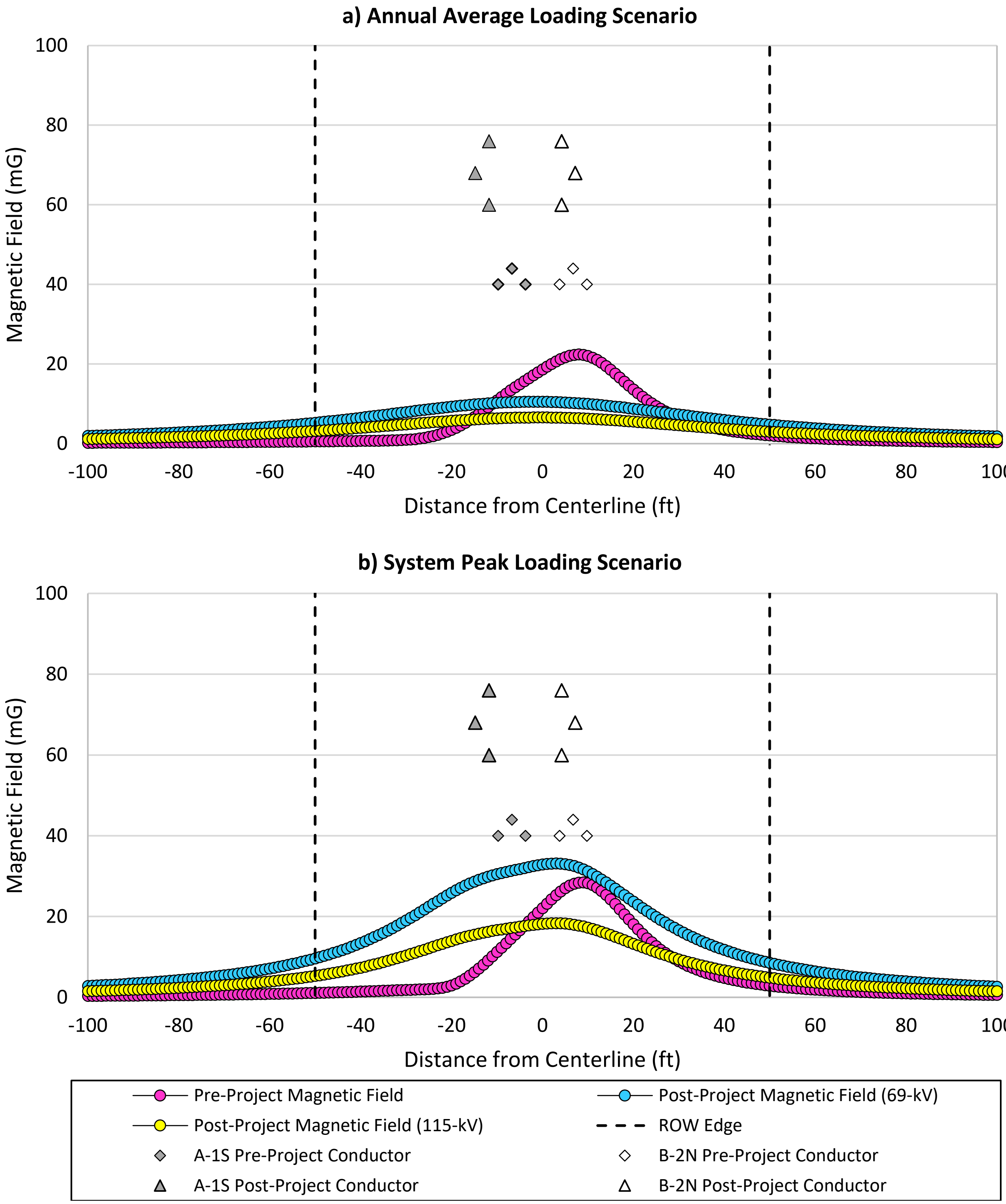

Figure B.7 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 7 Cross Section (Structures 343-1–346). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

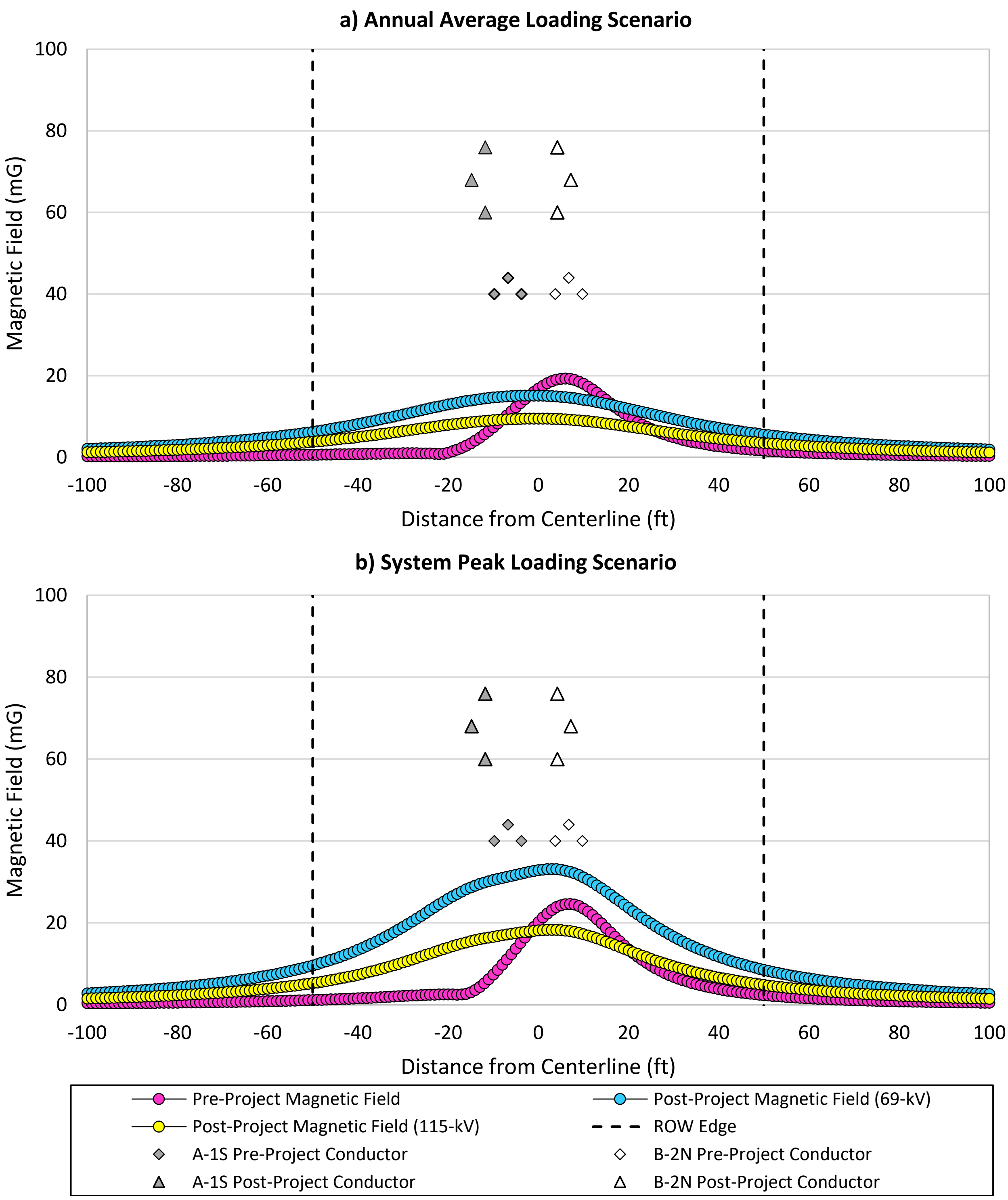

Figure B.8 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 8 Cross Section (Structures 347–Otter River). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

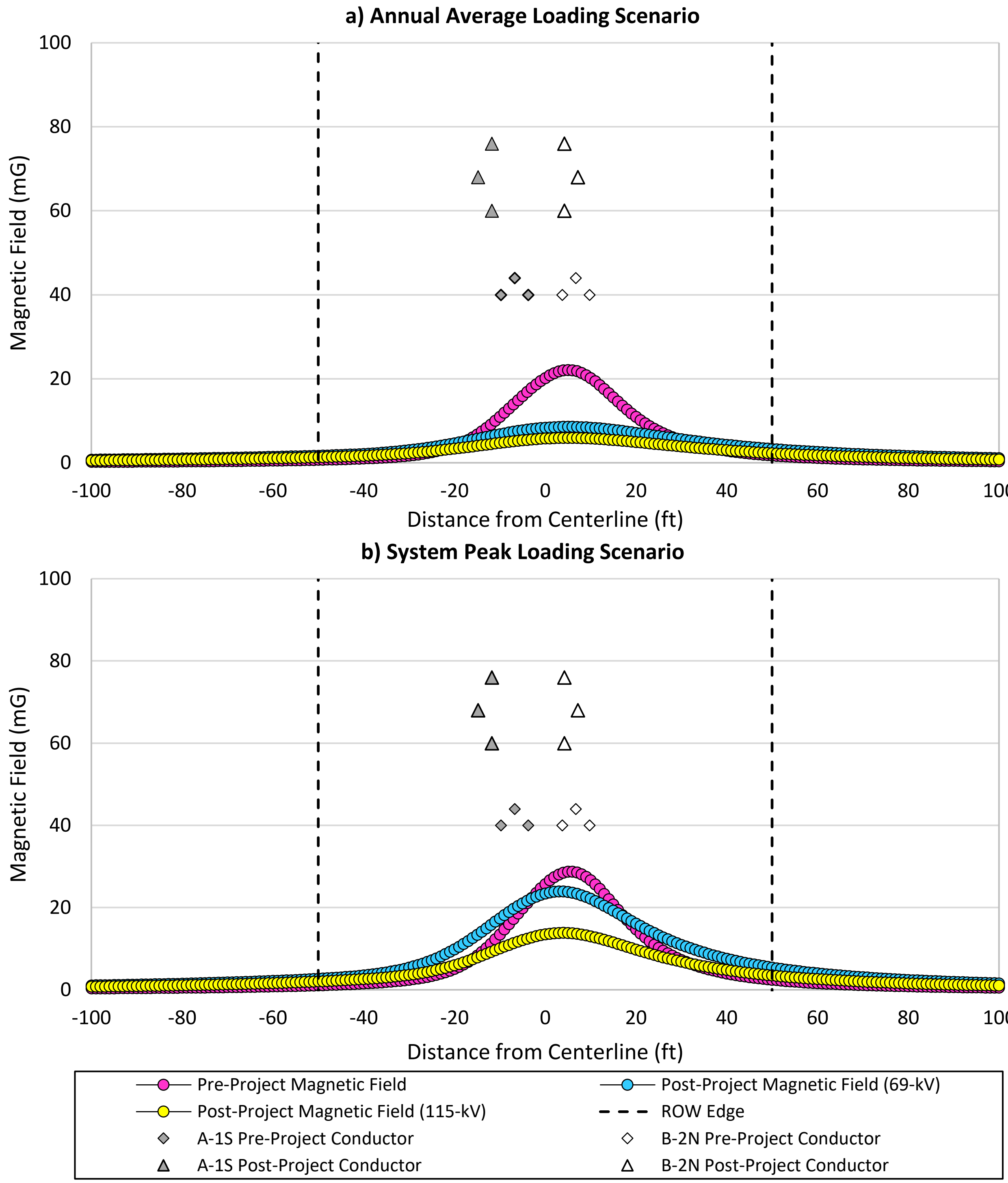

Figure B.9 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 9 Cross Section (Otter River–Structure 358). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

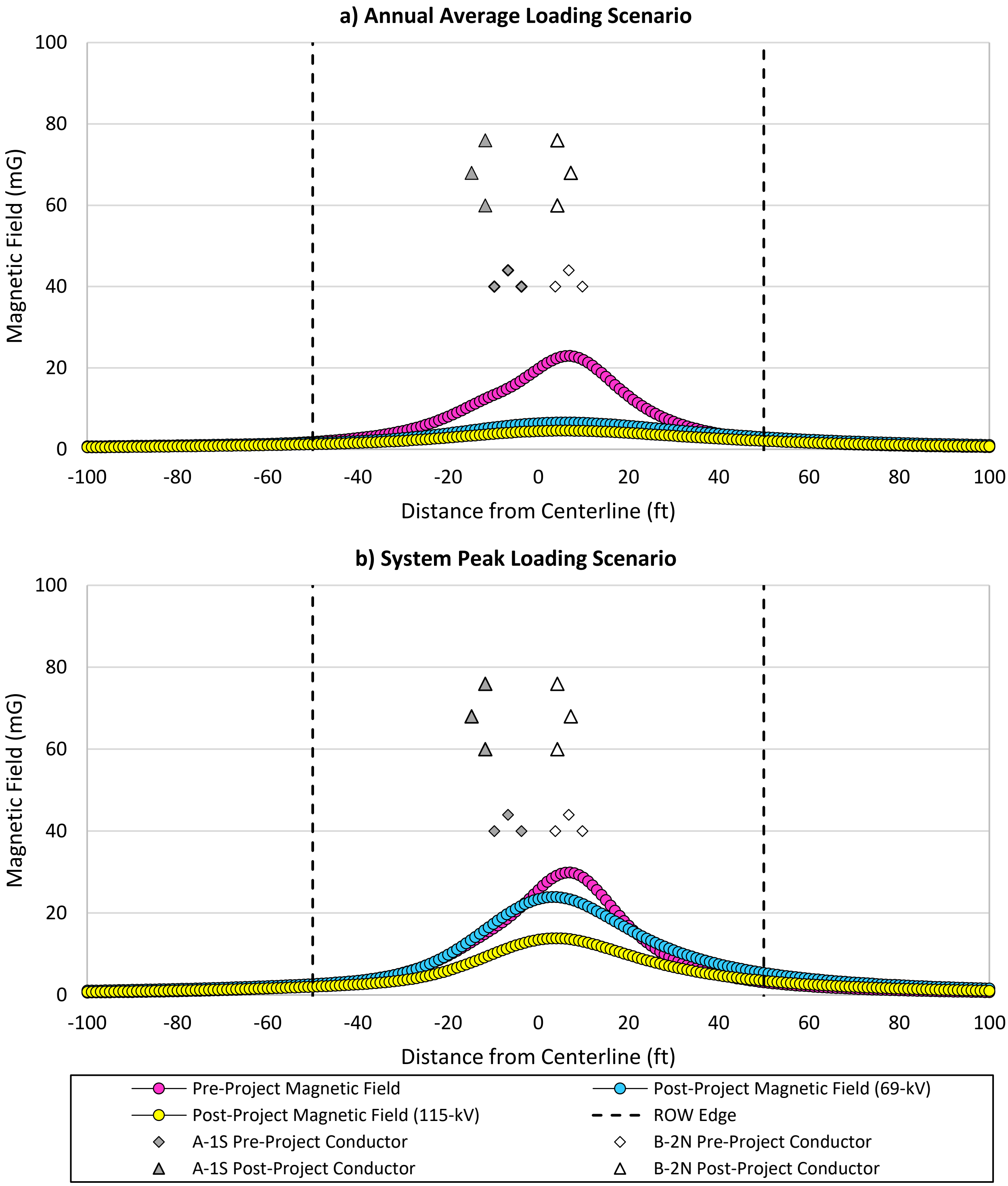

Figure B.10 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 10 Cross Section (Structures 358–377). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

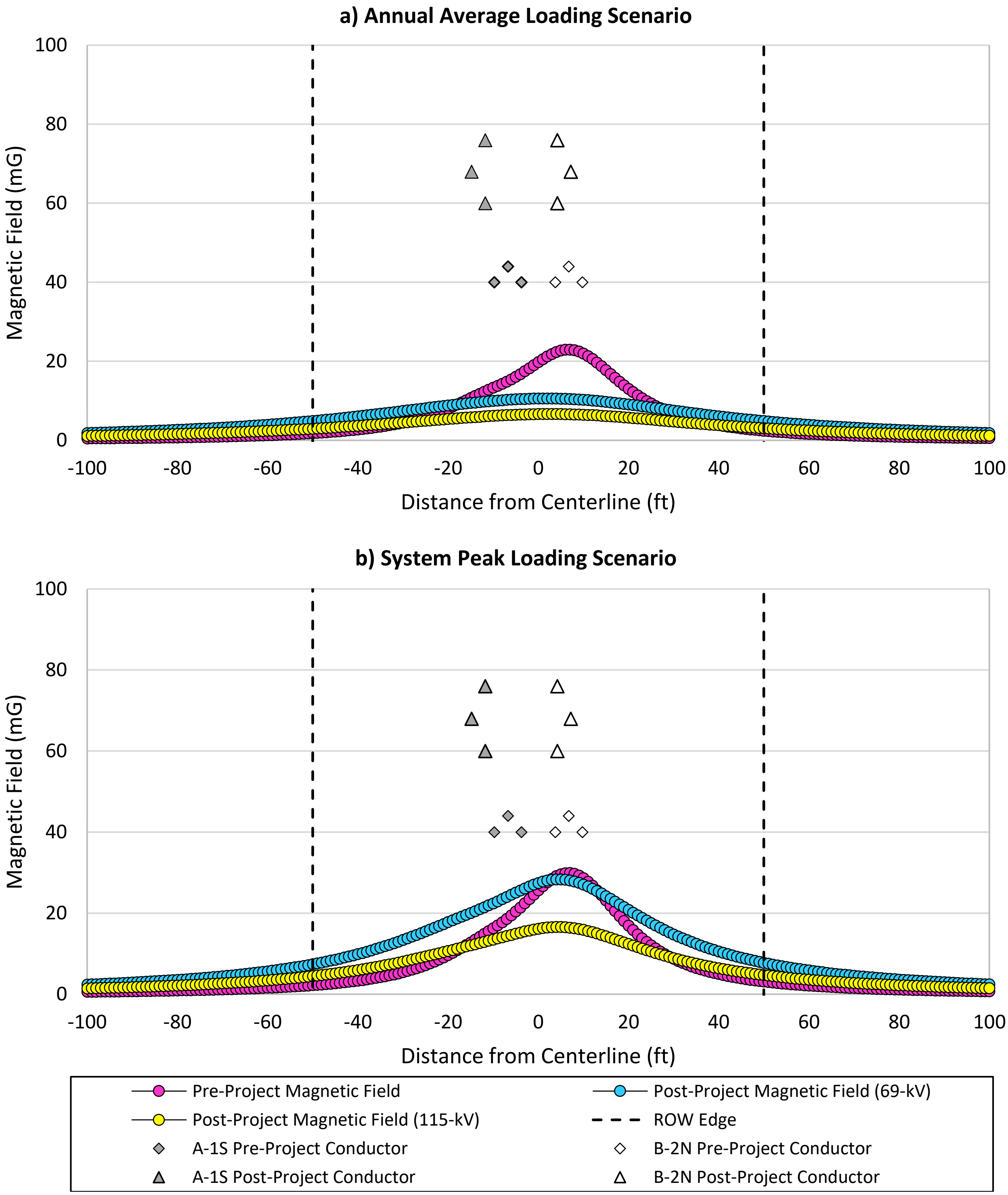

Figure B.11 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 11 Cross Section (Structures 377–400). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

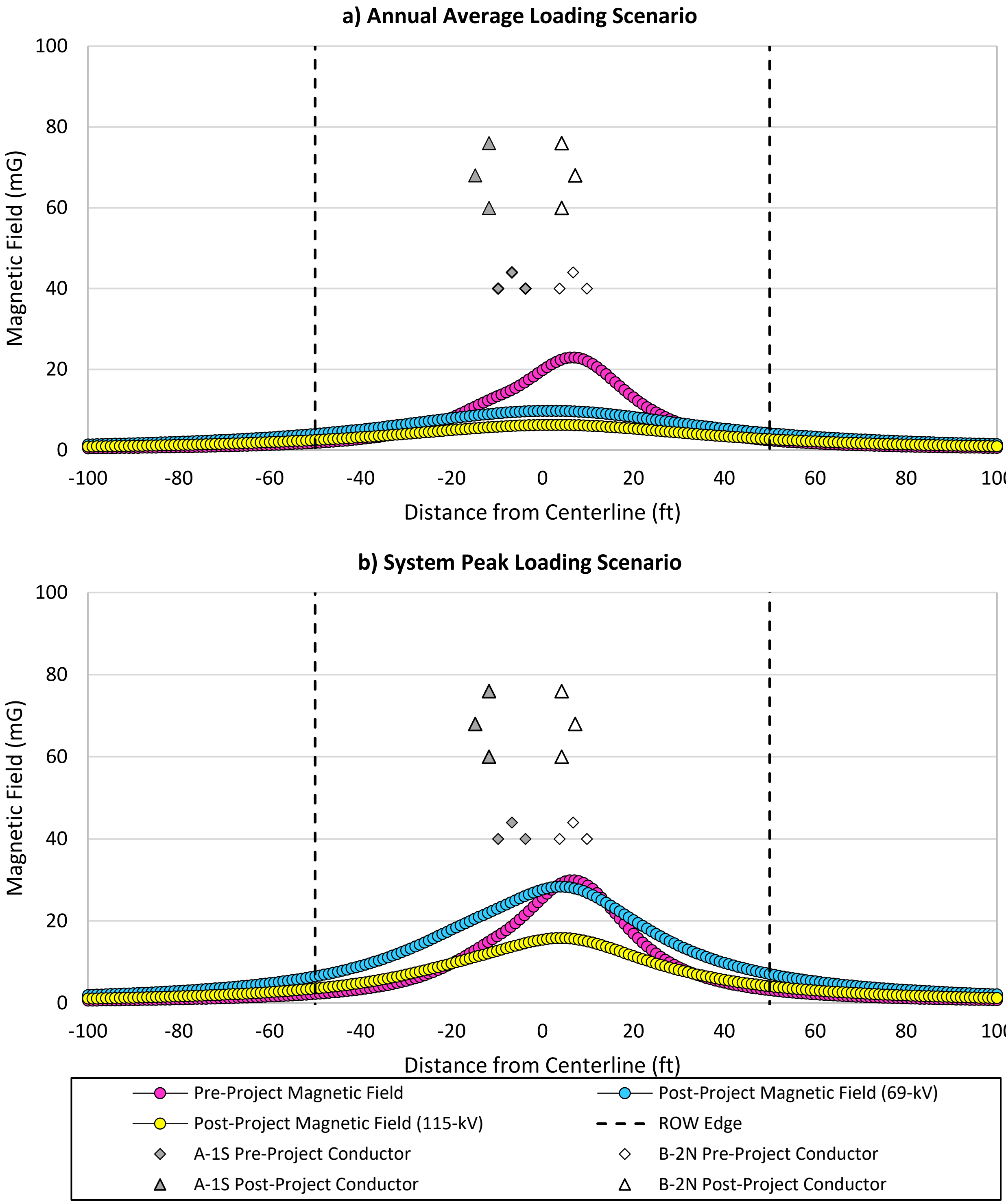

Figure B.12 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 12 Cross Section (Structure 400–Gardner Switch Tower). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

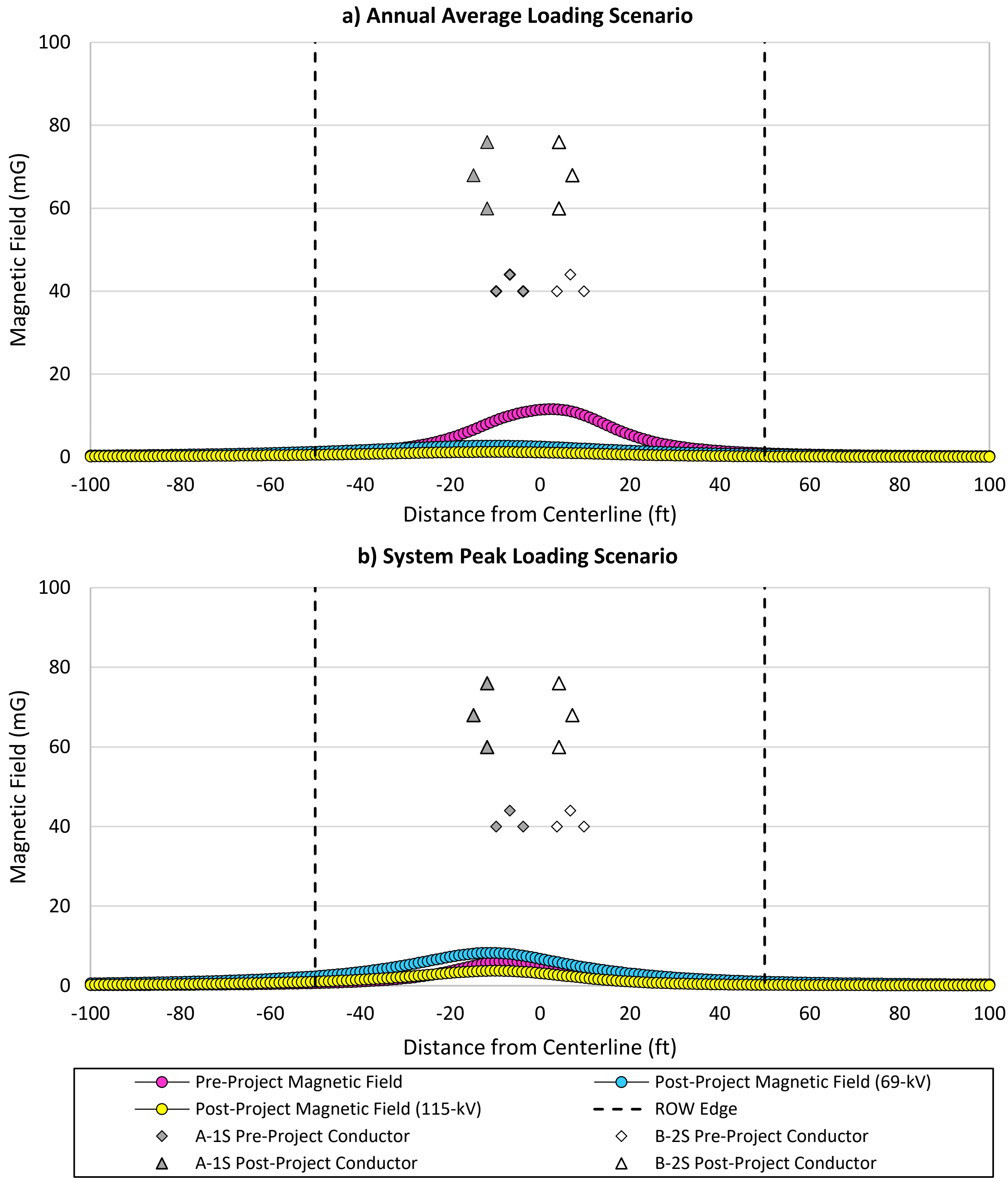

Figure B.13 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 13 Cross Section (Gardner Switch Tower–Westminster Station). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

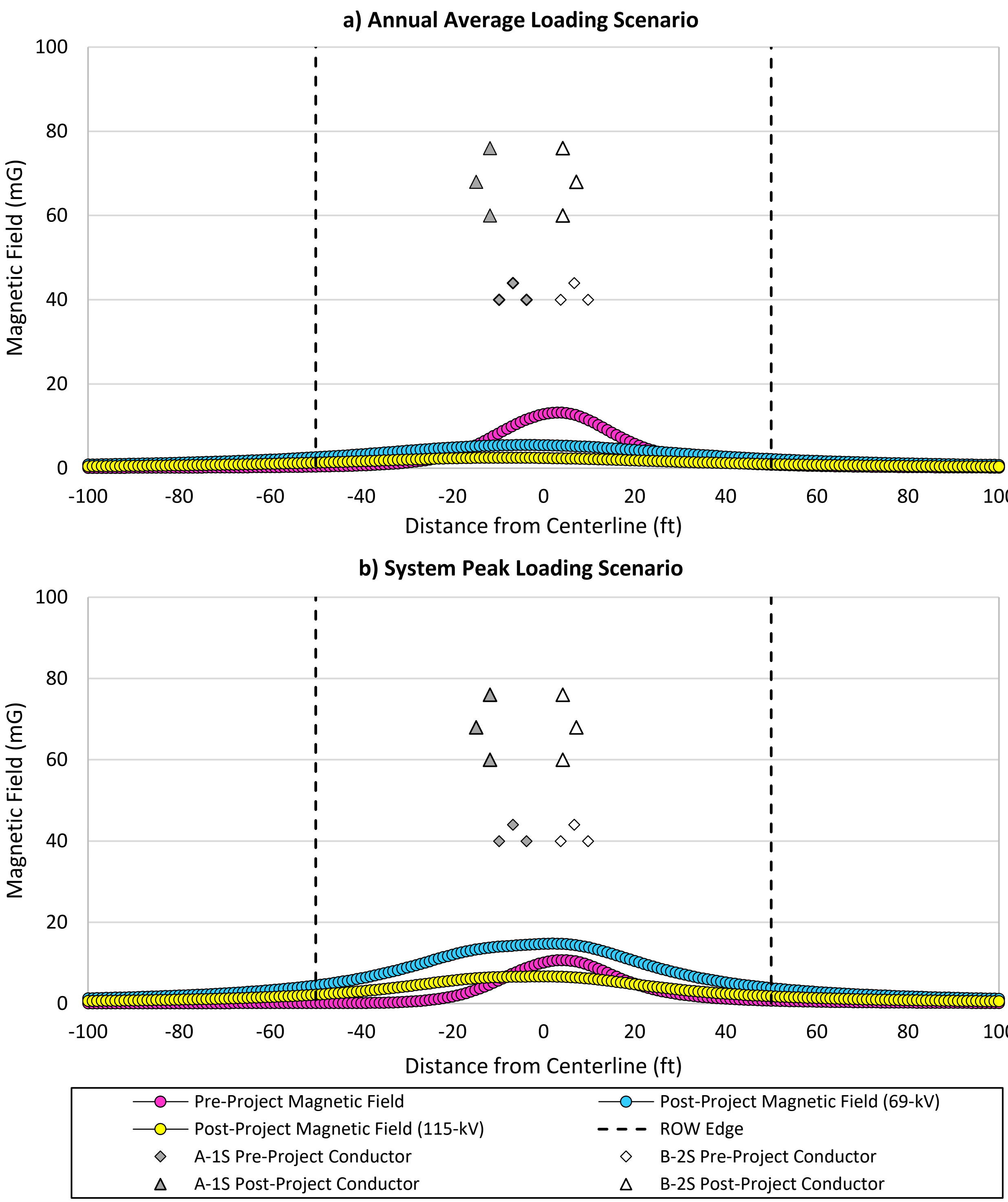

Figure B.14 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 13 Cross Section (Westminster Station–Structure 499). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

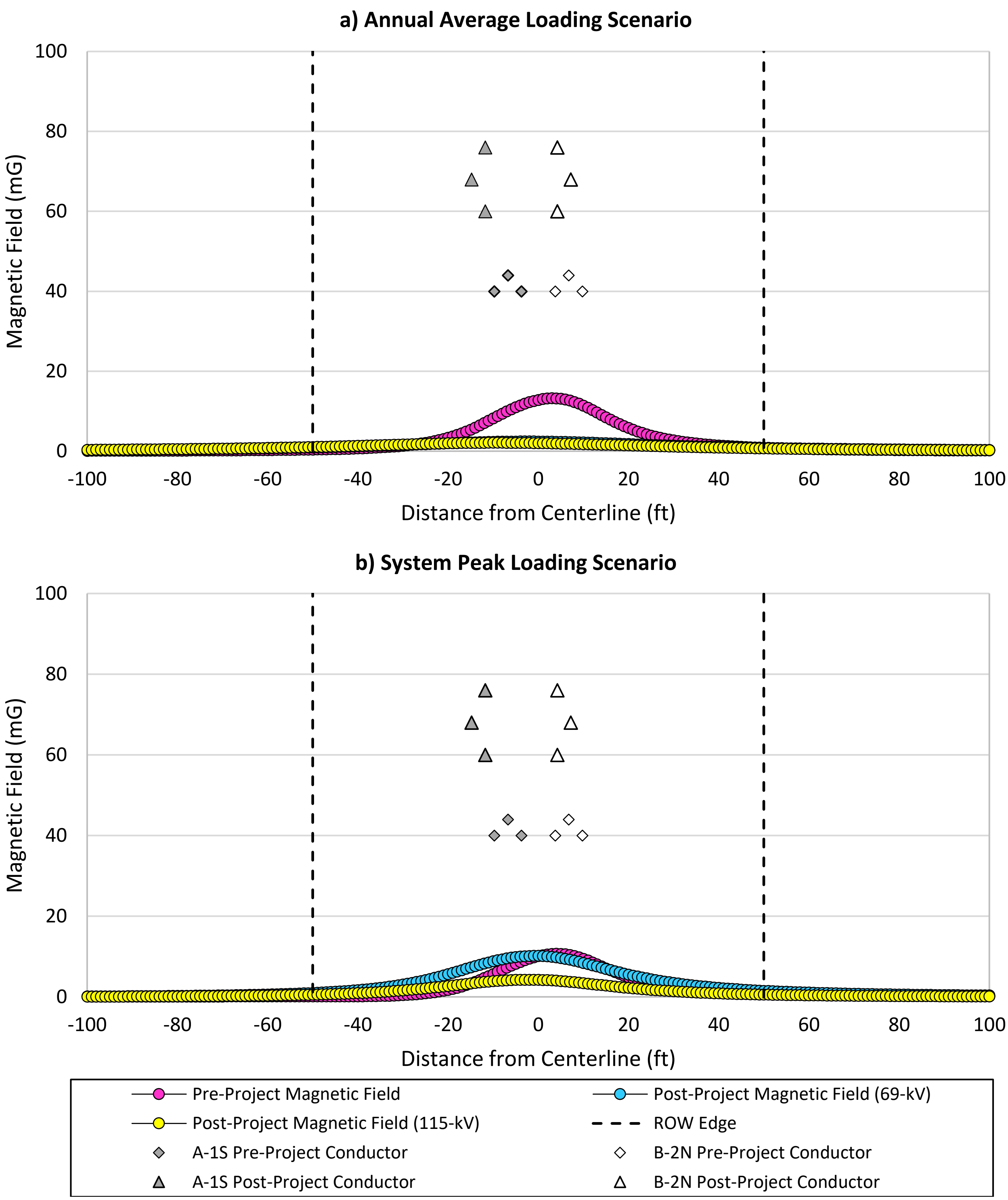

Figure B.15 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 14 Cross Section (Structure 499–East Westminster). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

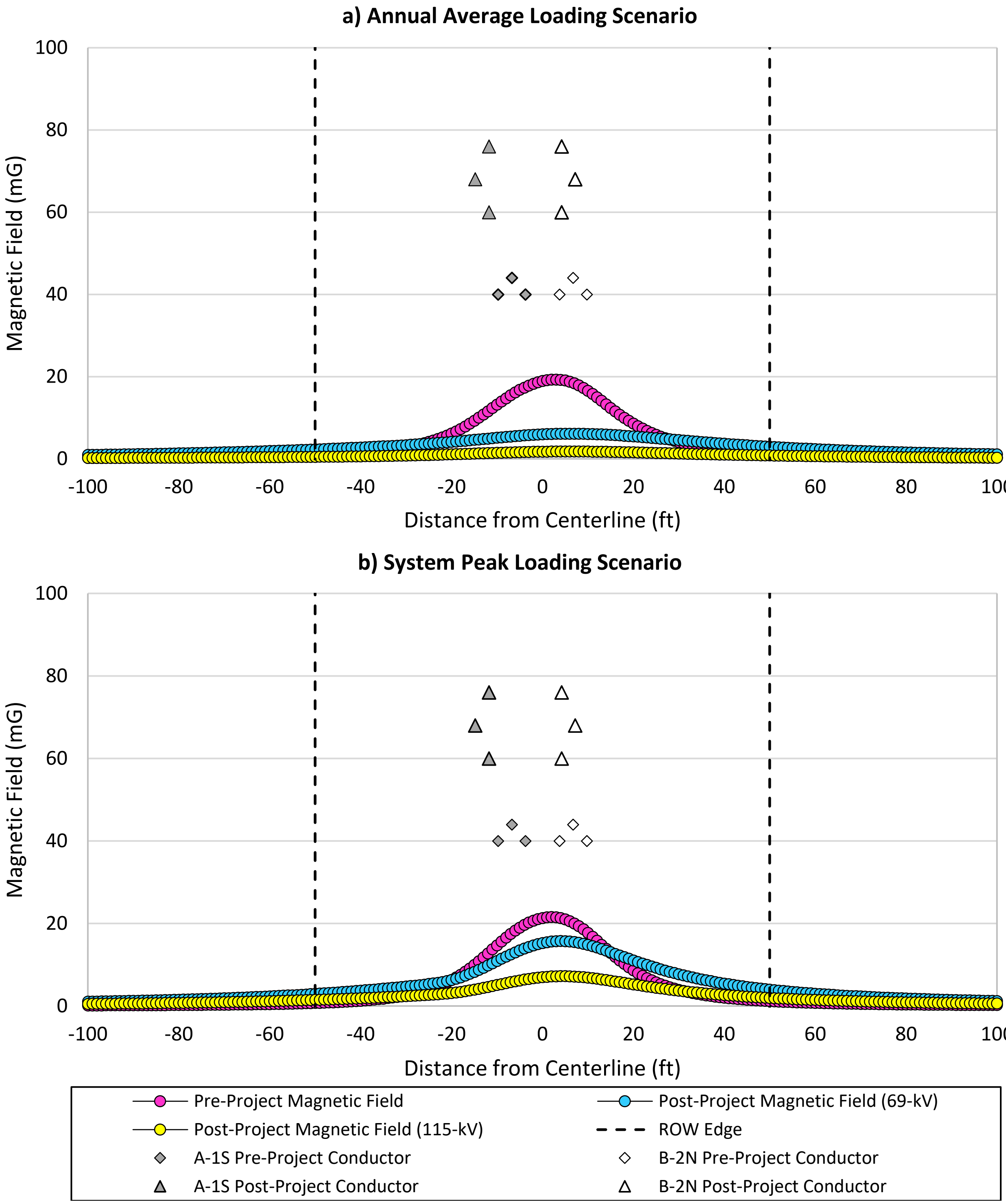

Figure B.16 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 14 Cross Section (East Westminster–Structure 561). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

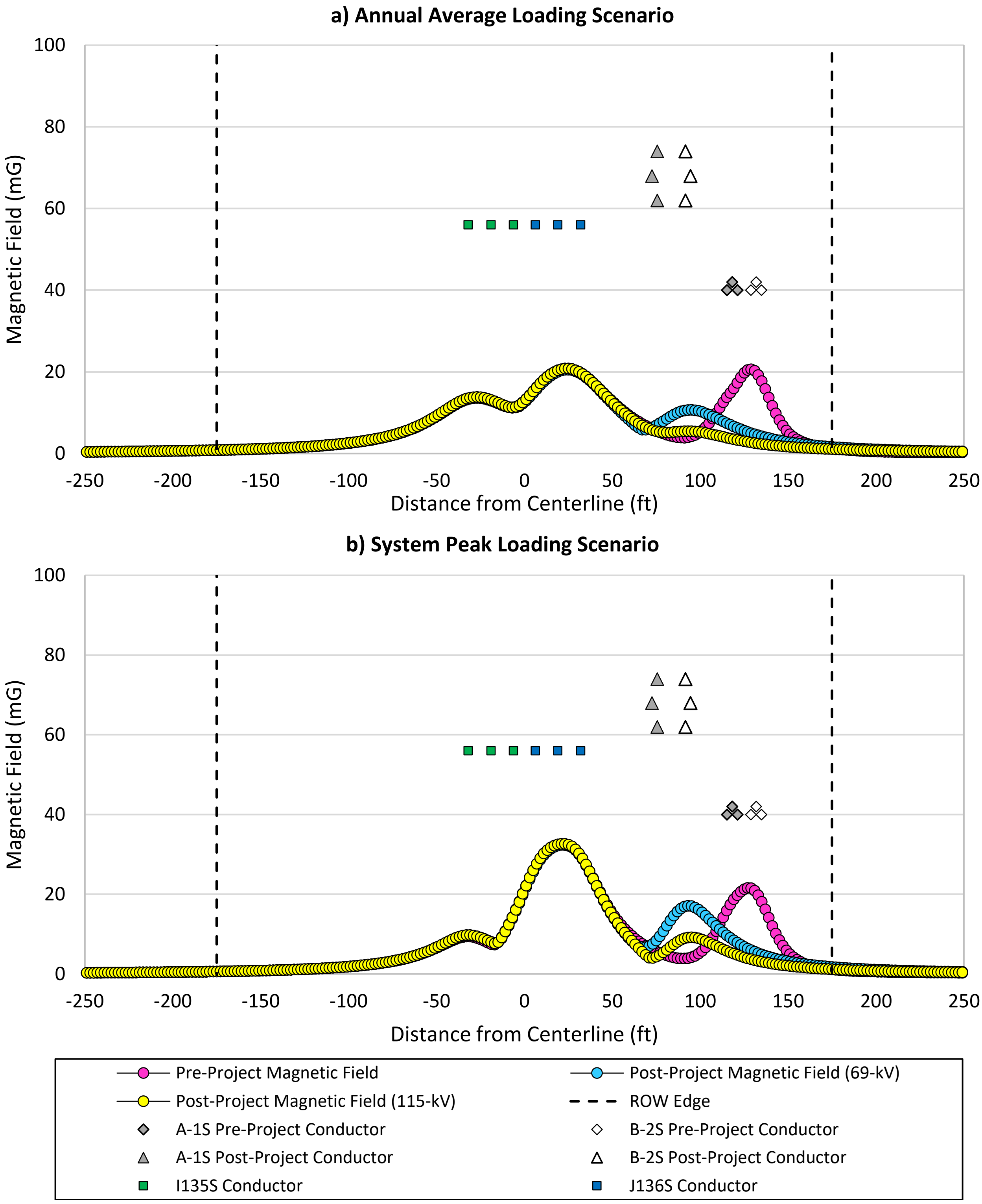

Figure B.17 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 15 Cross Section (Structures 561–575). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

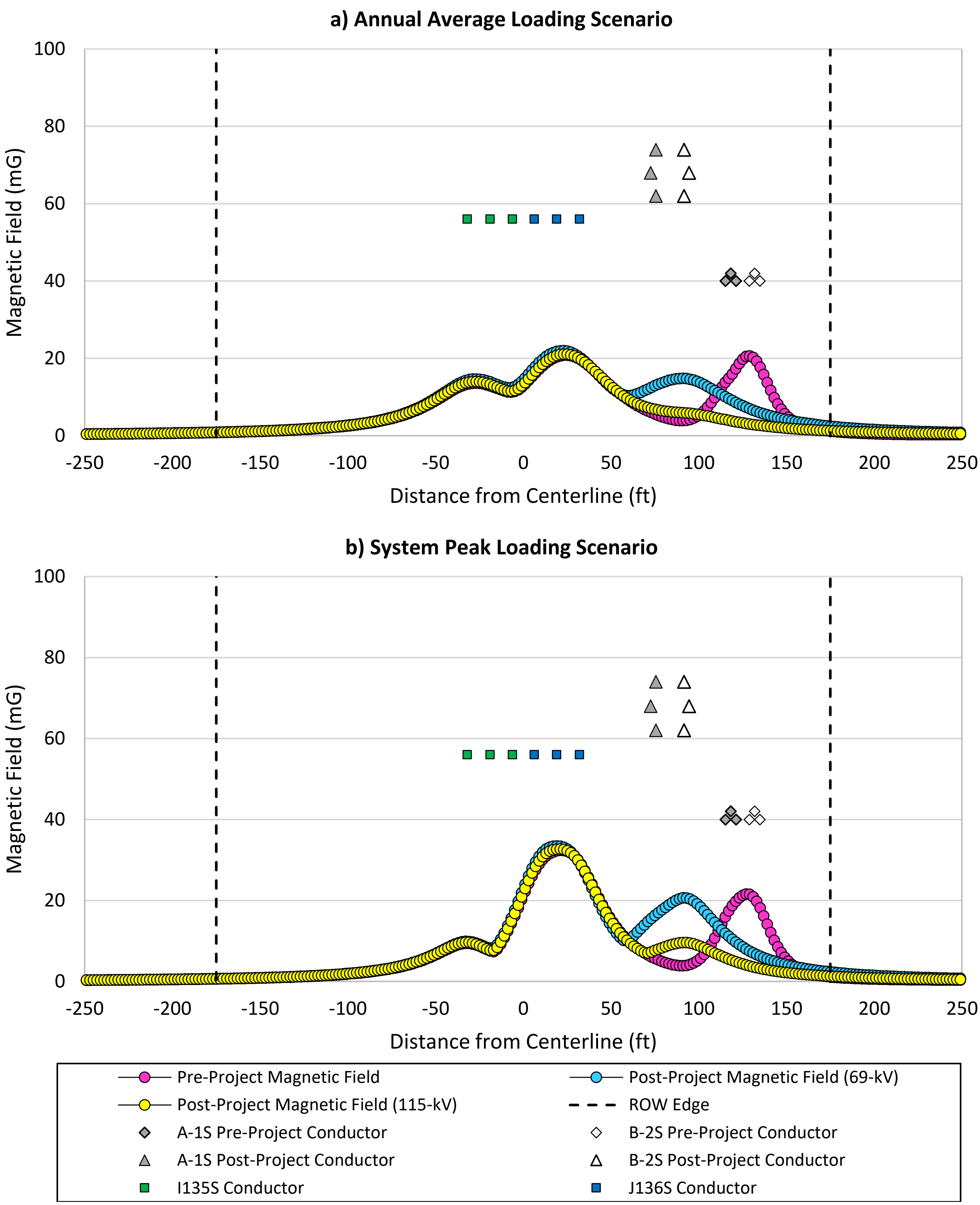

Figure B.18 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 16 Cross Section (Structures 575–615). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

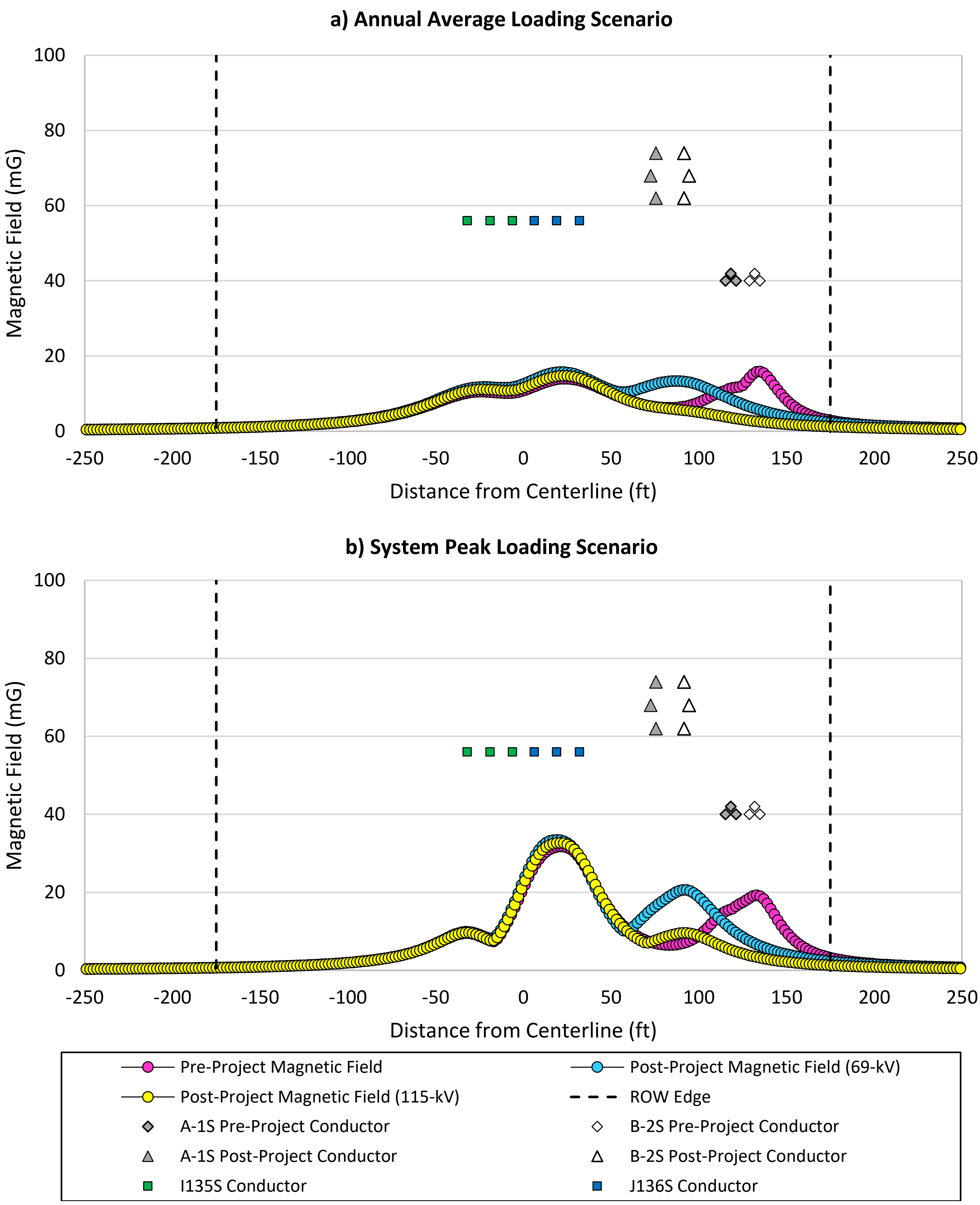

Figure B.19 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 17 Cross Section (Structures 615–642). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

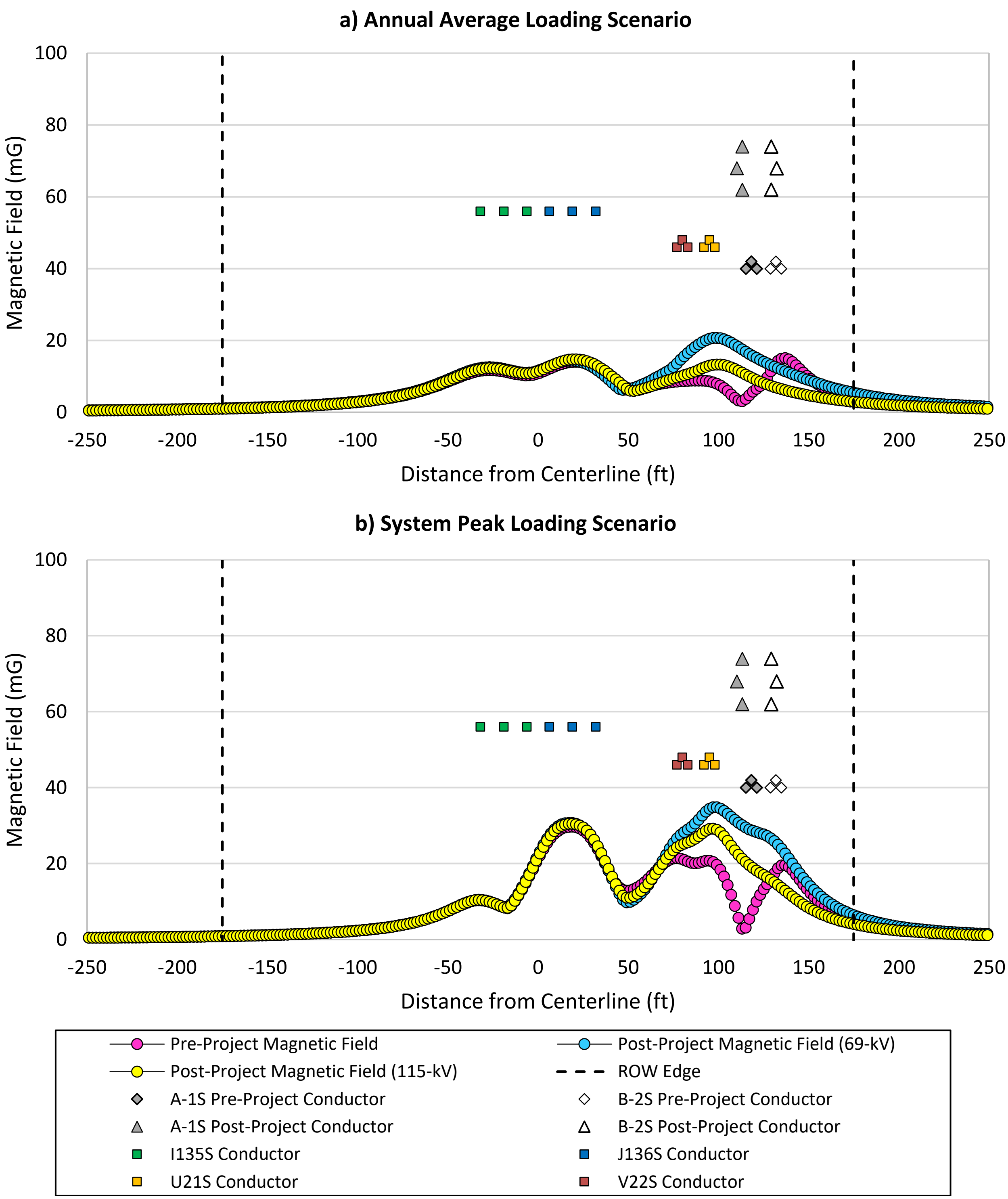

Figure B.20 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 18 Cross Section (Structures 643–647). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

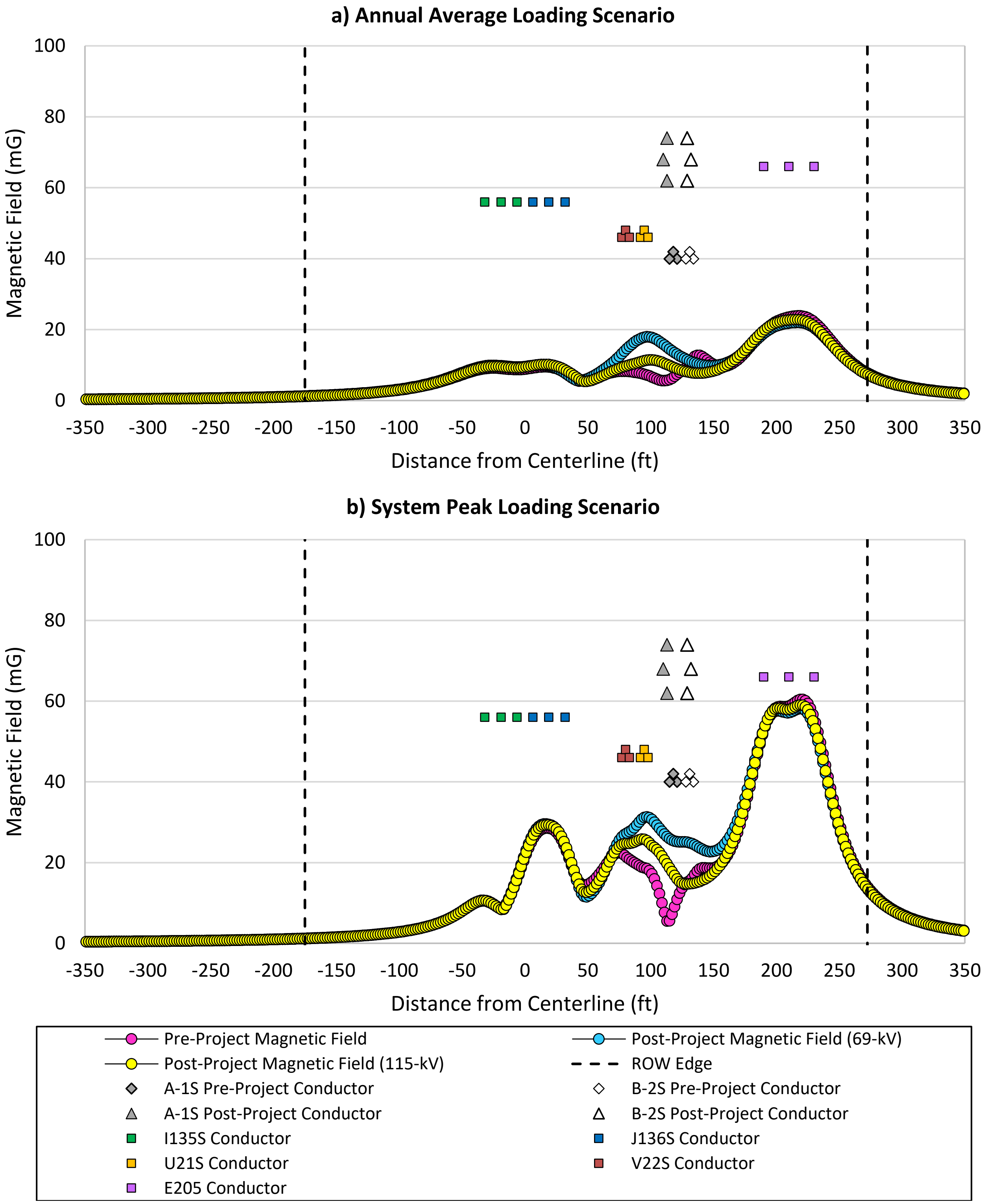

Figure B.21 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 19 Cross Section (Structures 648–653). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

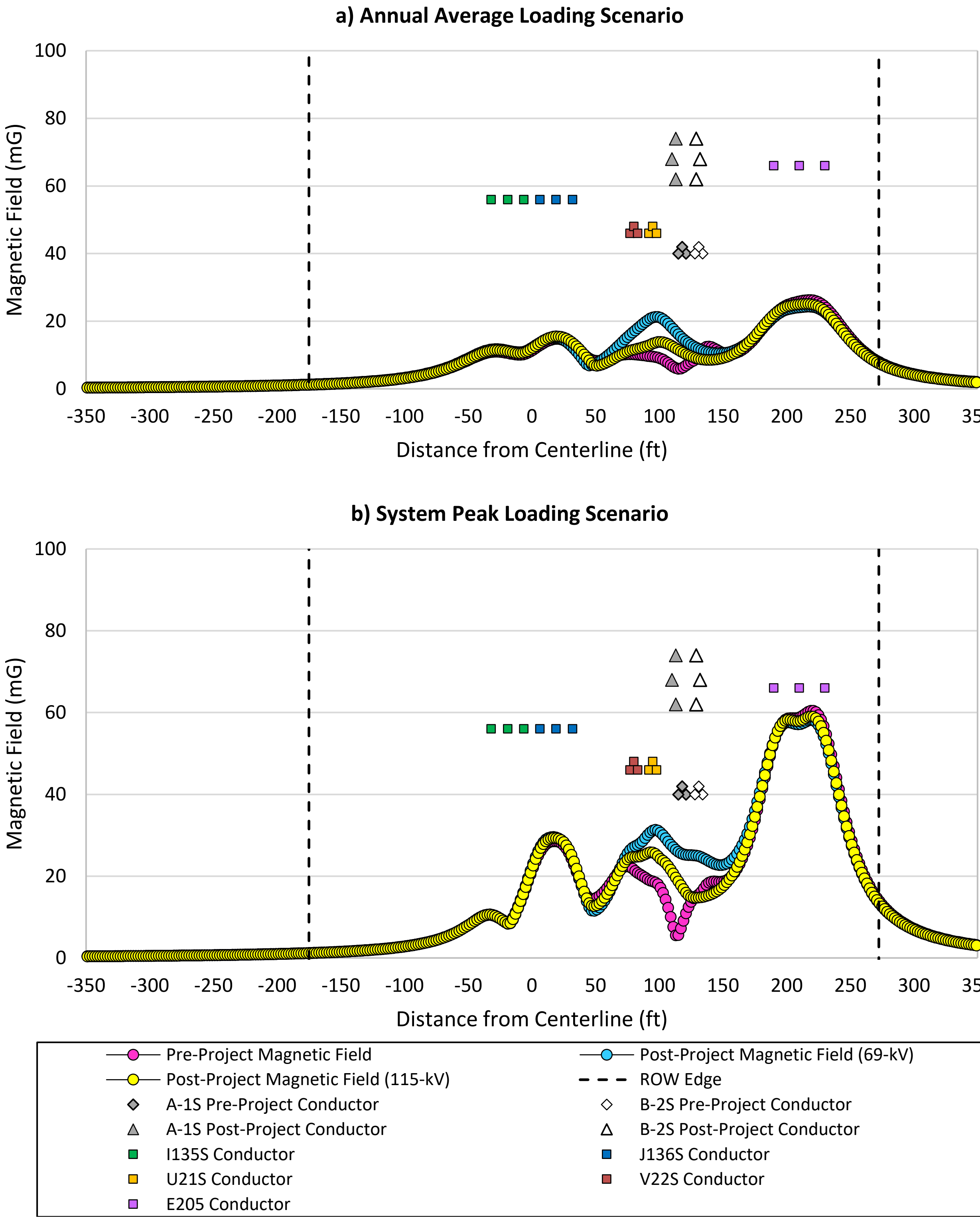

Figure B.22 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 20 Cross Section (Structures 654–661). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

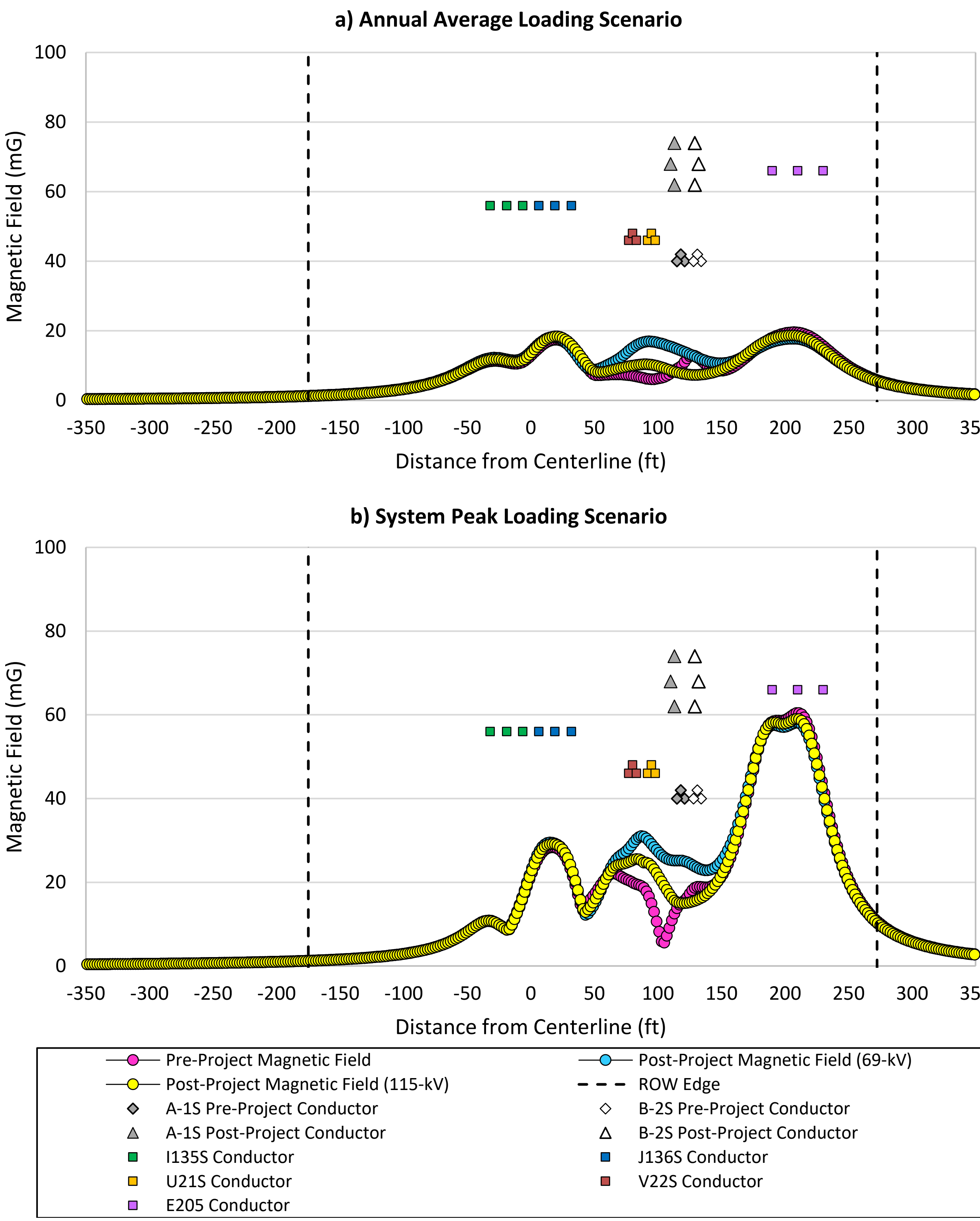

Figure B.23 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 21 Cross Section (Structures 661–Pratts). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

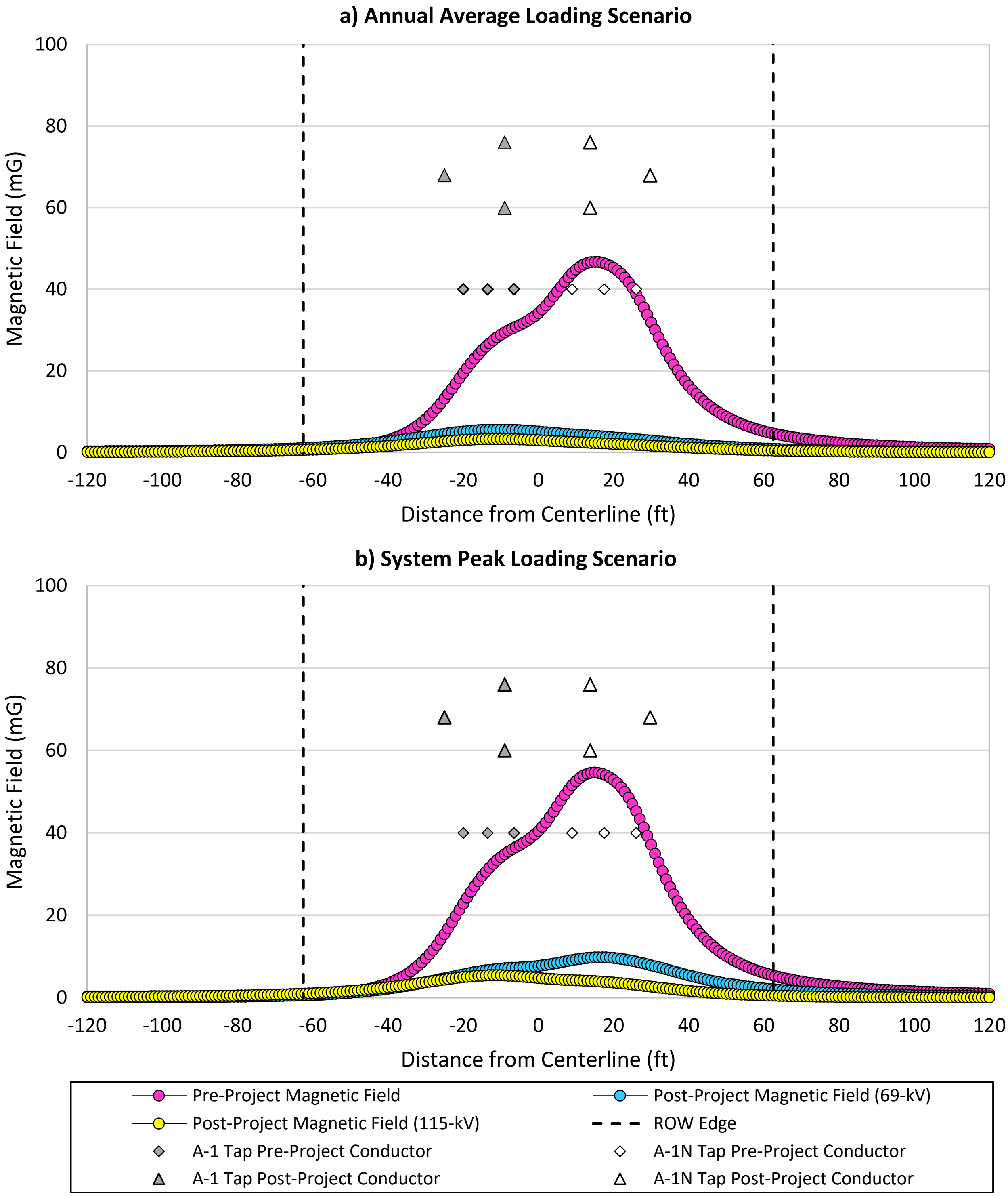

Figure B.24 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15192-NE Sheet 1 Cross Section in the Athol Tap Line (Royalston—Structures 71/72). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

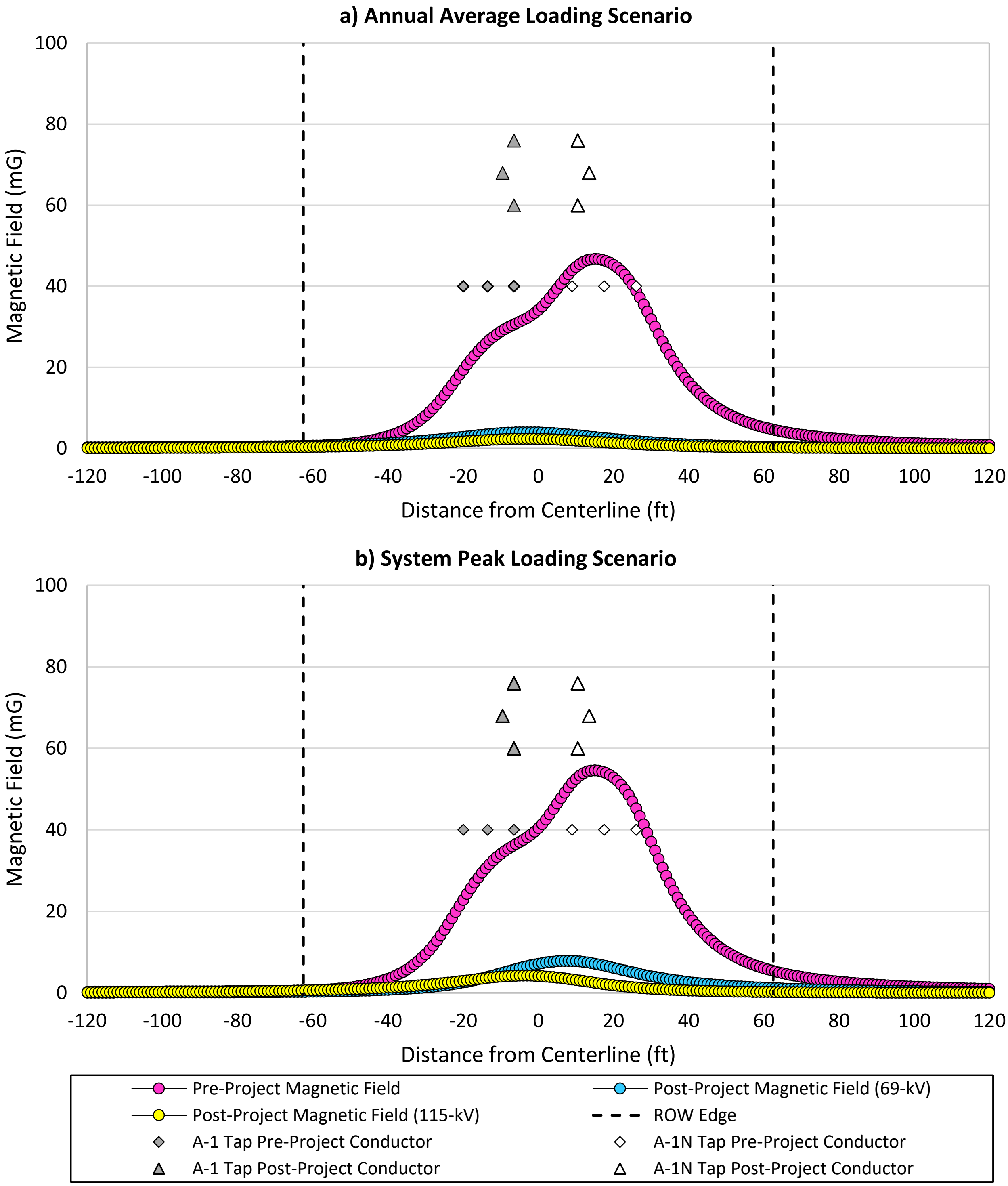

Figure B.25 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15192-NE Sheet 2 Cross Section in the Athol Tap Line (Structure 71/72—Chestnut Hill). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

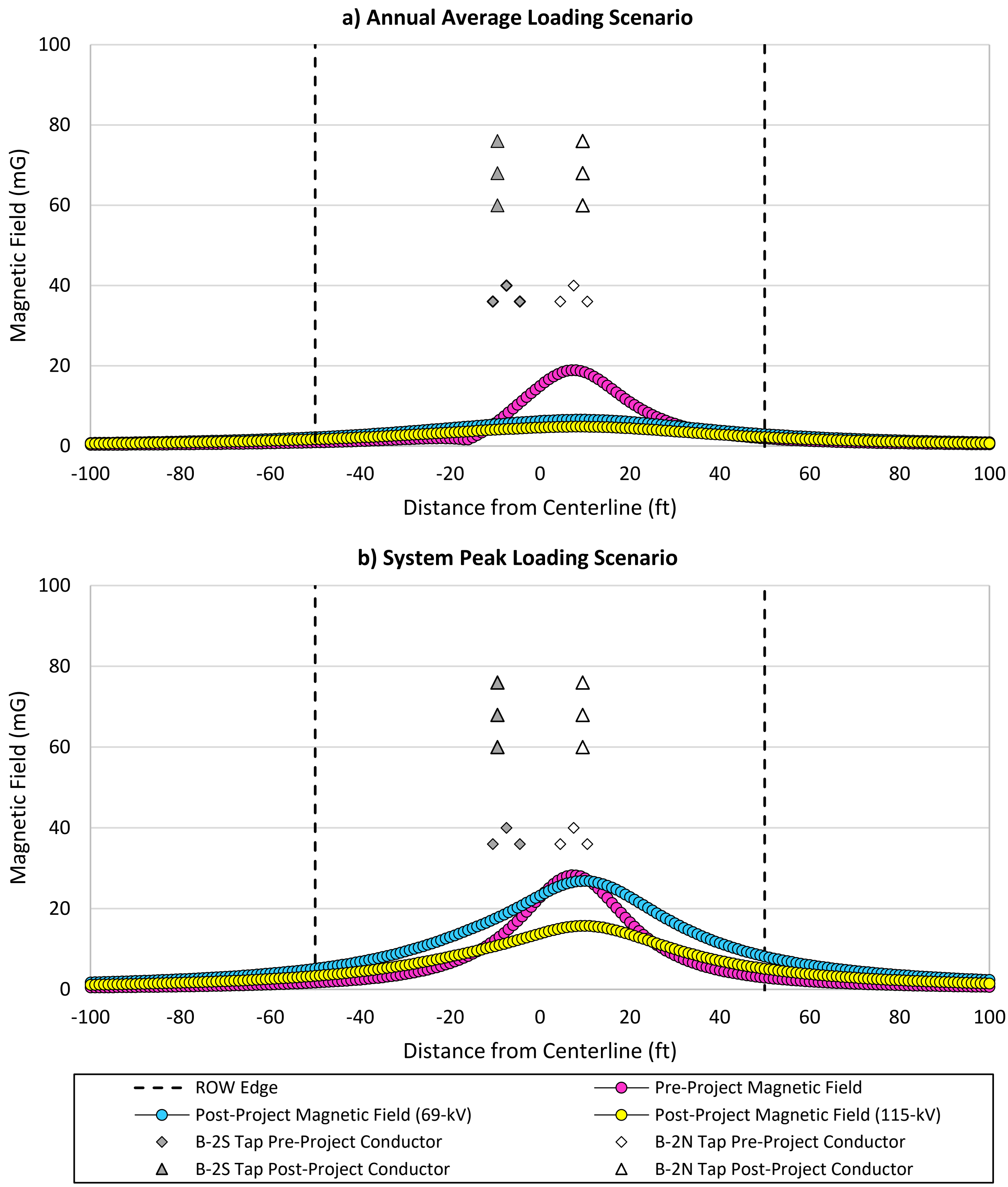

Figure B.26 Magnetic Field Modeling Results at 1 Meter Aboveground for the B-15193-NE Sheet 1 Cross Section in the Gardner Tap Line (Gardner Switch Tower—Crystal Lake). ft = Feet; kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

Appendix C

Electric Field Profiles for Each Route Segment and Loading Scenario

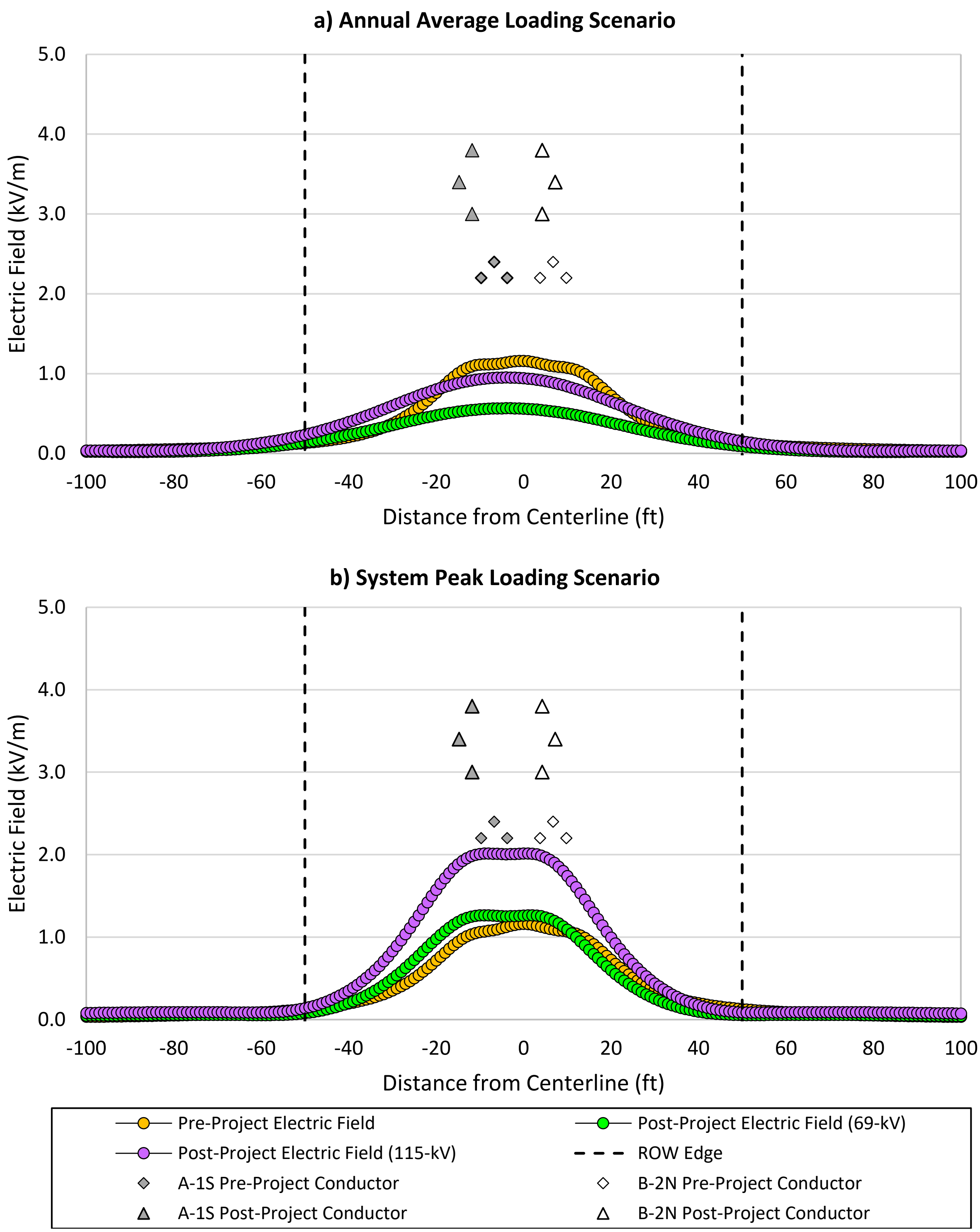

Figure C.1 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 1 Cross Section (Structures 99–186). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

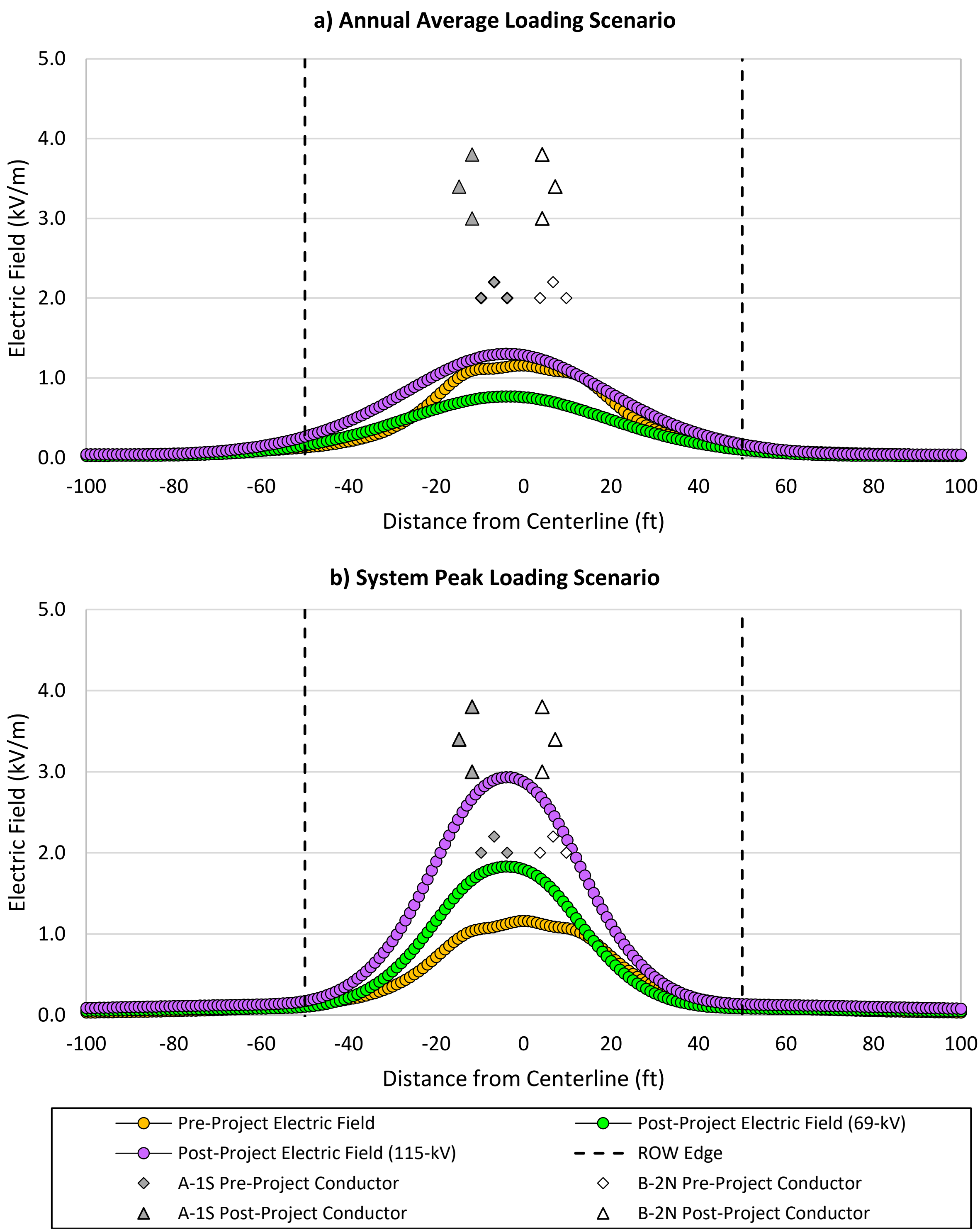

Figure C.2 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 2 Cross Section (Structures 186–201). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

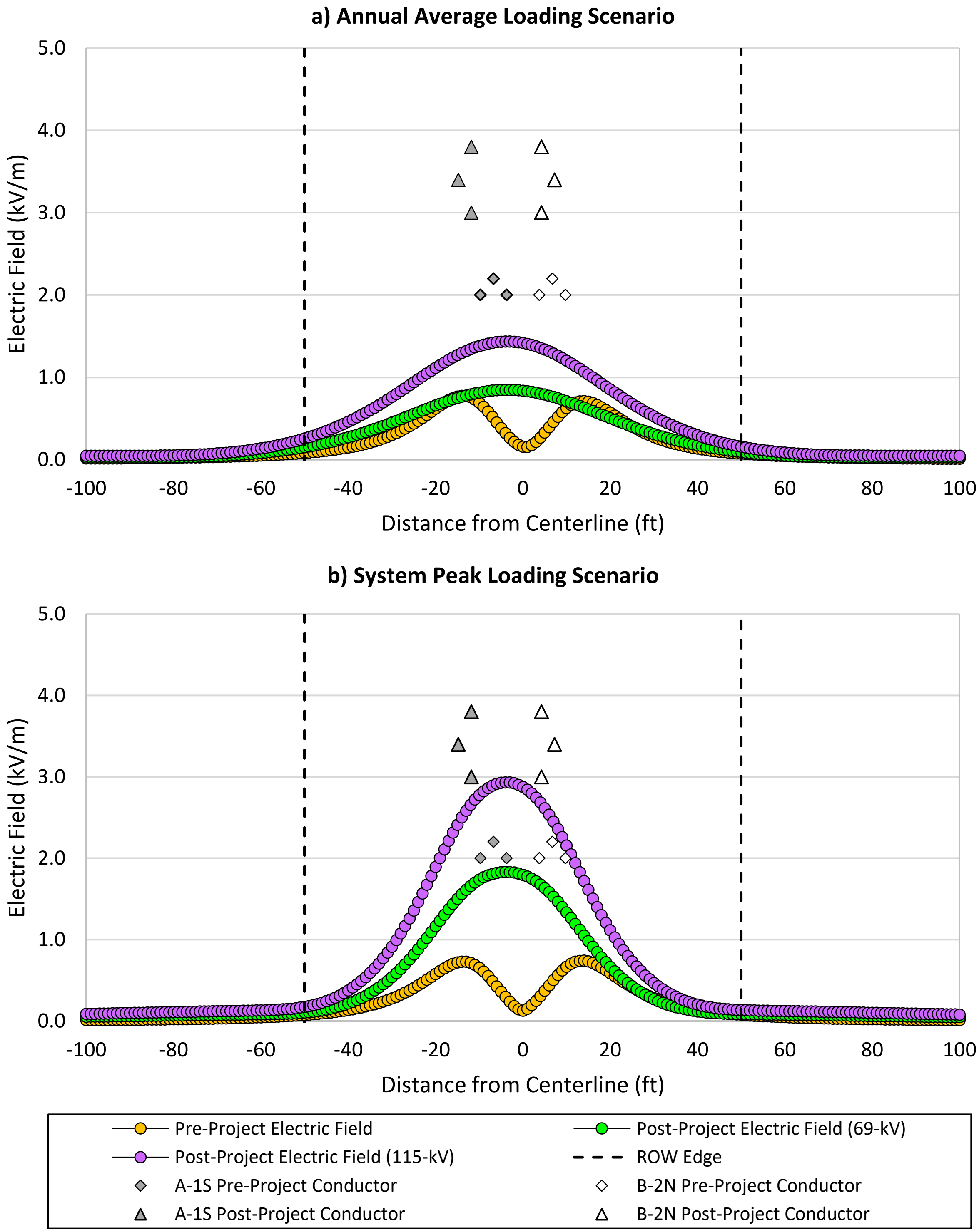

Figure C.3 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 3 Cross Section (Structure 201–Royalston Station). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

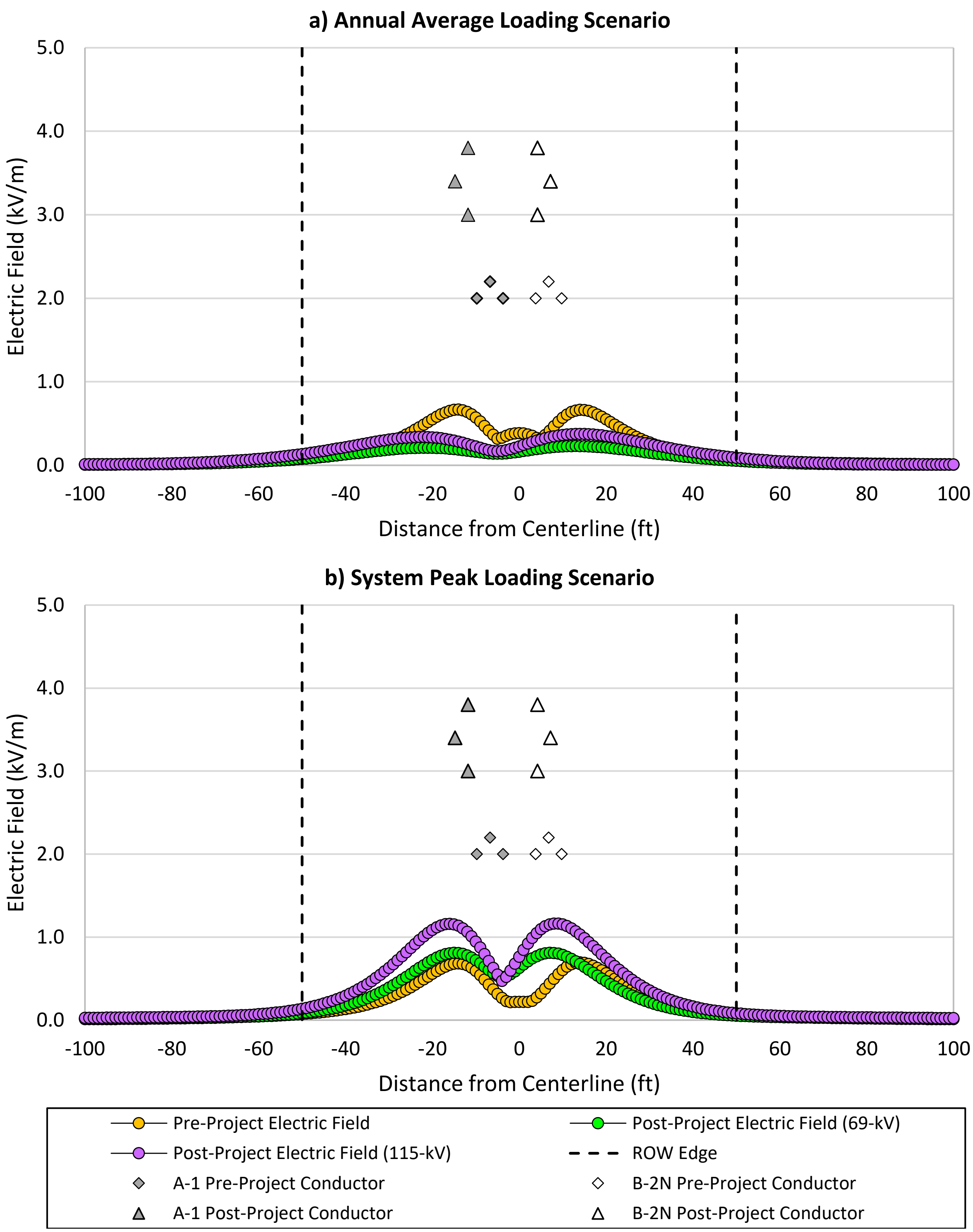

Figure C.4 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 4 Cross Section (Royalston Station–Structure 318). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

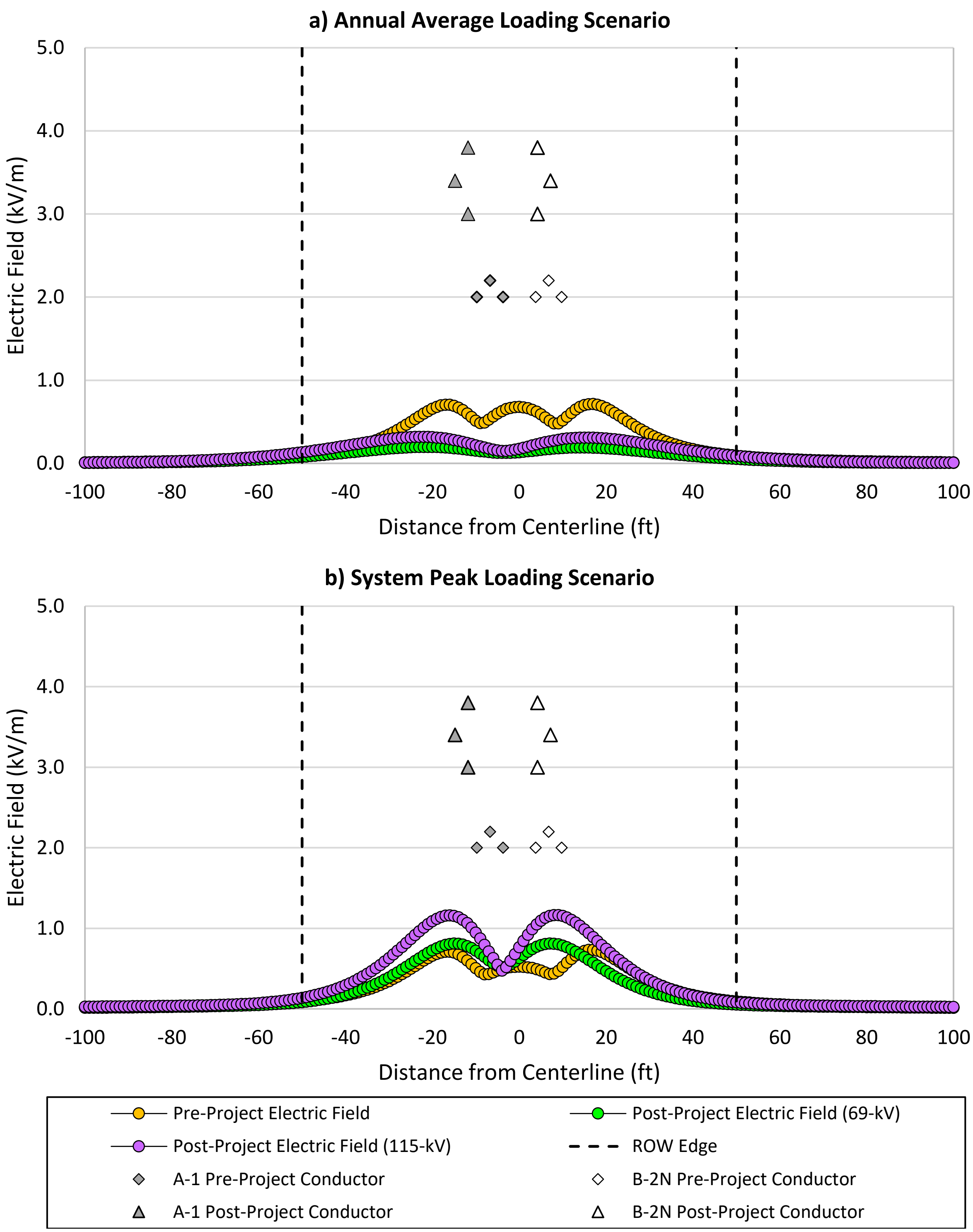

Figure C.5 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 5 Cross Section (Structures 318–319). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

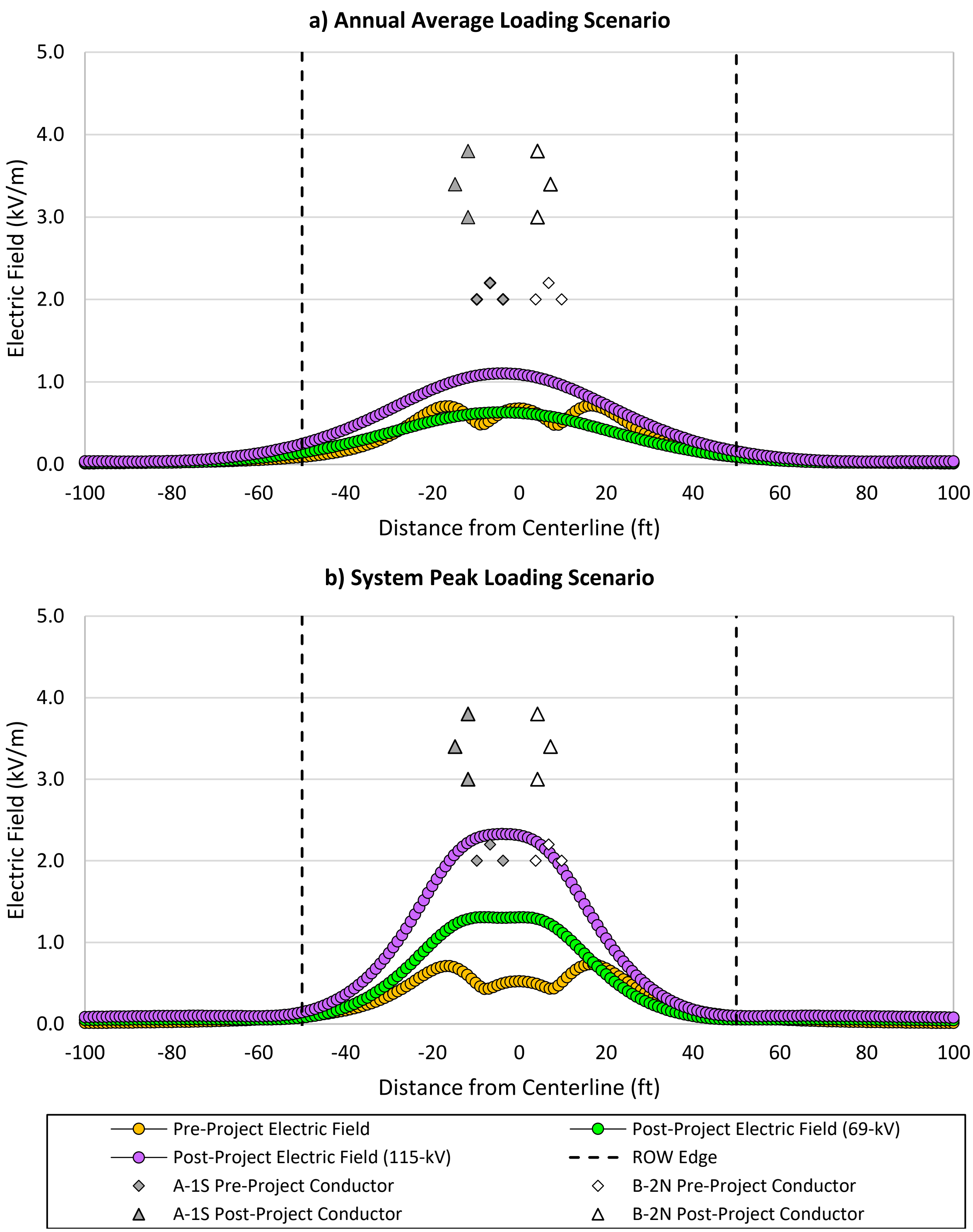

Figure C.6 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 6 Cross Section (Structures 319–343-1). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

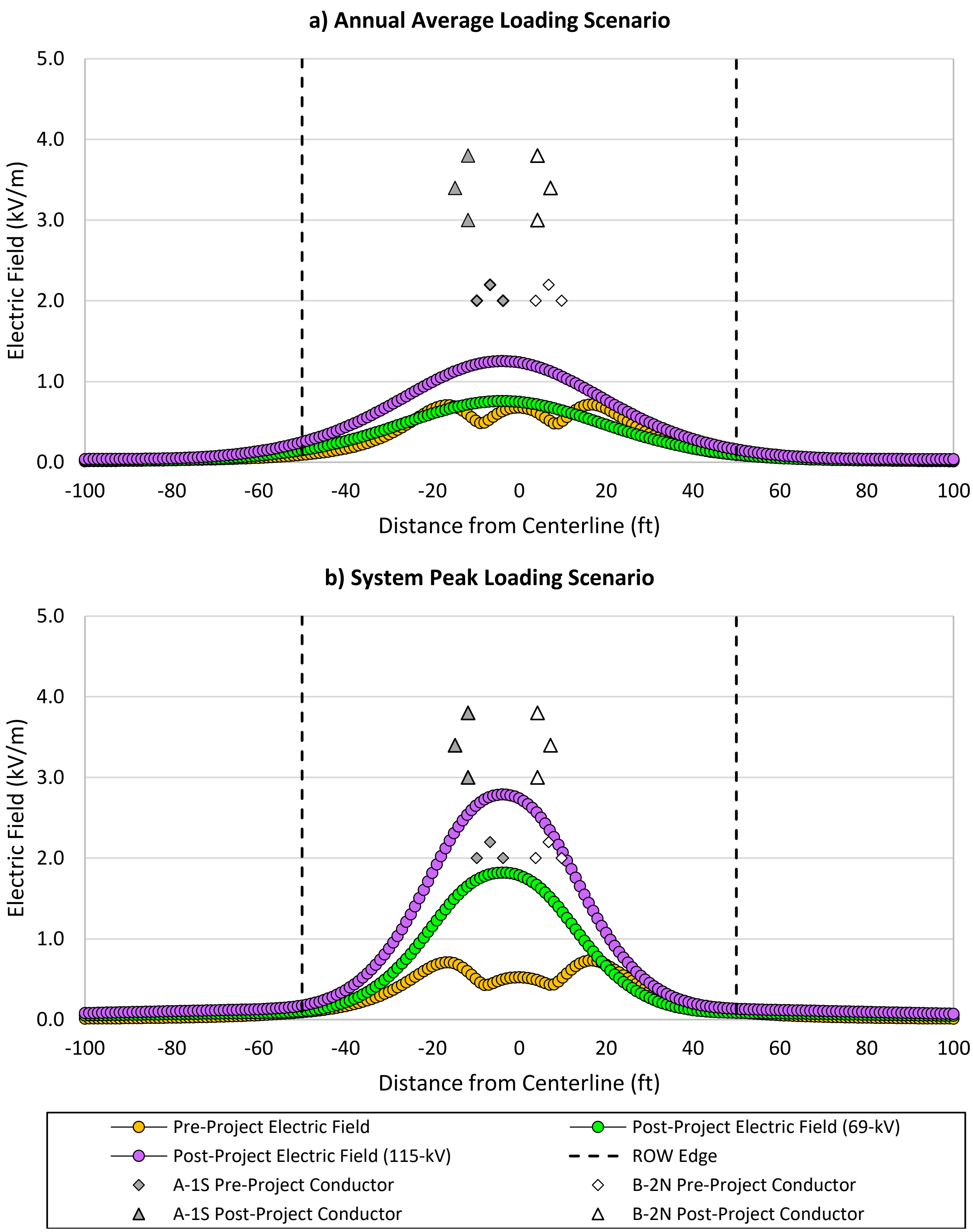

Figure C.7 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 7 Cross Section (Structures 343-1–346). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

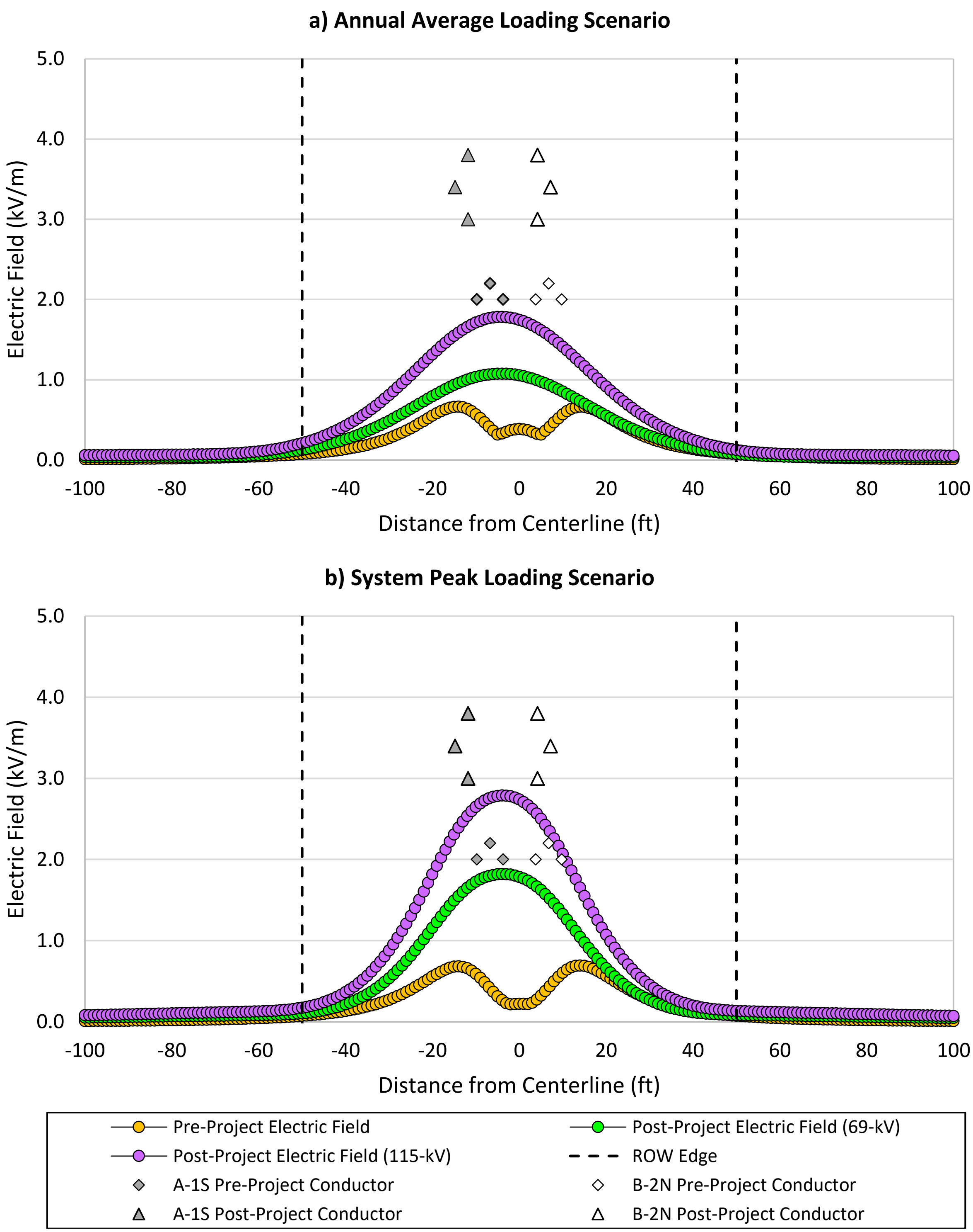

Figure C.8 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 8 Cross Section (Structures 347–Otter River). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

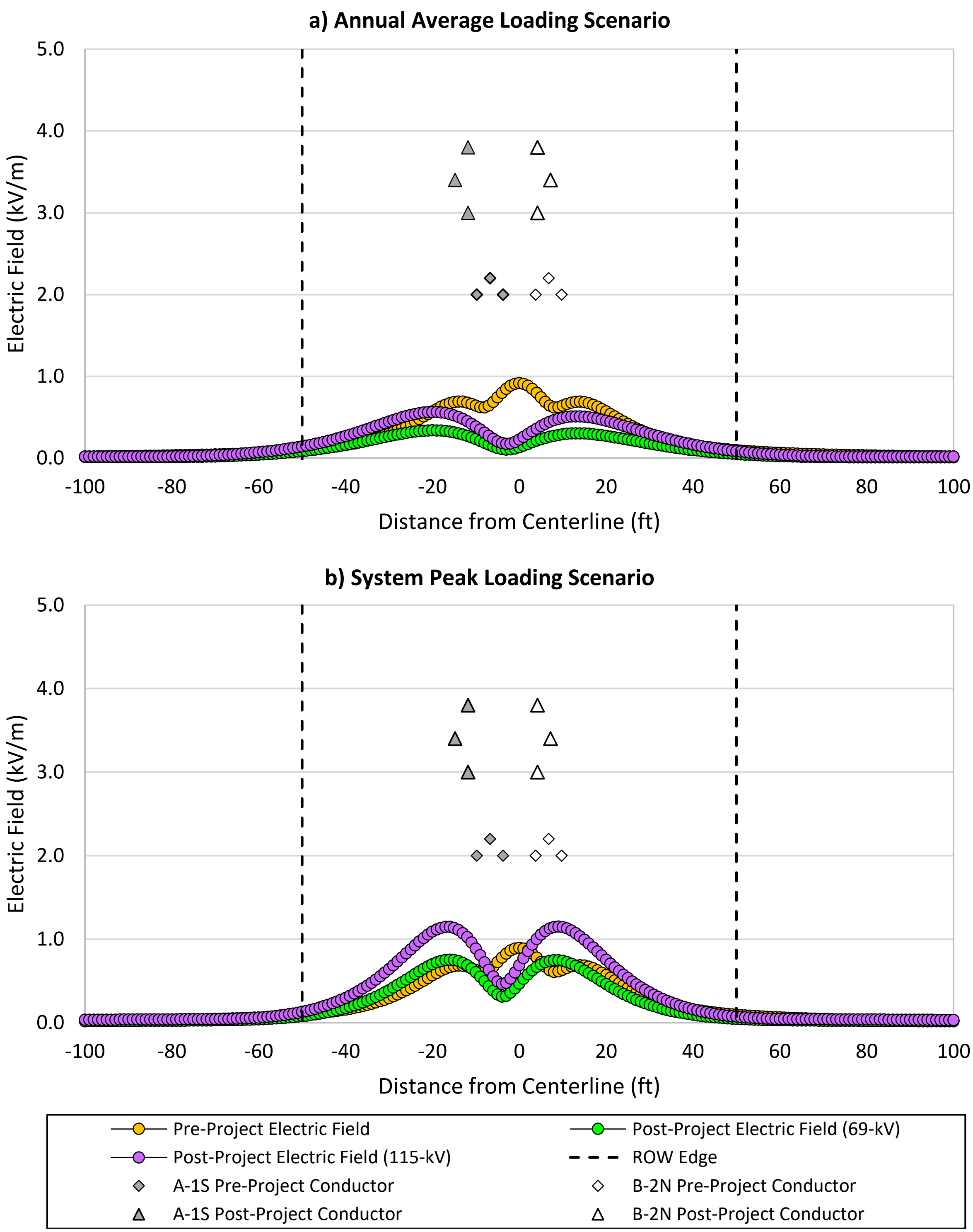

Figure C.9 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 9 Cross Section (Otter River–Structure 358). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

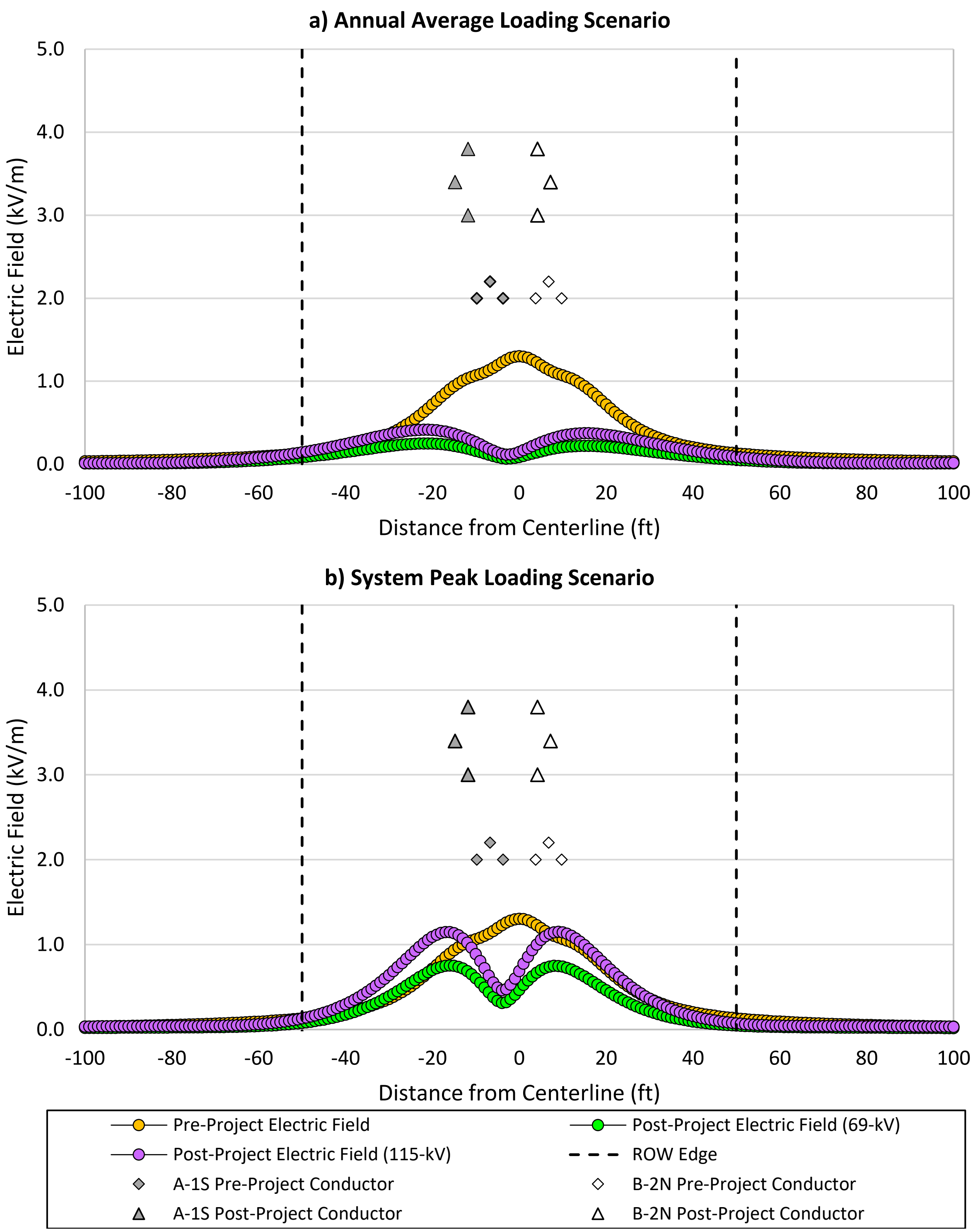

Figure C.10 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 10 Cross Section (Structures 358–377). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

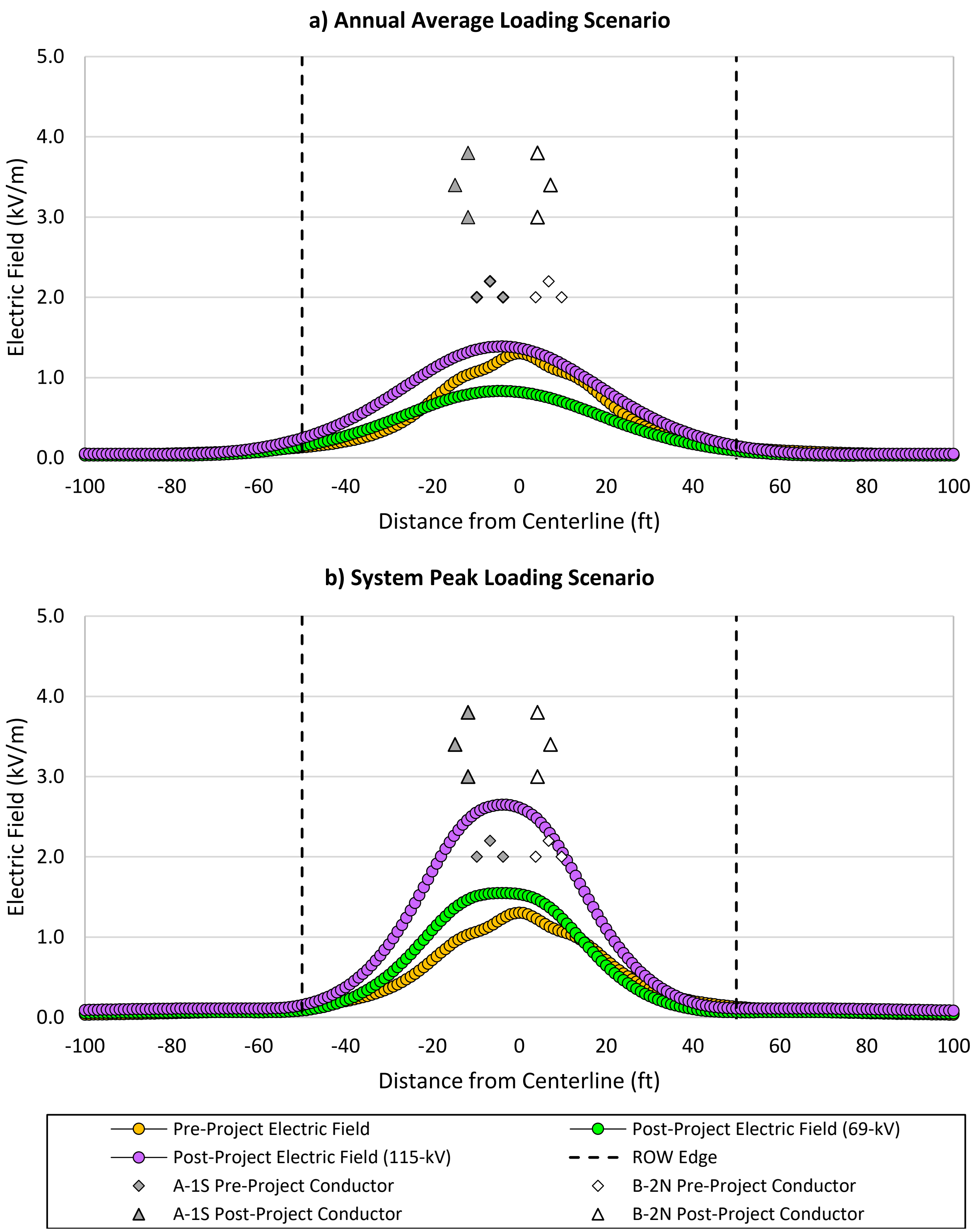

Figure C.11 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 11 Cross Section (Structures 377–400). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

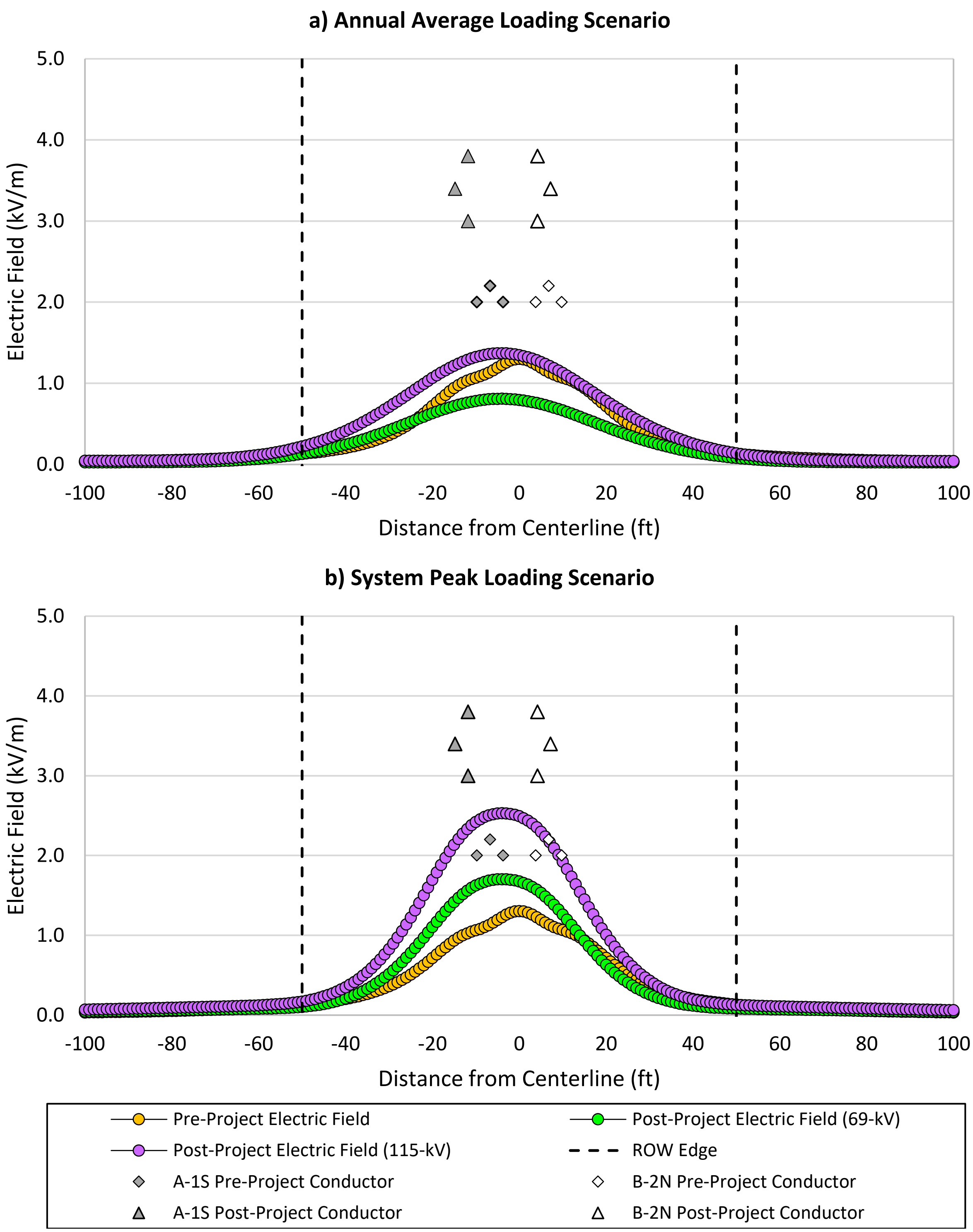

Figure C.12 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 12 Cross Section (Structure 400–Gardner Switch Tower). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

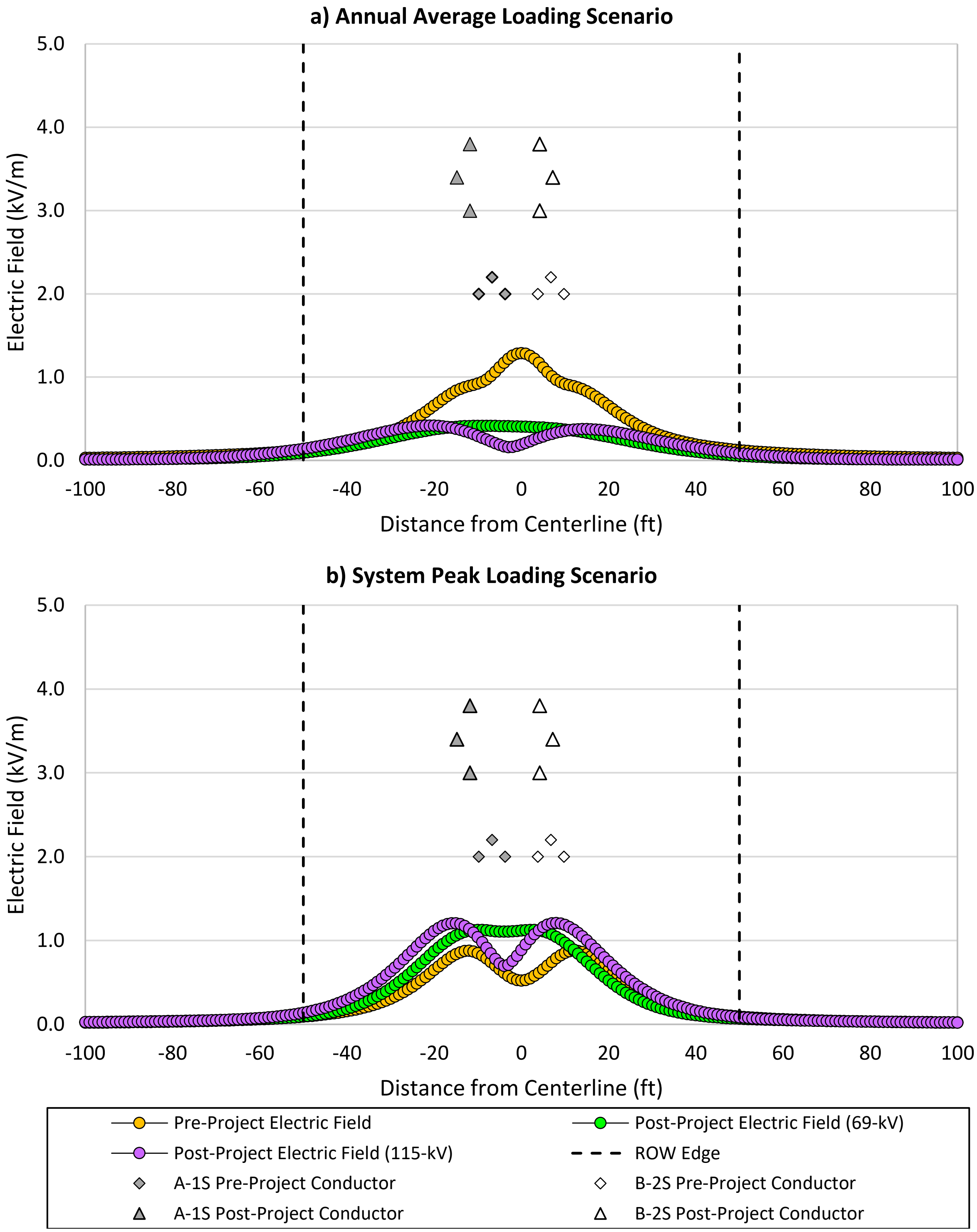

Figure C.13 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 13 Cross Section (Gardner Switch Tower–Westminster Station). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

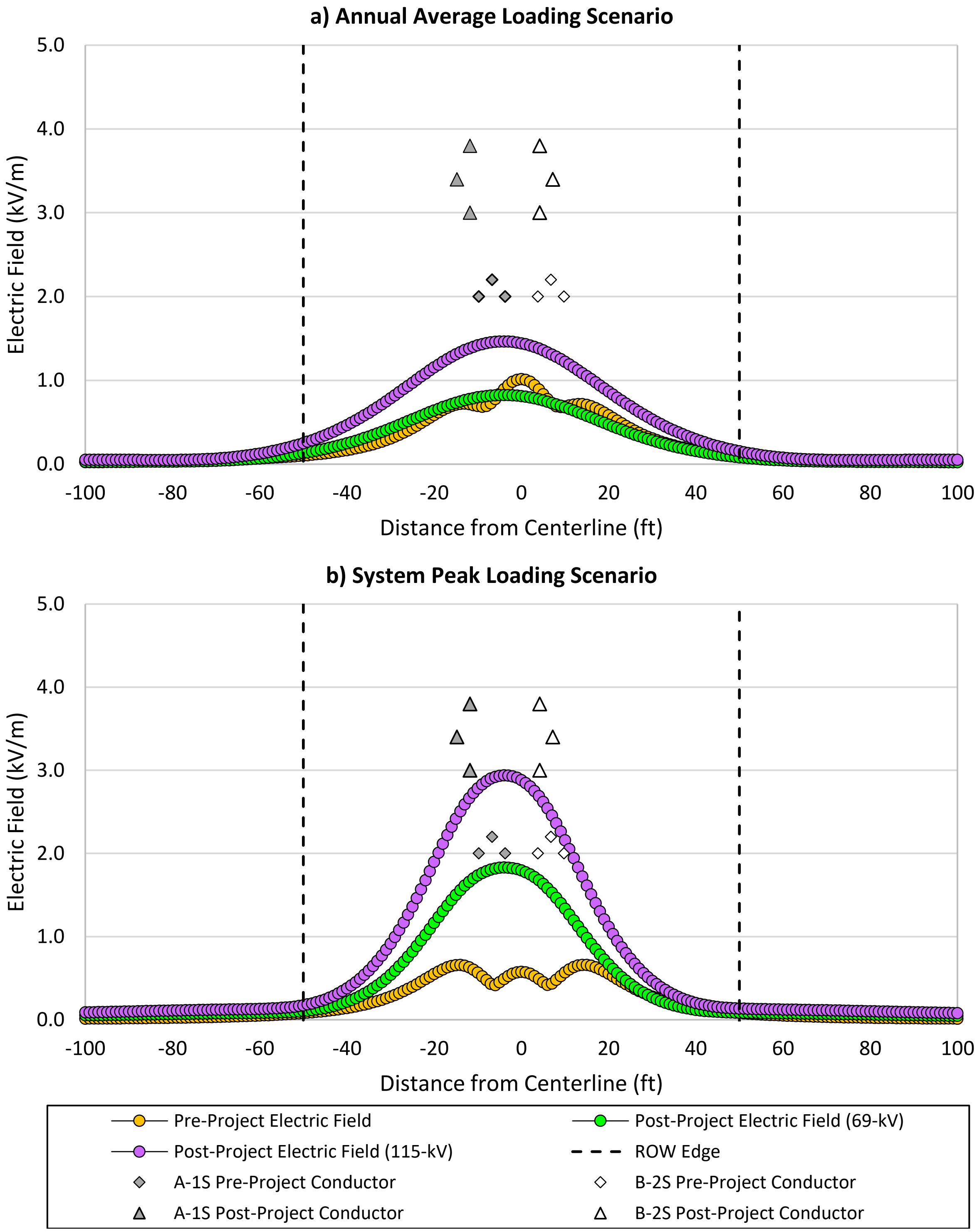

Figure C.14 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 13 Cross Section (Westminster Station–Structure 499). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

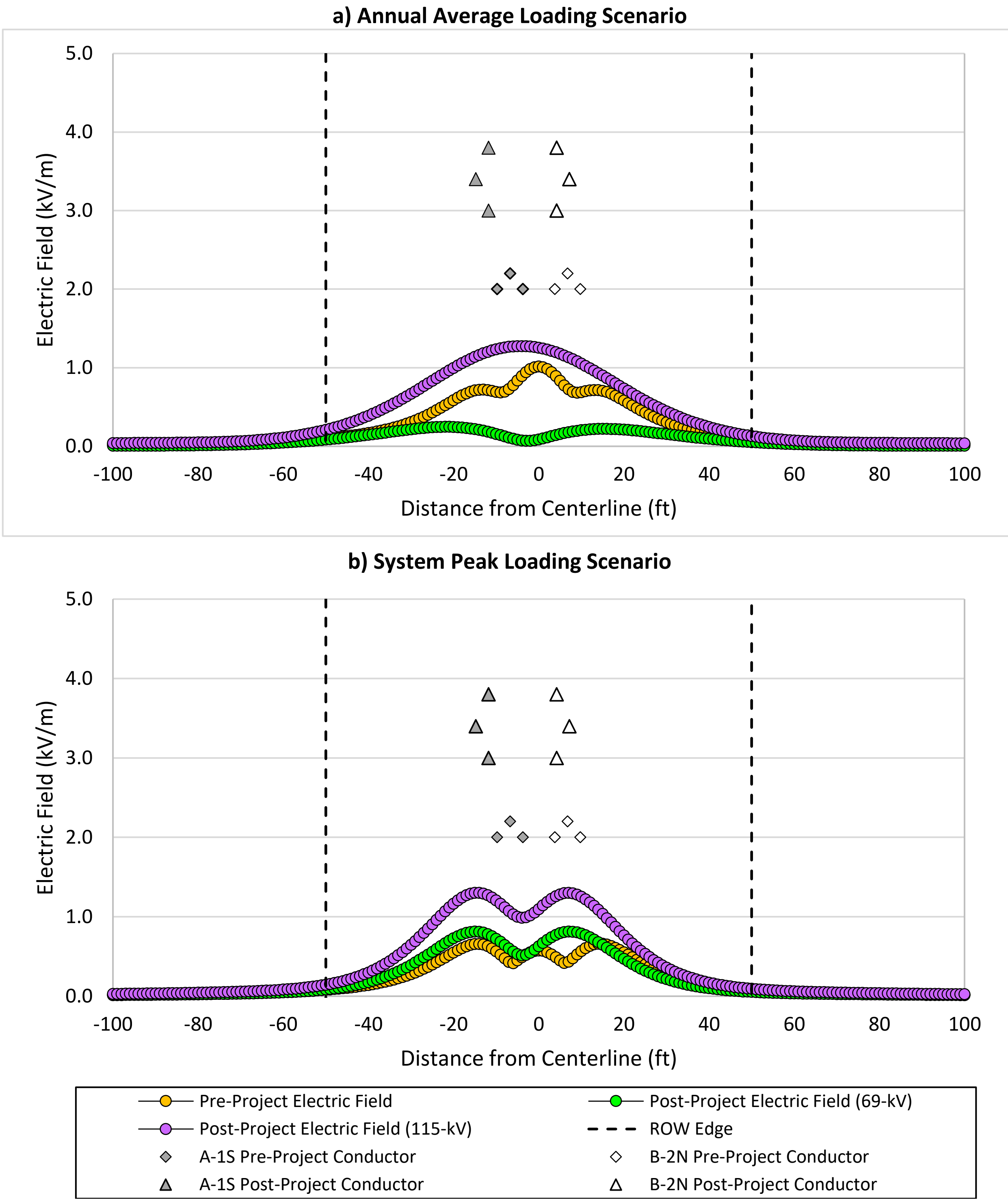

Figure C.15 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 14 Cross Section (Structure 499–East Westminster). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

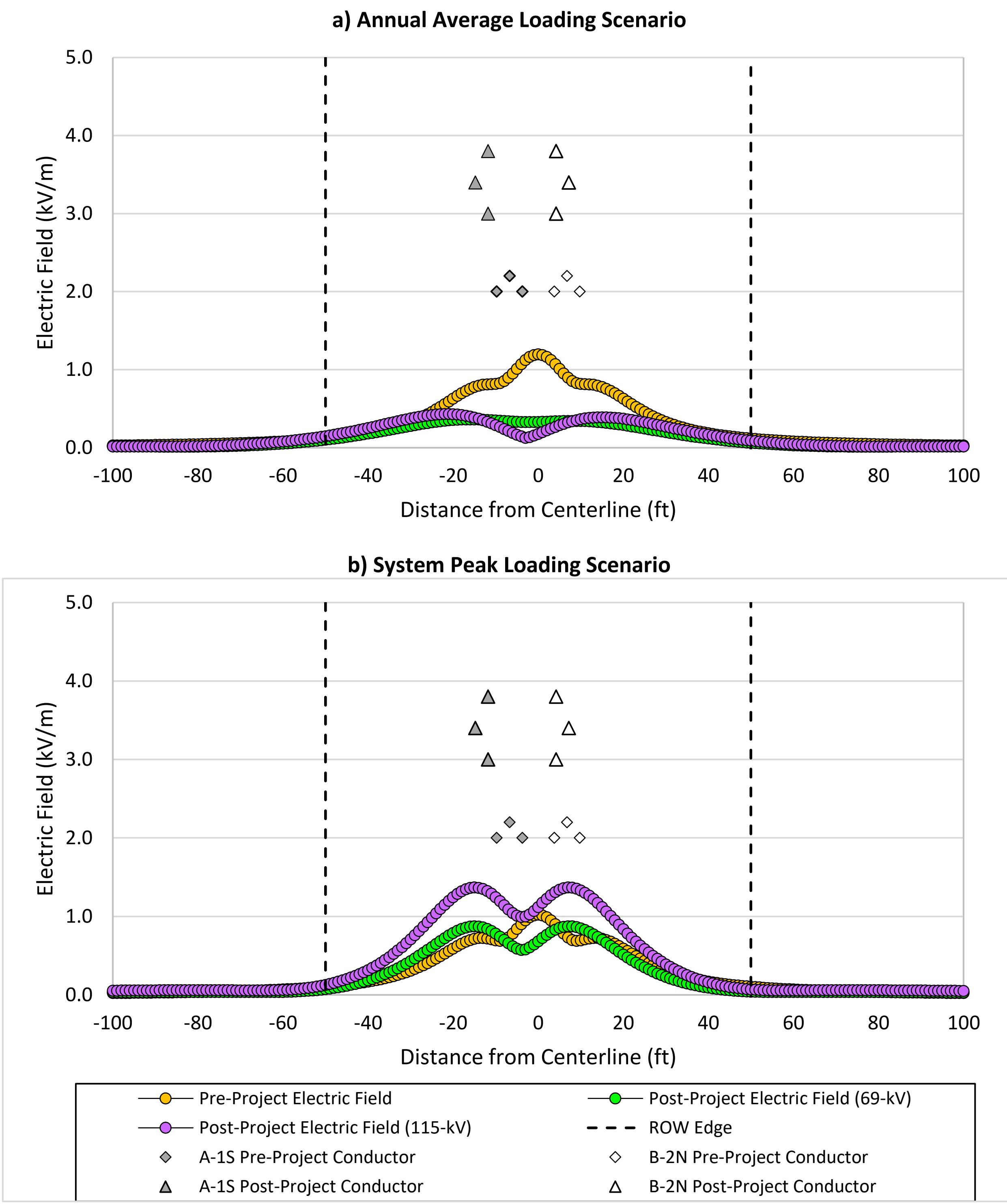

Figure C.16 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 14 Cross Section (East Westminster–Structure 561). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

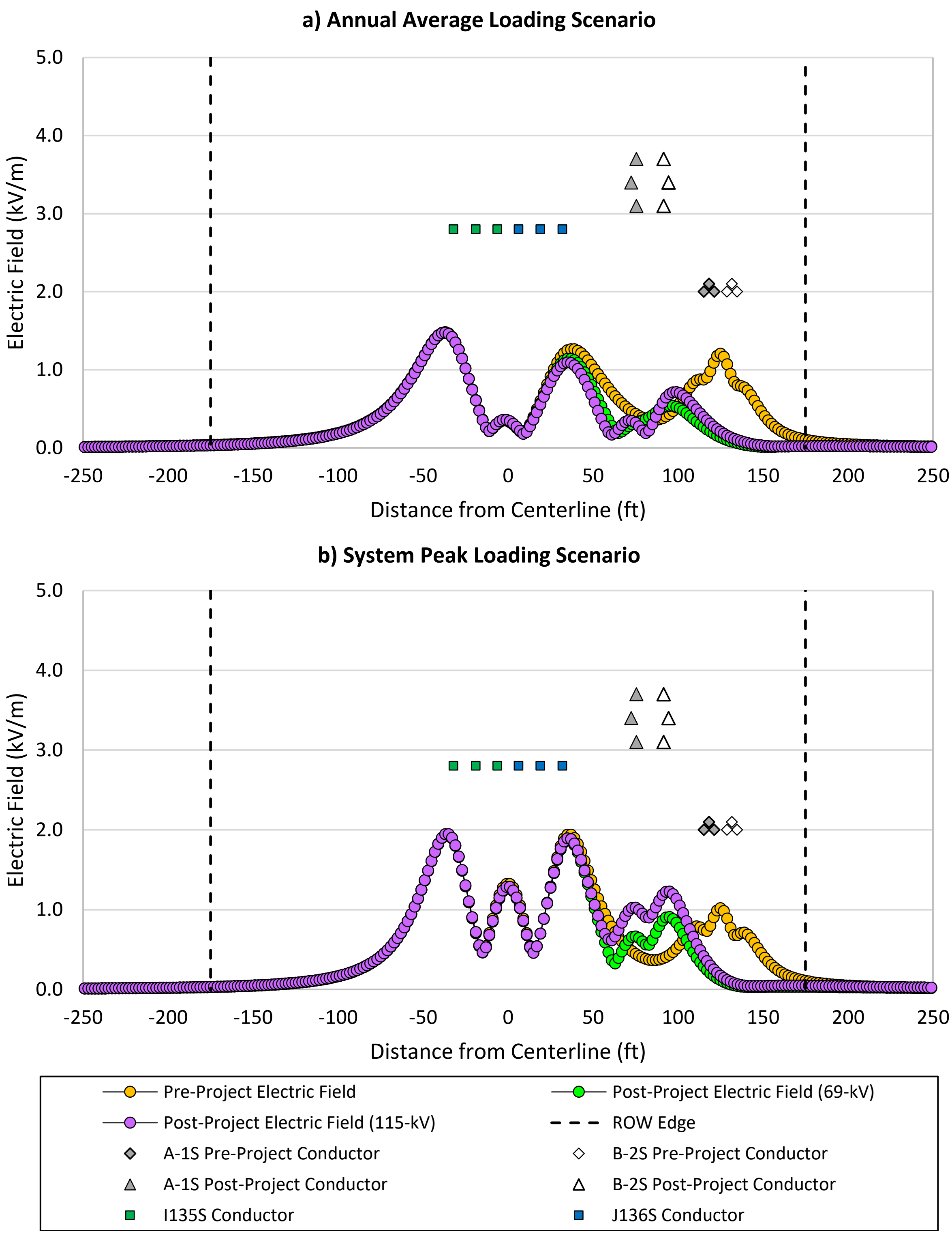

Figure C.17 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 15 Cross Section (Structures 561–575). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

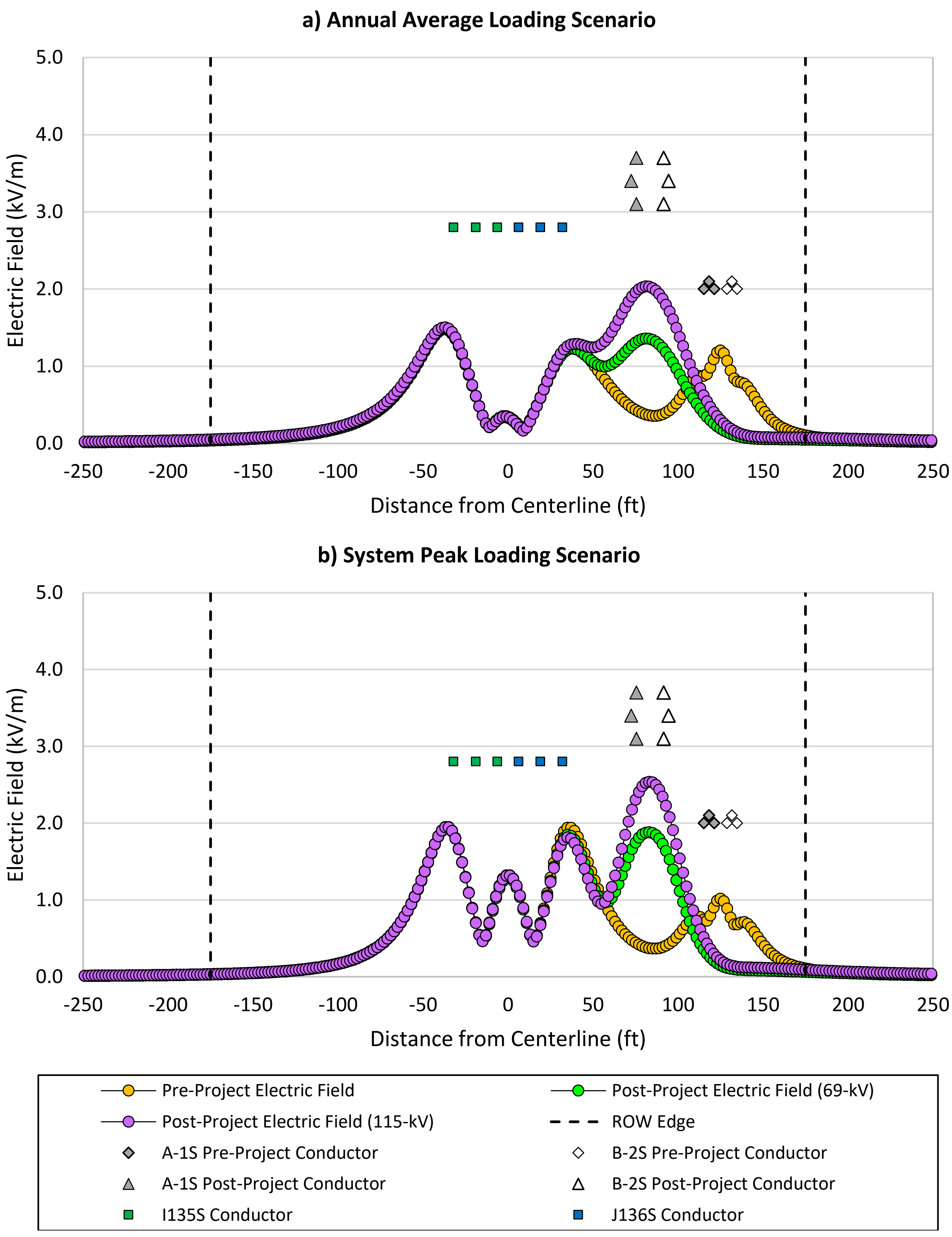

Figure C.18 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 16 Cross Section (Structures 575–615). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

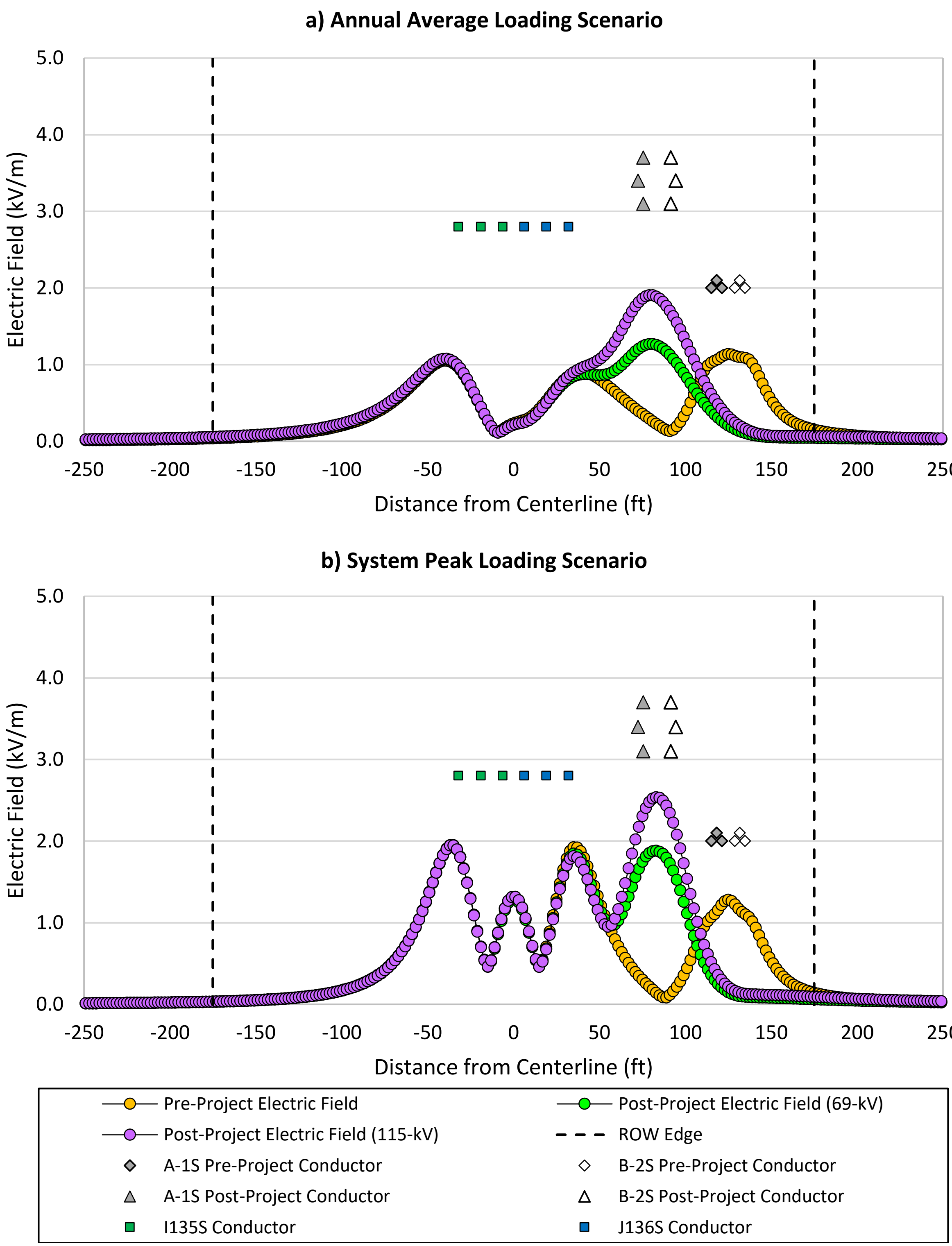

Figure C.19 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 17 Cross Section (Structures 615–642). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

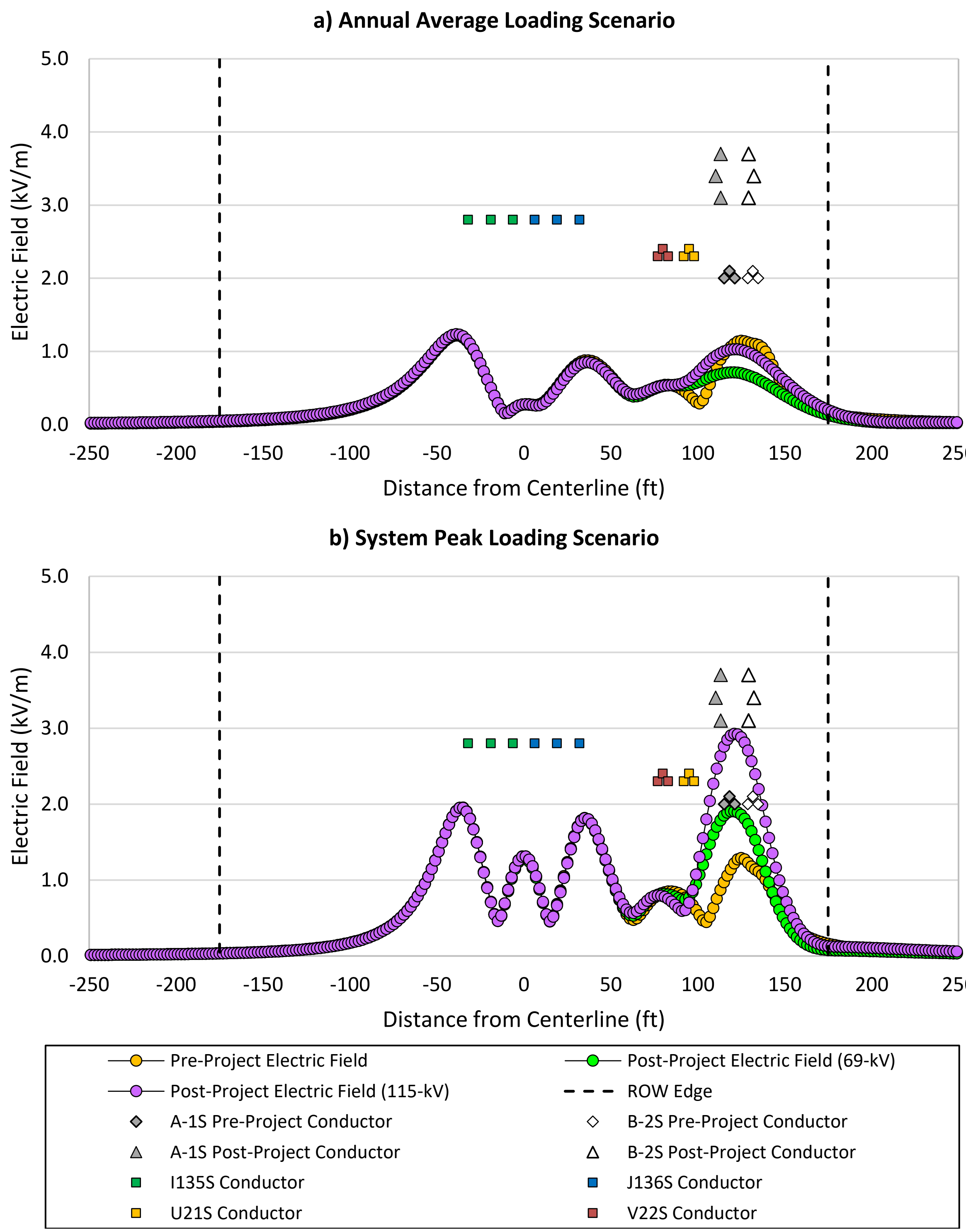

Figure C.20 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 18 Cross Section (Structures 643–647). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

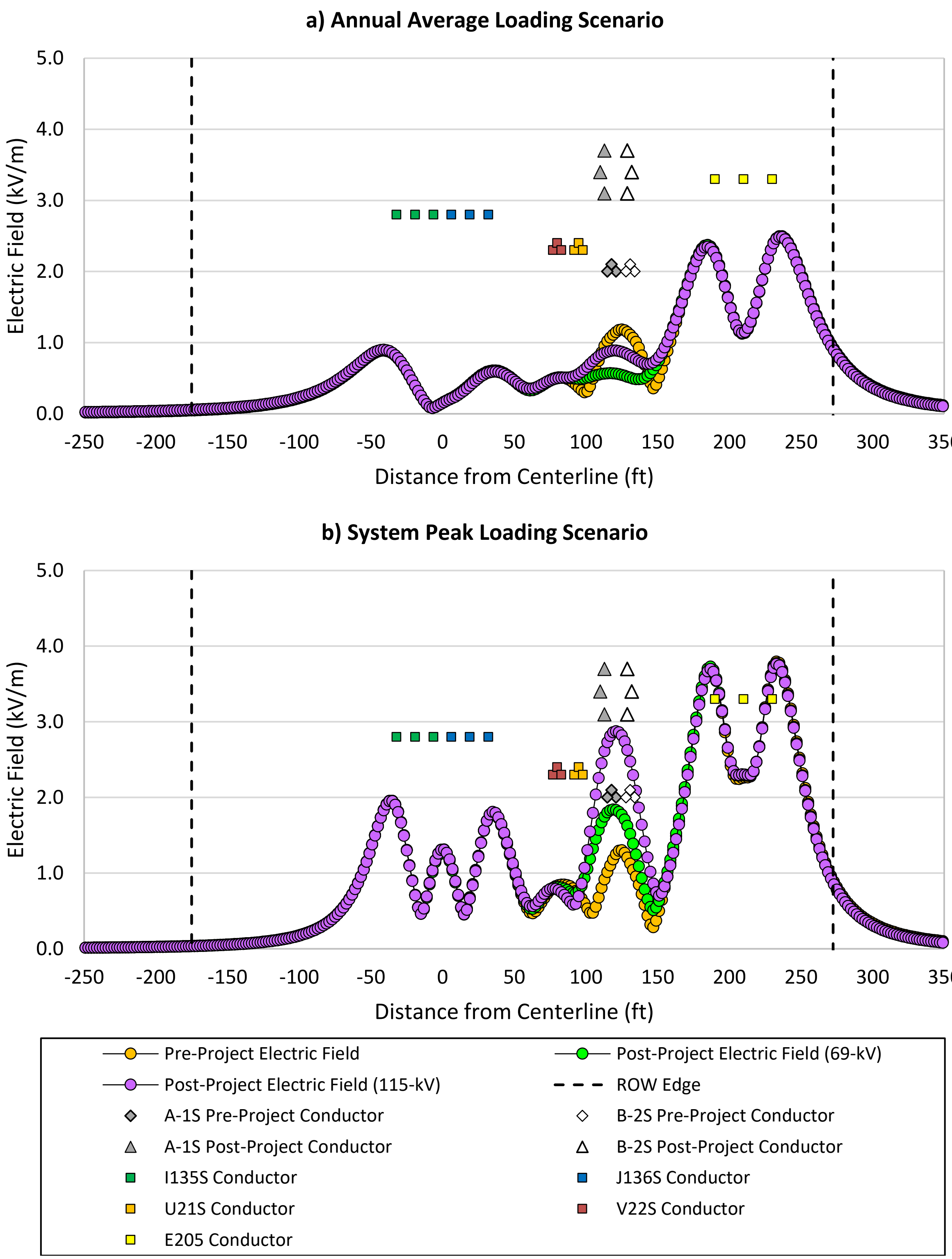

Figure C.21 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 19 Cross Section (Structures 648–653). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

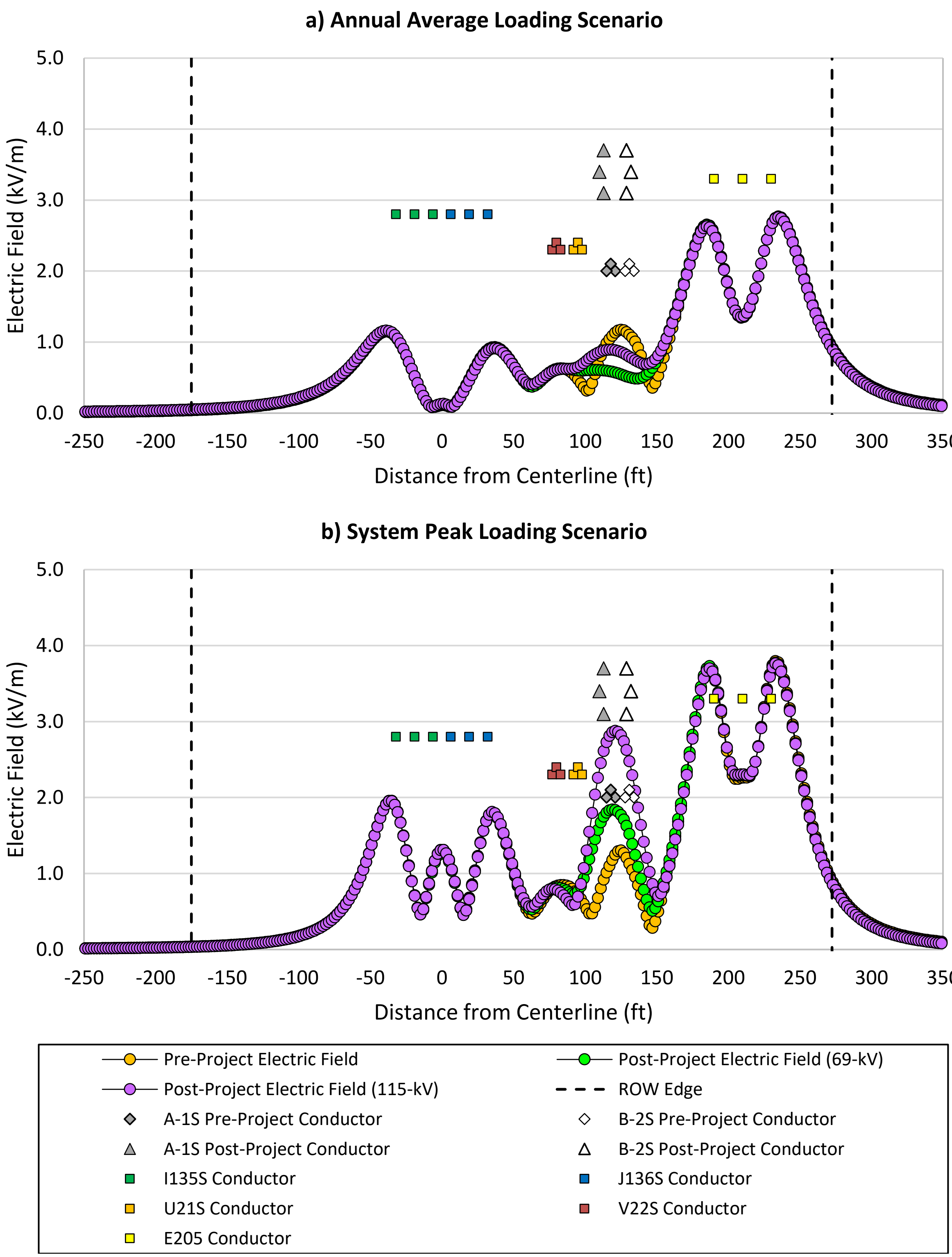

Figure C.22 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 20 Cross Section (Structures 654–661). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

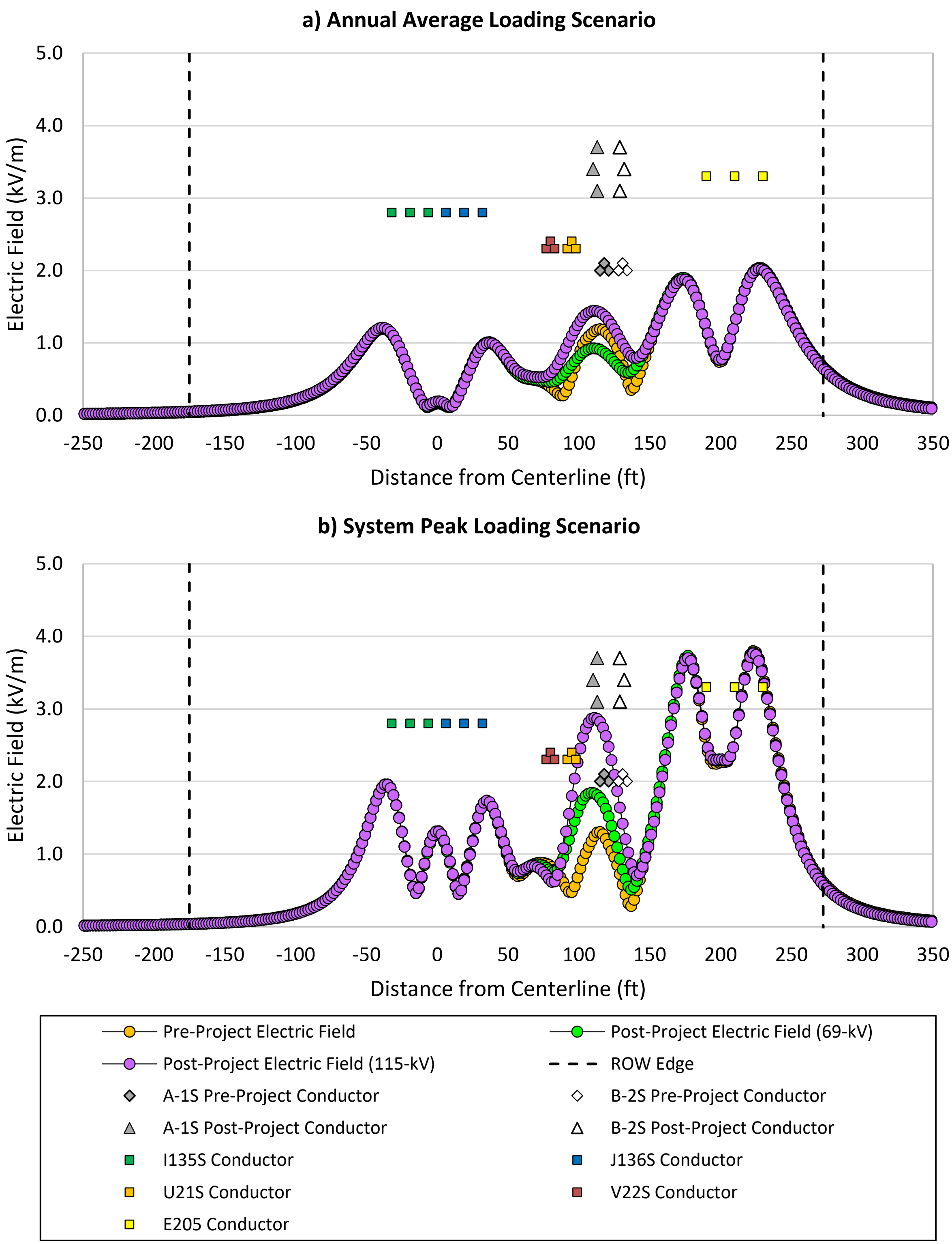

Figure C.23 Electric Field Modeling Results at 1 Meter Aboveground for the B-15191-NE Sheet 21 Cross Section (Structures 661–Pratts). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

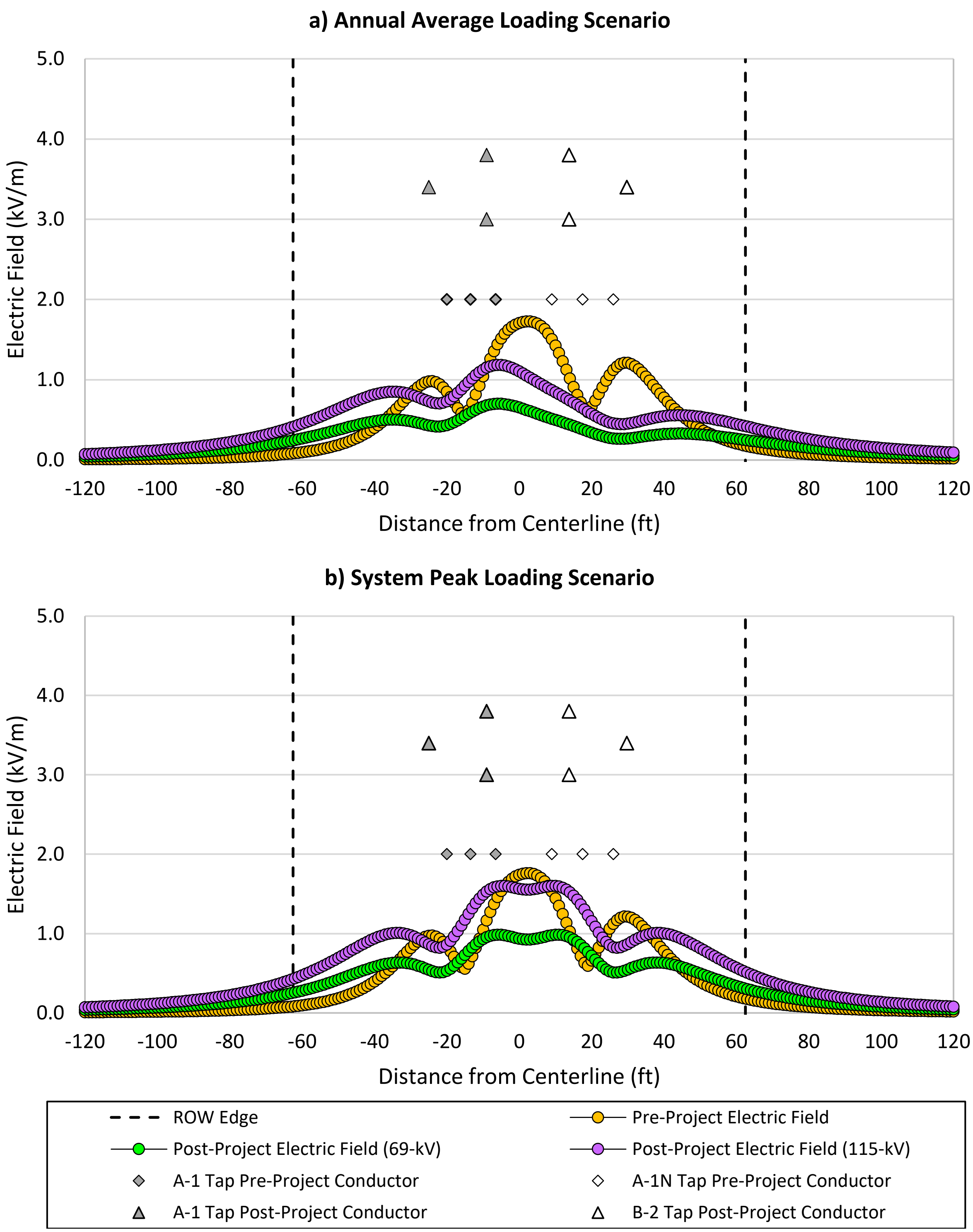

Figure C.24 Electric Field Modeling Results at 1 Meter Aboveground for the B-15192-NE Sheet 1 Cross Section in the Athol Tap Line (Royalston—Structure 71/72). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

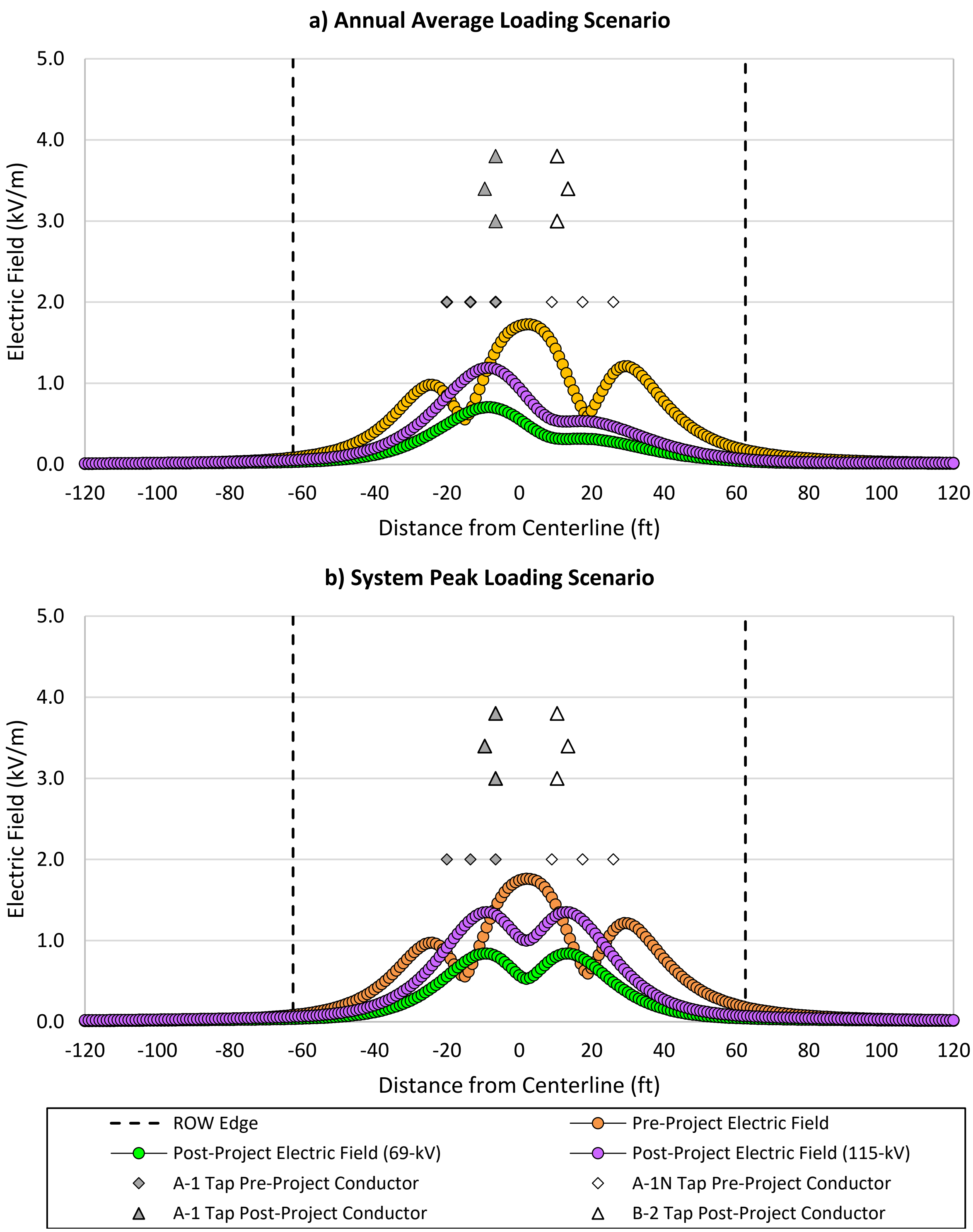

Figure C.25 Electric Field Modeling Results at 1 Meter Aboveground for the B-15192-NE Sheet 2 Cross Section in the Athol Tap Line (Structure 71/72—Chestnut Hill). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

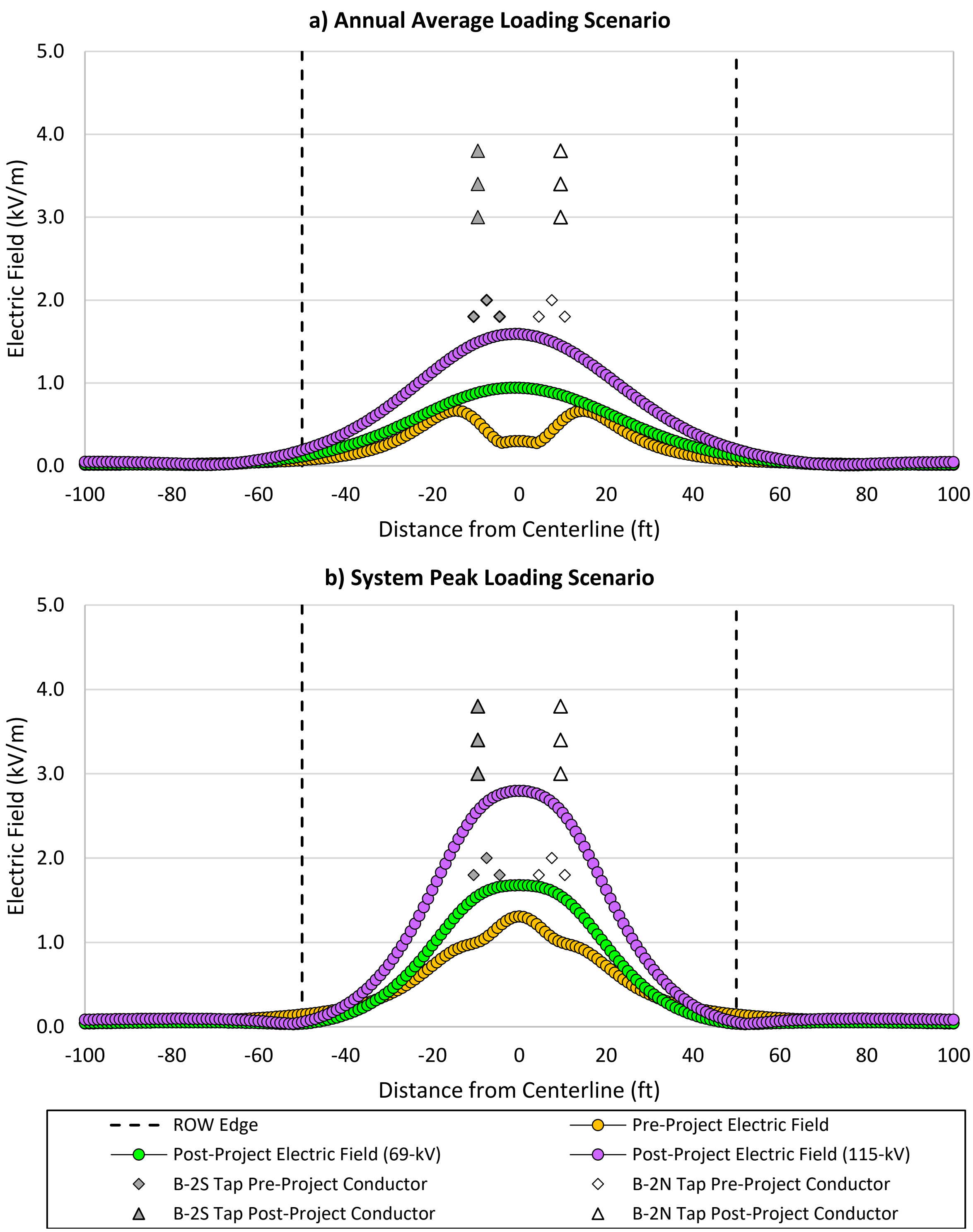

Figure C.26 Electric Field Modeling Results at 1 Meter Aboveground for the B-15193-NE Sheet 1 Cross Section in the Gardner Tap Line (Gardner Switch Tower—Crystal Lake). ft = Feet; kV = Kilovolt; kV/m = Kilovolts Per Meter, ROW = Right-of-Way. Panel (a) shows the results for annual average loading conditions, and panel (b) shows the results for system peak loading conditions. Conductor locations on the graphs are not to scale and are provided to show relative locations.

Appendix D

Summary of Current Status of Health-Effect Conclusions for 60-Hz Alternating Current Electric and Magnetic Fields

Summary of Current Status of Health-Effect Conclusions for 60-Hz Alternating Current (AC) Electric and Magnetic Fields (EMFs)

Introduction

Electric and Magnetic Fields (EMFs) are invisible lines of force associated with anything that generates, transmits, or uses electricity, including high-voltage transmission lines and substations, as well as the overhead and underground distribution lines on residential streets, home wiring, and household appliances. As illustrated by Figure D.1, power-frequency (60-Hertz [Hz]) alternating current (AC) EMFs are an extremely low frequency form of non-ionizing electromagnetic radiation. Electric fields (EFs) from power lines, which are usually expressed in units of kilovolts per meter (kV/m), are a product of the voltage difference between power lines and ground. Magnetic fields (MFs) are produced by the electric current carried on power lines and are usually expressed in units of gauss (G) or milligauss (mG) (1 G = 1,000 mG).[1] Unlike ionizing radiation (*e.g.*, ultraviolet rays, X-rays, gamma rays), power-frequency EMFs do not carry enough energy to break molecular bonds and damage DNA, biological cells, or tissues.

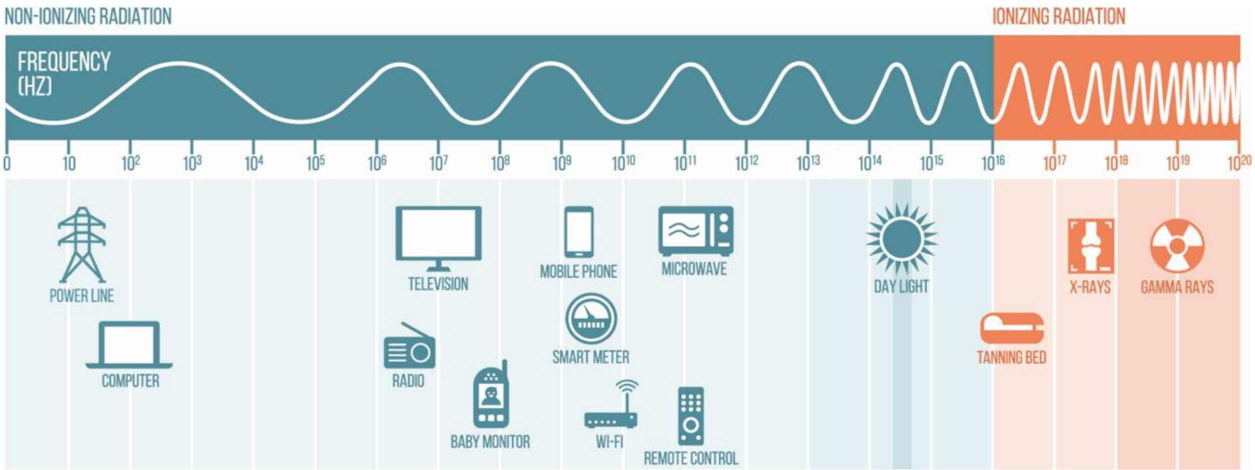

Figure D.1 The electromagnetic spectrum. As shown in the figure, the US electric power system operates at 60 Hz, and EMFs are thus frequently described as extremely low frequency (ELF) fields (*e.g.*, ELF-MFs and ELF-EFs).

Since the late 1970s when exposure to power-frequency EMFs emerged as a public health concern, following the reporting of epidemiological associations suggesting that children residing in greater proximity to overhead power lines may have a small increased risk of childhood leukemia, there has been a massive international research effort to understand whether and how power-frequency EMFs could cause childhood leukemia and other diseases (see Moulder, 2000). As described in more detail below, the three major lines of health-effects investigation for power-frequency EMFs consist of epidemiology studies of human populations, laboratory animal studies, and mechanistic studies. The biological effects of power-frequency EMFs have now been the focus of scientific research for over four decades, totaling thousands of published studies and tens of millions of dollars of research funding. More than 40 epidemiology studies

[1] Another unit for magnetic field (MF) levels is the microtesla (µT) (1 µT = 10 mG).

alone have investigated statistical associations between residential EMF exposures or surrogates of exposure (*e.g.*, distance to transmission lines) and risk of childhood leukemia (Schmidt *et al*., 2021), and epidemiology studies have investigated associations for risks of other health endpoints, including brain cancer, breast cancer, adult leukemia and lymphoma, reproductive and developmental effects, and neurodegenerative diseases.

With a knowledge base that now totals 40 years of scientific research and thousands of published studies, scientists have not been able to identify a plausible mechanism whereby biological processes can be adversely affected by typical levels of power-frequency EMFs. Despite advancements in study designs and larger and larger study populations, the epidemiological associations with childhood leukemia risk remains weak and inconsistent; as discussed later, more recent epidemiology studies with improved study designs and larger study populations have tended to observe weaker associations, and frequently no association at all, as compared to older studies. The scientific basis for reported statistical associations for risk of childhood leukemia remains unexplained, as many subsequent experimental and mechanistic studies have been unable to identify a biologic process whereby power-frequency EMFs can exert such an effect. Moreover, studies of carcinogenicity in animals exposed to elevated levels of EMF have been overwhelmingly negative and do not support the hypothesis that EMF exposure is a significant risk factor for carcinogenesis (NIEHS, 2002). Overall, the accumulated EMF health-effects data fail to provide a clear and coherent picture whereby the levels of power-frequency EMFs that we encounter in our daily lives present a hazard to human health.

It is the consensus opinion of a number of public health agencies and expert scientific committees, including the United States (US) National Institute for Environmental Health Sciences (NIEHS), the World Health Organization (WHO), and the US Environmental Protection Agency (US EPA), that there are no confirmed chronic (*e.g.*, long-term) human health risks from exposure to power-frequency EMFs, such as increasing the risk of developing cancer. In 1999, the NIEHS published its final report for the Electric and Magnetic Fields Research and Public Information Dissemination Program (EMF-RAPID) that was authorized and funded in 1992 by the US Congress to conduct fundamental scientific research to clarify the potential for health risks from power-frequency EMF exposure (NIEHS, 1999). An extensive range of laboratory toxicology and exposure characterization studies were conducted as part of the EMF-RAPID program, with the NIEHS concluding in its final report (NIEHS, 1999): "The ultimate goal of any risk assessment is to estimate the probability of disease in an exposed population…The NIEHS believes that the probability that ELF-EMF exposure is truly a health hazard is currently small. The weak epidemiological associations and lack of any laboratory support for these associations provide only marginal, scientific support that exposure to this agent is causing any degree of harm." NIEHS further addressed the body of health-effects evidence in a seminal 2002 question and answer (Q&A) booklet on power-frequency EMFs (NIEHS, 2002): "Over the past 25 years, research has addressed the question of whether exposure to power-frequency EMF might adversely affect human health. For most health outcomes, there is no evidence that EMF exposures have adverse effects. There is some evidence from epidemiology studies that exposure to power-frequency EMF is associated with an increased risk for childhood leukemia. This association is difficult to interpret in the absence of reproducible laboratory evidence or a scientific explanation that links magnetic fields [MFs] with childhood leukemia." Currently, on its website,[2] NIEHS states that utility "Power Lines" fall into the "non-Ionizing" radiation category, and goes on to explain, "Non-ionizing: low-level radiation […] is generally perceived as harmless to humans."

In 2007, the WHO published one of the most comprehensive health risk assessments of EMF in the power-frequency range, in which the WHO critically reviewed the cumulative epidemiologic and laboratory research, taking into account the strength and quality of individual research studies (WHO, 2007a). WHO concluded overall: "Acute biological effects have been established for exposure to ELF electric and

[2] https://www.niehs.nih.gov/health/topics/agents/emf/.

magnetic fields [EMFs] in the frequency range up to 100 kHz that may have adverse consequences on health. Therefore, exposure limits are needed. International guidelines exist that have addressed this issue. Compliance with these guidelines provides adequate protection. Consistent epidemiological evidence suggests that chronic low intensity ELF magnetic field [MF] exposure is associated with an increased risk of childhood leukaemia. However, the evidence for a causal relationship is limited, therefore, exposure limits based upon epidemiological evidence are not recommended, but some precautionary measures are warranted." (WHO, 2007a). As part of its International EMF Project, the WHO has continued to conduct comprehensive reviews of EMF health-effects research and existing standards and guidelines, and has not changed its conclusion that the health-effects evidence for power-line frequencies of EMF does not support a causal relationship of EMF exposure with increased childhood leukemia risk or with other adverse health effects (WHO, 2022).

The US EPA has not established any hazard levels or exposure standards for power-frequency EMFs. On its webpage focused on "Electric and Magnetic Fields [EMFs] from Power Lines," US EPA states, "Scientific studies have not clearly shown whether exposure to EMF increases cancer risk."[3]

As discussed more below, there is consistency in the conclusions from expert and governmental reviews of the full body of EMF health-effects research performed by international scientific, health, and safety organizations, and governmental public health agencies, that there are no confirmed chronic health risks for power-frequency EMF. While the possible linkage between ELF-MF exposure and risk of childhood leukemia remains a continued focus of researchers, findings from recent studies arguably only add to the uncertainties in this body of evidence. As described below, recent findings are suggestive of a decline in the association between ELF-MF exposure and risk of childhood leukemia in studies of more recent time periods (*e.g.*, post-1990s). These findings cannot be readily explained by MF exposures, and researchers continue to investigate the potential roles of confounding factors and sources of bias as alternative explanations for the observed epidemiological associations (*e.g.*, Amoon *et al*., 2022; Nguyen *et al*., 2022; Amoon *et al*., 2019).

Below, we continue our summary of the current status of power-frequency EMF health-effect conclusions with a brief discussion of the lines of scientific investigation that apply to understanding the potential human health effects of any exposure, including power-frequency EMF. We then present the status of EMF health-effect conclusions from international scientific, health, and safety organizations, and governmental public health agencies. This is followed by a discussion of recent research publications focused on the potential linkage between residential exposure to power-frequency MFs and risk of childhood leukemia, which continues to be the subject of updated epidemiological analyses and systematic reviews. Our review concludes with a summary of available health-based exposure guidelines established by international health and safety organizations, which are designed to be protective against adverse health effects, as well as state guidelines for power-frequency EMFs.

[3] https://www.epa.gov/radtown/electric-and-magnetic-fields-power-lines.

Lines of Scientific Inquiry into EMF Health Effects

Epidemiology

Because of the statistical associations reported by early EMF epidemiology studies, the International Agency for Research on Cancer (IARC), which is part of the WHO, classified power-line MFs as a 'possible' (Group 2B) carcinogen in 2002 (IARC, 2002).[4,5] IARC's cancer classification for power-line MFs was based on "limited" evidence from humans concerning childhood leukemia, "inadequate" evidence from humans concerning all other cancer types, and "inadequate" evidence from animals. Even though some epidemiology studies continue to provide weak suggestions of power-frequency MF health risk, the results among the studies remain inconsistent, poorly linked to actual MF exposures, and insufficient to demonstrate a causal relationship.

Epidemiology can provide statistical, correlative results between presumed exposures and disease patterns in human populations, but such associations are not able to establish causation. That is, while a laboratory scientist can precisely set exposure conditions, randomly allocate groups to be exposed or non-exposed, do careful pathology on the outcome, and can read the results blindly (*i.e.*, without knowing the exposure history), epidemiology is an observational science and cannot utilize these same rigorous scientific methods. Additional problems confound the interpretation of the power-frequency EMF epidemiology. For example, few of the epidemiology studies used actual measurements of MF exposure, and none of the exposure assessments were based on plausible mechanisms of interaction, or on validated MF metrics. Also, an epidemiologic study that reports 'statistically significant' associations is only testing that significance against the role of random chance, given the size of the populations studied. If other sources of uncertainty in epidemiologic studies were to be quantitatively included in the confidence interval (*e.g.*, confounding factors, measurement error, selection bias, misclassification), the margin of error would become wider and may well overlap a null outcome (*i.e.*, 'no association'). Reviews of MF epidemiology emphasize this point, namely that the error bars in reported results do not reflect all sources of uncertainty, and, consequently, the results are less indicative of an actual "statistically significant" link than typical confidence intervals suggest.

Laboratory Animal Studies

Hundreds of laboratory animal studies have examined the biological effects of power-frequency MF exposure in mammalian species expected to have reactions similar to humans. Support from such studies would make interpretation of power-frequency MF epidemiology less clouded and uncertain. However, these other lines of scientific evidence weigh against assigning a causal basis to the associations reported by epidemiology. Scientists have not been able to identify an established laboratory bioassay or animal model by which power-line MFs can be shown to consistently initiate or accelerate biological changes related to cancer risk. Lifetime exposures to high levels of 60-Hz MFs have been tested in numerous animal studies (using different species), with results failing to show that 60-Hz MFs can initiate or exacerbate any

[4] Note that IARC's Group 2B possible human carcinogen classification was specific to ELF-MF. For ELF-EF, IARC concluded that there was "inadequate evidence" of carcinogenicity in humans. In general, the remaining health concerns related to power-frequency EMFs are now focused primarily on ELF-MFs rather than ELF-EFs. ELF-EFs are generally considered to be of potential lesser health concern than MFs due to consistent null findings from early research studies and because they are readily shielded by conductive objects like trees and vegetation, as well as buildings. Because they are readily shielded, power lines are generally not significant sources of long-term average EF exposure, even for populations residing nearby to utility rights-of-way (ROWs).

[5] Other agents classified as Group 2B possible human carcinogens by IARC include aloe vera, picked vegetables, and gasoline fumes. Coffee was classified as a Group 2B possible human carcinogen for about 25 years until 2016 when it was re-assessed by IARC and re-classified into Group 3 not classifiable as to its carcinogenicity to humans. Both consumption of red meat and drinking very hot beverages are classified as Group 2A probable human carcinogens by IARC.

disease or pre-cancerous condition, even in genetically modified and susceptible animals. For example, research by the National Toxicology Program (NTP) extensively tested elevated, lifetime 60-Hz AC MF exposures, and the study scope and quantity of animals tested is unlikely to ever be duplicated (Moulder, 2000). The NTP study found no cancer risks, even at high MF exposure levels (1 to 2 μT, or 10,000 to 20,000 mG). Such animal testing is the foundation (or "gold standard") for probing health effects, because it is often through such exhaustive animal studies that regulators can determine what (if any) aspect of an exposure (*e.g.*, what chemicals or what MF parameter [*e.g.*, frequency, intensity, duration, polarization]) should be regulated.

Mechanistic Studies

Studies of 'mechanisms of action' utilize well-established laws of physics, chemistry, and biology to predict and understand how MFs might alter the function of biological structures like cell membranes or genetic (DNA) molecules. Mechanistic MF research to date, representing extensive efforts by scientists worldwide, has not been able to identify plausible mechanisms or causal pathways by which typical levels of power-line MFs can cause adverse health effects. MF interactions with biological systems have been analyzed carefully in light of the biophysics of electromagnetic field interactions with matter in general and biological molecules in particular. Unlike ionizing radiation *(e.g.,* ultraviolet rays, X-rays, gamma rays), non-ionizing radiation does not carry enough energy to break molecular bonds,

The applicability of fundamental physics to all systems, and to biology in particular, permits evaluation of the interaction of MFs with ions, molecules, cells, and organisms. The conclusions are that typical power-line MFs do not create disturbances that are detectable above the many sources of disturbance (electrical, thermal agitation, and other 'noise') that are naturally present in living systems. Notably, a common medical procedure, magnetic resonance imaging (MRI), exposes patients to extremely intense static and time varying MFs *via* both the main static field and the oscillating gradient MFs that generate the MRI image. Yet, such treatments leave no biomarkers of exposure and are safer than conventional X-ray images and computerized tomography (CT) scans or nuclear medicine images. In fact, many studies have been conducted to examine the ability of human beings to detect the existence of MFs, but no convincing evidence of such a sensory ability has been found.

Consideration of different parameters of MF exposure (frequency, intensity, duration, wave shape, polarization, modulation, intermittency, *etc.*) have revealed no firm basis on which to attribute a potential for adverse biological effects to the specific values of, for example, any of the following EMF metrics: (1) electric or MF magnitudes, (2) the fundamental frequency or to harmonic frequencies, (3) continuous exposure *vs*. intermittent exposure, (4) time-averaged fields *vs*. peak fields, (5) constant-frequency MFs *vs*. variable-frequency MFs. Over the years, many hypotheses have been proposed regarding how MFs may elicit a carcinogenic response and many analyses have been performed; however, diligent attention by scientists has not yielded identified aspects, levels, or durations of MF exposure that can be traced to increased cancer risk through a chain of causal events. Without an understanding of mechanism, it remains unknown as to what, if any, aspect of MF exposure should be controlled to reduce health risks.

Integration of Lines of Health-Effects Evidence

Biological-effect evidence that may establish the existence of a health impact is often illustrated as a 'three-legged stool' (Figure D.2), where strength in each line of evidence (each leg) is required for overall strength and stability, and weakness in any one leg makes the stool unstable. That is, lack of support from all three lines of evidence restricts the conclusions that can be drawn as to the existence of a human health risk. The three legs are: (1) exposure/disease correlations in human populations (epidemiology); (2) empirical laboratory animal studies at controlled and elevated levels of exposure; and (3) *in vitro* and/or mechanistic studies of the agent's mode of action.

Figure D.2 Three-legged stool: Health-effects research looks at three independent lines of evidence – cellular and molecular studies (mechanism of action), laboratory animal studies, and population studies (epidemiology). To understand toxicity, support is required in each area.

For low-frequency MFs, evidence suggesting adverse health effects derives primarily from leg (1), but there is a profound lack of support from animal studies and mechanistic studies (legs [2] and [3]). In fact, much of the evidence from legs (2) and (3) suggests an absence of health risks from ELF-MF exposure.

Mechanistic evidence (leg 3) is crucial, as living organisms rely upon the same physical laws that govern all matter. As shown in Figure D.3 below, physics forms the basis of chemistry, which forms the basis of biology and, in turn, forms the basis of physiology and medicine. Hence, even though there is an increase in complexity as you move up in this hierarchy, each successive layer must obey the fundamental laws found to be valid for the layer below. At the most fundamental level are the laws of physics, which have been validated by experiment and internal consistency. Maxwell's laws of electromagnetism are accepted to be invariant in time and space, and their accuracy in describing the interactions between electromagnetic fields and matter underlies the functioning of virtually all technology. No exceptions have been found, despite constant challenges and tests. Likewise, physics has been found to be valid in complex systems, encompassing chemistry, biology, technology, and medicine. Simple conservation laws *(e.g.*, conservation of mass+energy, conservation of electric charge, and conservation of linear and angular momentum) apply universally, without exception.

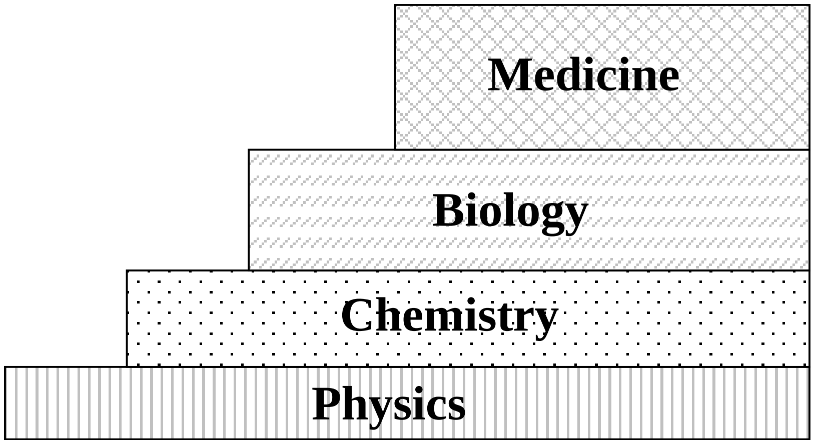

Figure D.3 Each scientific discipline rests on the underlying laws of a more basic discipline.

In order for MFs to cause changes within living cells, the fields must in some manner modify molecules or structures in the organism. By their very definition, MFs interact with matter only by exerting force on stationary or moving electric charges. At sufficiently high levels, these forces will add thermal energy or change the configuration of a charged biological molecule or structure. However, the magnitudes of natural forces that cells use (and are sensitive to) have been measured, and the results demonstrate that biological structures can withstand forces far larger than can be generated by typical MFs. Cells and organs function properly in spite of many internal sources of interfering thermal, chemical, electrical, and physical force effects, which exceed by a large factor the forces that can be caused by power-line MFs.

In summary, for MFs to alter physiological function, initiate dysfunction, or cause the onset of disease in humans or animals there must exist a mechanism by which magnetic forces alter molecules, chemical reactions, cell membranes, or biological structures (*i.e.*, DNA, RNA, plasma membranes, mitochondria). A MF is not a foreign molecular or chemical agent, and biological plausibility must be assessed with this in mind. The initial physical step sets off the following causal chain that must be completed in order to make any connection to disease:

Magnetic fields ⇒ matter (physics) ⇒ molecules (chemistry) ⇒ organisms (biology) ⇒ disease

A necessary condition for MFs to impact on human or ecosystem biology is that the MF-induced changes have to exceed chemical and thermal changes from natural or background influences. Changes in biological molecules are coupled to MFs through changes in forces on electrically charged structures, which in turn, must be coupled to metabolically important chemical processes (*e.g.*, reaction rates or transport rates).

Summary of EMF Health-Effect Conclusions from International Scientific, Health, and Safety Organizations, and Governmental Public Health Agencies

As summarized below, a number of international scientific, health, and safety organizations, and governmental public health agencies have reviewed the EMF health-effects literature and provided their interpretations of the EMF health-effects science. Below, we have compiled summaries that are illustrative of the current positions of a number of international scientific, health, and safety organizations, and governmental public health agencies, regarding the EMF health-effects science and the potential for human health risks arising from power-frequency EMF exposure. As discussed below, it is the consensus opinion of a number of international scientific, health, and safety organizations, and public health agencies, including the WHO, US EPA, and NIEHS, that there are no confirmed chronic human health risks for everyday exposures to power-frequency EMFs, including risk of cancers.

None of the international scientific, health, and safety organizations, and governmental public health agencies that have conducted comprehensive (*i.e*., weight-of-evidence[6]) reviews of the EMF health-effects science have concluded that there is a sound scientific basis for causally linking long-term exposure to power-frequency EMFs with chronic health risks, and for justifying a need for health-based standards and exposure guidelines to protect against chronic health risks. As noted below and discussed more in the section on "EMF Standards and Guidelines," two international health and safety organizations (ICNIRP and the International Committee on Electromagnetic Safety [ICES]) have developed health-based exposure guidelines for power-frequency EMFs that are based on protection against acute or short-term effects (*e.g*., electrostimulation). It also bears mentioning that a number of public health agencies do not even address power-frequency EMF health-effects concerns or provide recommendations on EMF exposure guidelines for power-frequency fields. This suggests that, even though the public's power-frequency EMF exposure is ubiquitous, the potential threat of a health hazard from power-line EMFs is not viewed as sufficiently established to warrant regulation. For example, the US Food and Drug Administration (US FDA), the Centers for Disease Control and Prevention (CDC), the Agency for Toxic Substances and Disease Registry (ATSDR), the Consumer Product Safety Commission (CPSC), the Office of the Surgeon General, and the NTP have not promulgated guidelines on power-frequency EMF exposure limits.

International scientific, health, and safety organizations, and governmental public health agencies, have provided the following conclusions regarding the EMF health-effects science and the potential for human health risks:

American Cancer Society (ACS) (2022):[7] "The possible link between electromagnetic fields and cancer has been a subject of controversy for several decades. It's not clear exactly how electromagnetic fields, a form of low-energy, non-ionizing radiation, could increase cancer risk. Plus, because we are all exposed to different amounts of these fields at different times, the issue has been hard to study."

US EPA (2022):[8] US EPA has not established any hazard levels or exposure standards for power-frequency EMFs, and US EPA states that "Scientific studies have not clearly shown whether exposure to EMF increases cancer risk."

European Commission, Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) (2015):[9] "In research on health effects of EMF, the lack of clearly focused working hypotheses for chosen biological endpoints is accentuated by the lack of an established biological or biophysical mechanism of action at environmental exposure levels. This does not allow researchers to conclude on the most relevant exposure parameter, and usually several alternative measures of exposure are evaluated (for instance field strength, exposure frequency, cumulative exposure, time since first exposure, *etc*.). In addition, some studies use multiple end-points which are equally prone to false positive results, without adequate statistical corrections. Good research practice requires that all hypotheses evaluated are clearly stated and that all results pertaining to them are reported. Selective reporting, with

[6] Weight-of-evidence approaches for reviewing health-effects evidence are well accepted in the public health field, and include such key elements as evaluating the entire body of relevant study findings, including from different types of studies (*e.g*., epidemiological studies, laboratory animal studies, human clinical studies, mechanistic studies); assessing study quality and giving more weight to higher quality studies when weighing evidence; and using established, transparent, and systematic methods for integrating study evidence and reaching causal conclusions.

[7] http://www.cancer.org/cancer/cancercauses/radiationexposureandcancer/extremely-low-frequency-radiation.

[8] https://www.epa.gov/radtown/electric-and-magnetic-fields-power-lines.

[9] http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_041.pdf.

emphasis on significant findings that were not specified in advance, can mislead the assessment by ignoring the issue of multiple testing […] The new epidemiological studies are consistent with earlier findings of an increased risk of childhood leukaemia with estimated daily average exposures above 0.3 to 0.4 µT [3 – 4 mG]. As stated in the previous [SCENIHR] Opinions, no mechanisms have been identified and no support is existing from experimental studies that could explain these findings, which, together with shortcomings of the epidemiological studies prevent a causal interpretation."

International Commission on Non-Ionizing Radiation Protection (ICNIRP) (2010):[10] ICNIRP (2010) conducted a comprehensive review of the body of scientific evidence related to potential adverse health effects from general public and occupational exposure to low frequency AC EMFs, concluding, "The epidemiological and biological data concerning chronic conditions were carefully reviewed and it was concluded that there is no compelling evidence that they are causally related to low-frequency EMF exposure…[A] causal relationship between magnetic fields [MFs] and childhood leukemia has not been established. The absence of established causality means that this effect cannot be addressed in the basic restrictions." ICNIRP (2010) acknowledged the epidemiological evidence, suggesting that long-term exposure to 50-60 Hz MFs might be weakly associated with an increased risk of childhood leukemia, and pointed to uncertainties in this evidence, including the roles of "a combination of selection bias, some degree of confounding and chance" as explaining the epidemiological findings. In addition, ICNIRP (2010) highlighted how "no biophysical mechanism has been identified and the experimental results from the animal and cellular laboratory studies do not support the notion that exposure to 50-60 Hz magnetic fields [MFs] is a cause of childhood leukemia."

Based on basic restrictions for protection against acute health effects (*e.g.*, retinal phosphenes, nerve and muscle stimulation, shocks and burns, surface electric-charge effects such as perception), ICNIRP (2010) has established a health-based guideline for allowable general public exposure to power-frequency MF at 2,000 mG, (200 microteslas [µT]), and a health-based guideline for allowable general public exposure to power-frequency EF at 4.2 kV/m. Importantly, ICNIRP (2010) describes its exposure guidelines as "limiting exposure to electric and magnetic fields (EMF) that will provide protection against <u>all established adverse health effects</u>" [underline emphasis added].

The ICES within the Institute of Electrical and Electronics Engineers (IEEE) (2019)[11] conducted an updated review of the scientific and medical research literature, and retained its safety guidelines for general public exposure to 60 Hz MF and EF at 9,040 mG (904 µT) and 5.0 kV/m, respectively. IEEE (2019) specifically evaluated the evidence of possible adverse health effects for chronic low-level EMF exposure, reaching the following conclusions for exposures to electric, magnetic, and electromagnetic fields at frequencies between 0 Hz and 300 GHz:

1. "The weight-of-evidence provides no credible indication of adverse effects caused by chronic exposures below levels specified in this standard."

2. "No biophysical mechanisms have been scientifically validated that would link chronic exposures below levels specified in this standard to adverse health effects."

3. "Based on the collective findings of recent reviews, the weight of the evidence continues to indicate that chronic exposure at levels specified in this standard is unlikely to cause adverse health effects."

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[10] International Commission for Non-Ionizing Radiation Protection (ICNIRP). 2010. "Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (1 Hz to 100 kHz)." *Health Phys.* 99(6):818–836.
[11] Institute of Electrical & Electronics Engineers (IEEE). 2019. "C95.1-2019 IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic and Electromagnetic Fields 0 to 300 GHz." IEEE Standards Coordinating Committee 39, NY: IEEE, Inc.

National Cancer Institute (NCI) (2022)[12] notes on its webpage focused on "Electromagnetic Fields and Cancer" that "No mechanism by which ELF-EMFs or radio frequency radiation could cause cancer has been identified […] Studies of animals have not provided any indications that exposure to ELF-EMFs is associated with cancer." Regarding the evidence from epidemiological studies, NCI concludes, "Most of the research has focused on leukemia and brain tumors, the two most common cancers in children. Studies have examined associations of these cancers with living near power lines, with magnetic fields [MFs] in the home, and with exposure of parents to high levels of magnetic fields [MFs] in the workplace. No consistent evidence for an association between any source of non-ionizing EMF and cancer has been found."

NIEHS (2022),[13] which funded and orchestrated a large laboratory-research program on power-frequency EMF, points out on its website that utility "Power Lines" fall into the "non-Ionizing" radiation category. On the website, NIEHS goes on to explain, "Non-ionizing: low-level radiation which is generally perceived as harmless to humans."

The WHO published a lengthy monograph (WHO, 2007a) for its "Health Risk Assessment" of power-frequency EMF in 2007, as part of its International EMF Project, and came to several conclusions. WHO (2007a) concluded overall, "Acute biological effects have been established for exposure to ELF electric and magnetic fields [EMFs] in the frequency range up to 100 kHz that may have adverse consequences on health. Therefore, exposure limits are needed. International guidelines exist that have addressed this issue. Compliance with these guidelines provides adequate protection. Consistent epidemiological evidence suggests that chronic low intensity ELF magnetic field [MF] exposure is associated with an increased risk of childhood leukaemia. However, the evidence for a causal relationship is limited, therefore exposure limits based upon epidemiological evidence are not recommended, but some precautionary measures are warranted." Specifically, with respect to the interpretation of epidemiology associations, the summary section on p. 12 in WHO (2007a) states: "Uncertainties in the hazard assessment include the role that control selection bias and exposure misclassification might have on the observed relationship between magnetic fields [MFs] and childhood leukaemia. In addition, virtually all of the laboratory evidence and the mechanistic evidence fail to support a relationship between low-level ELF magnetic fields [MFs] and changes in biological function or disease status. Thus, on balance, the evidence is not strong enough to be considered causal, but sufficiently strong to remain a concern."

The WHO released a fact sheet in June 2007 (WHO, 2007b) to accompany its full environmental health criteria monograph, and it contained similar conclusions regarding important limitations to the epidemiological evidence for childhood leukemia: "However, the epidemiological evidence is weakened by methodological problems, such as potential selection bias. In addition, there are no accepted biophysical mechanisms that would suggest that low-level exposures are involved in cancer development. Thus, if there were any effects from exposures to these low-level fields, it would have to be through a biological mechanism that is as yet unknown. Additionally, animal studies have been largely negative. Thus, on balance, the evidence related to childhood leukaemia is not strong enough to be considered causal." WHO (2007b) went on to discuss how the scientific evidence for other health endpoints was even weaker than that for childhood leukemia: "A number of other adverse health effects have been studied for possible association with ELF magnetic field [MF] exposure. These include other childhood cancers, cancers in adults, depression, suicide, cardiovascular disorders, reproductive dysfunction, developmental disorders, immunological modifications, neurobehavioural effects and neurodegenerative disease. The WHO Task Group concluded that scientific evidence supporting an association between ELF magnetic field [MF] exposure and all of these health effects is much weaker than for childhood leukaemia. In some instances

[12] https://www.cancer.gov/about-cancer/causes-prevention/risk/radiation/electromagnetic-fields-fact-sheet.
[13] https://www.niehs.nih.gov/health/topics/agents/emf/.

(*i.e.*, for cardiovascular disease or breast cancer) the evidence suggests that these fields do not cause them." Therefore, WHO (2007b) recommended, "policies based on the adoption of arbitrary low exposure limits are not warranted."

The WHO maintains and updates a website[14] for its International EMF Project where it provides summaries of existing standards and guidelines and fact sheets, as well as scientific reviews of EMF health-effects research. On this website,[15] WHO states [in 2023], "[T]he main conclusion from the WHO reviews is that EMF exposures below the limits recommended in the ICNIRP international guidelines do not appear to have any known consequence on health." On another webpage with an EMF Q&A,[16] WHO provides the following conclusions regarding EMF health-effects research: "Despite the feeling of some people that more research needs to be done, scientific knowledge in this area is now more extensive than for most chemicals. Based on a recent in-depth review of the scientific literature, the WHO concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields. However, some gaps in knowledge about biological effects exist and need further research."

Summary of Recent Research Publications on Childhood Leukemia

The potential linkage between residential exposure to power-frequency MFs[17] (*i.e.*, ELF-MFs) and risk of childhood leukemia continues to be the subject of updated epidemiological analyses and systematic reviews. In particular, Amoon *et al*. (2022) published an updated analysis that included pooled results from epidemiology studies published from 2010 to 2020 of MFs and childhood leukemia. Led by researchers in the Department of Epidemiology at the University of California, Los Angeles (UCLA) and the Los Angeles County Department of Public Health, this study observed no increased risk of leukemia among children exposed to greater MF levels (odds ratio [OR] = 1.01, for exposure ≥ 0.4 µT [4 mG] compared with exposures < 0.1 µT [1 mG]). The results of the pooled analysis, which combined the primary individual-level data (24,994 cases, 30,769 controls) from either new or updated epidemiological studies conducted in California, Italy, the United Kingdom, and Denmark, are supportive of other study findings indicating a decline in reported leukemia risks from epidemiological studies using more recent (*i.e*., post-1990s) data. Specifically, Amoon *et al*. (2022) concluded, "[O]ur results do not show the risk increase observed in previous pooled analysis and, over time, show a decrease in effect to no association between MF and childhood leukemia."

Consistent with the Amoon *et al*. (2022) findings, researchers from the WHO's IARC reported findings from the Childhood Leukaemia International Consortium (CLIC) supporting a lack of association between occupational ELF-MF exposure of parents and leukemia risk for their children (Talibov *et al*., 2019). Talibov *et al*. (2019) conducted a pooled analysis of individual-level data from 11 case-control studies (9,723 childhood leukemia cases, 17,099 controls) and reported ORs that were not statistically different from one for both paternal and maternal ELF-MF exposures and leukemia risk (including all leukemia subtypes, as well as specifically acute lymphoblastic leukemia [ALL] and acute myeloid leukemia [AML]), indicating no elevation in childhood leukemia risk with increased parental MF exposure. Based on their findings, Talibov *et al*. (2019) concluded, "In conclusion, using a large international pool of case–control studies and a detailed quantitative JEM [job-exposure matrix], we did not find any evidence for an association between fathers' occupational ELF-MF exposures around the time of conception or mothers' occupational ELF-MF exposures during pregnancy and leukaemia in their offspring. Considering our

[14] http://www.who.int/peh-emf/en/.
[15] https://www.who.int/teams/environment-climate-change-and-health/radiation-and-health/protection-norms.
[16] https://www.who.int/news-room/questions-and-answers/item/radiation-electromagnetic-fields.
[17] As mentioned previously, most of the remaining health concerns related to power-frequency EMFs are thus focused on MFs rather than EFs.

findings and those of previous smaller less consistent studies together suggests that parental ELF-MF exposure plays no relevant role in the aetiology of childhood leukaemia."

Several meta-analysis and systematic review studies have been published in the last couple years, and despite often examining the results from a similar body of epidemiology studies, have reached different conclusions regarding the strength of the epidemiological evidence for ELF-MF exposure and risk of childhood leukemia. Seomun *et al*. (2021) reported statistically significant associations between exposure to ELF-MFs and childhood leukemia for their meta-analysis that included 27 case-control studies. Since case-control studies are subject to selection bias, as well as other methodological problems, Seomun *et al*. (2021) acknowledged their exclusive reliance on case-control studies as an important limitation to their analysis that reduces the strength of their findings. For their systematic review and meta-analysis of case-control studies and cohort studies, Brabant *et al*. (2022) reported findings indicating a statistically significant association between ELF-MF and childhood leukemia, with analyses indicating that this association was driven by results from studies performed before 2000.

Onyije *et al*. (2022) conducted an "umbrella review" of environmental risk factors for childhood ALL that integrated findings from previously published systematic reviews or meta-analyses. For ELF-MF, Onyije *et al*. (2022) concluded that there was "some" level of evidence for an association between postnatal ELF-MF exposure and childhood ALL, in particular for the highest MF-exposed categories; in contrast, they concluded that exposure to low doses of ionizing radiation during childhood and general pesticide exposure during pregnancy were both "strongly" associated with childhood ALL. They highlighted ELF-MF as "an example where the epidemiological association was established more than 20 years ago but concerns about bias and the lack of biological plausibility of the association have precluded any conclusions on causality." The English abstract for the Herkert *et al*. (2021)[18] integrative review, which analyzed five case-control studies published between 2012 and 2020 that investigated the association between exposure to ELF-MF and risk of childhood leukemia, includes the following overall conclusion: "Due to methodological heterogeneity and confounding variables in the analyzed articles, the authors concluded that it was not possible to demonstrate the relationship between low-frequency non-ionizing radiation sources and the development of childhood leukemia." Similarly, for their recent review paper, Schmidt *et al*. (2021) emphasized how ELF-MF has yet to be "verified" as a risk factor for childhood leukemia, and they pointed to the lack of a plausible biological mechanism and the inadequate evidence from experimental animal studies: "However, how ELF-MF may cause leukemia is unknown – until today, no plausible biological mechanism has been found, and experimental *in vitro* and *in vivo* studies do not confirm the results of the epidemiological studies."

Finally, epidemiological studies continue to investigate possible alternative explanations for the observed epidemiological associations between ELF-MF exposure and risk of childhood leukemia, with postulated factors including socioeconomic status, residential mobility, residential dwelling type, viral contacts, environmental tobacco smoke, dietary agents, traffic density (as a proxy for air pollution exposure), pesticides, and corona ions (Crespi *et al*., 2019). Using the large dataset from the California Power Line Study (CAPS), several recent studies have examined potential bias and/or confounding from factors that include potential pesticide exposures associated with commercial plant nurseries located in areas underneath power lines (Nguyen *et al*., 2022), dwelling type (*e.g*., single-family homes *vs*. apartments/mobile dwellings; Amoon *et al*., 2020), and residential mobility (Amoon *et al*., 2019). While none of the investigated sources of potential bias and/or confounding have been found to explain the entirety of previously observed associations between power-frequency MFs and risk of childhood leukemia, these studies have reported some findings requiring additional investigation. For example, Nguyen *et al*. (2022) reported findings suggesting close residential proximity to nurseries as an independent risk factor for childhood leukemia, but not as an explanation for observed associations between power-frequency EMFs

[18] The full paper is only available in Portuguese and has not been reviewed.

and childhood leukemia risk; however, they discussed how their ability to fully assess its potential confounding role was limited by the small numbers of study subjects with both high ELF-MF exposures and with close proximity to power lines and plant nurseries. Based on analyses they conducted to probe the confounding effect of residential mobility, Amoon *et al*. (2019) concluded, "We conclude that uncontrolled confounding by residential mobility had some impact on the estimated effect of EMF exposures on childhood leukemia, but that it was unlikely to be the primary explanation behind previously observed largely consistent, but unexplained associations." An additional study using the CAPS data (Crespi *et al*., 2019) conducted modeling analyses to examine the interaction between distance from high voltage lines and calculated magnetic field [MF] levels as exposure metrics, and reported findings that "argue against magnetic fields [MFs] as a sole explanation for the association between distance and childhood leukemia and in favor of some other explanation linked to characteristics of power lines."

EMF Standards and Guidelines

The US has no federal standards limiting either residential or occupational exposure to 60-Hz AC EMFs. Table D.1 shows health-based exposure guidelines established by international health and safety organizations that are designed to be protective against adverse health effects. As mentioned earlier, these exposure guidelines are based on protection against acute or short-term effects (*e.g*., electrostimulation) as these organizations have concluded that the health-effects evidence is too inconsistent and weak to justify a need for or to support the development of exposure guidelines for chronic health risks. ICNIRP (2010) concluded that there was not sufficient evidence to support the development of an exposure guideline specific to long-term exposure, citing both the lack of any consistent increases in any types of cancer (*e.g.*, hematopoietic, mammary, brain, skin tumors) in large-scale, long-term laboratory animal studies and the weak and inconsistent evidence from human epidemiological studies, including those addressing risk of childhood leukemia. For example, ICNIRP concluded, "It is the view of ICNIRP that the currently existing scientific evidence that prolonged exposure to low frequency magnetic fields [MFs] is causally related with an increased risk of childhood leukemia is too weak to form the basis for exposure guidelines. In particular, if the relationship is not causal, then no benefit to health will accrue from reducing exposure."

The limit values should not be viewed as demarcation lines between safe and dangerous levels of EMFs but, rather, levels that assure safety with an adequate margin to allow for uncertainties in the science. This is because they incorporate safety factors; for example, the ICNIRP general public MF guideline of 2,000 mG incorporates a safety factor of 5. In summary, available exposure guidelines such as the ICNIRP general public exposure guidelines are generally applied for both short-term and long-term exposures, and are reasonable for use in both contexts, because there is no scientific rationale for separate guidelines focused specifically on long-term EMF exposure.

Table D.1 60-Hz AC EMF Guidelines Established by International Health and Safety Organizations

Organization	Electric Field	Magnetic Field
American Conference of Governmental and Industrial Hygienists (ACGIH) (occupational)	25 kV/m(1)	10,000 mG(1) 1,000 mG(2)
International Commission on Non-Ionizing Radiation Protection (ICNIRP) (general public)	4.2 kV/m(3)	2,000 mG(3)
International Commission on Non-Ionizing Radiation Protection (ICNIRP) (occupational)	8.3 kV/m(3)	10,000 mG(3)
Institute of Electrical and Electronics Engineers (IEEE) Standard C95.1TM-2019 (general public)	5.0 kV/m(4)	9,040 mG(4)
Institute of Electrical and Electronics Engineers (IEEE) Standard C95.1TM-2019 (occupational)	20.0 kV/m(4)	27,100 mG(4)

Notes:
AC = Alternating Current; EMF = Electric and Magnetic Field; Hz = Hertz; kV/m = Kilovolts Per Meter; mG = Milligauss.
(1) The ACGIH guidelines for the general worker (ACGIH, 2022).
(2) The ACGIH guideline for workers with cardiac pacemakers (ACGIH, 2022).
(3) ICNIRP (2010).
(4) IEEE (2019); developed by the IEEE International Committee on Electromagnetic Safety (ICES).

Table D.2 lists 60-Hz AC EMF guidelines that have been adopted by various states in the US, including by the Massachusetts Energy Facilities Siting Board (MA EFSB). The MA EFSB has adopted, and long used, edge-of-ROW guideline levels of 85 mG and 1.8 kV/m for 60-Hz AC magnetic and electric fields, respectively. State guidelines such as those of the MA EFSB are not health-effect based and have typically been adopted to maintain the *status quo* for MFs on and near a transmission line right-of-way (ROW).

Table D.2 State EMF Standards and Guidelines for Transmission Lines

State	Line Voltage (kV)	Electric Field (kV/m)		Magnetic Field (mG)	
		On ROW	Edge of ROW	On ROW	Edge of ROW
Florida(1)	69-230 >230-500 >500	8.0 10.0 15.0	2.0(2) 2.0(2) 5.5(2)		150(2) 200(2) 250(2,3)
Massachusetts			1.8		85
Minnesota		8.0			
Montana		7.0(4)	1.0(5)		
New Jersey			3.0		
New York(1)		11.8 11.0(6) 7.0(4)	1.6		200
Oregon		9.0			

Notes:
Blank = Not Applicable/Not Available; EMF = Electric and Magnetic Field; kV = Kilovolt; kV/m = Kilovolts Per Meter; mG = Milligauss; ROW = Right-of-Way.
Sources: NIEHS (2002); FLDEP (2008); MA EFSB (2009).
(1) Magnetic fields for winter-normal (*i.e.*, at maximum current-carrying capability of the conductors).
(2) Includes the property boundary of a substation.
(3) Also applies to 500-kV double-circuit lines built on existing ROWs.
(4) Maximum for highway crossings.
(5) May be waived by the landowner.
(6) Maximum for private road crossings.

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Expanded Environmental Notification
Project Narrative

A1/B2 Asset Condition Refurbishment Project - Massachusetts

Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, Athol, and Sterling

September 12, 2022

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Glossary

115 kV:	115 kilovolts or 115,000 volts
1987 Manual:	USACE Wetland Delineation Manual, January 1987
69 kV:	69 kilovolts or 69,000 volts
A1/B2 ACR:	A1/B2 Asset Condition Refurbishment Project (“the Project”)
ACI:	American Concrete Institute
ACHP:	Advisory Council on Historic Preservation
ACSS:	Aluminum-conductor steel-supported
ANSI:	American National Standards Institute
AP:	Adaptation Pathways (*climate change*)
APE:	Area of Potential Effects (*cultural resources)*
ASCE:	American Society of Civil Engineers
BAY-DE:	Bayonet Deadend
Bank:	Inland Bank, as defined by the Massachusetts Wetlands Protection Act
BLSF:	Bordering Land Subject to Flooding, as defined by the Massachusetts Wetlands Protection Act
BMPs:	Best Management Practices
BSC:	BSC Group, Inc.
BIL:	Basic Insulation Level
Bundle (conductor):	Two or more wires joined together to operate as a single phase.
BVW:	Bordering Vegetated Wetlands
Cable:	A fully insulated conductor is usually installed underground but, in some circumstances, can be installed overhead.
CBO:	Community-based organization (*Environmental Justice)*
cf:	Cubic Feet
Circuit:	A system of conductors (three conductors or three bundles of conductors) through which an electric current is intended to flow, and which may be supported above ground by transmission structures or placed underground.
CMP:	Conservation Management Permit
CMR:	Commonwealth of Massachusetts Regulations
Commonwealth	The Commonwealth of Massachusetts
Conductor:	A metallic wire busbar, rod, tube or cable that serves as a path for electric current to flow.
Contingency:	An event, usually involving the loss of one or more elements, which affects the power system at least momentarily.
CVP:	Certified Vernal Pool
CWA:	Clean Water Act
cy:	Cubic yard
Demand:	The total amount of electric power required at any given time by an electric supplier’s customers.
	Designated Geographic Area, as defined by 301 CMR 11.02
DGA:	Department of Public Utilities
DPU:	Department of Conservation and Recreation
DCR:	
DFW:	Massachusetts Division of Fisheries and Wildlife
EEA:	Energy and Environmental Affairs

EFI:	Environmental Field Issue Guidelines: set of guidelines developed for all construction and maintenance projects
EFSB:	Energy Facilities Siting Board
EIR:	Environmental Impact Report, per MEPA regulations
EJ:	Environmental Justice
EF:	Electric Field. A field produced as a result of voltages applied to electrical conductors and equipment; usually measured in units kilovolts per meter.
Electric Transmission:	The facilities (≥69 kV) that transmit electrical energy from generating plants to substations.
EG-303NE:	National Grid Environmental Guidance Document
ENF:	Environmental Notification Form, per MEPA regulations
Environmental Monitor:	Inspects environmental conditions within the construction site, reviews the contractors' compliance with environmental permit conditions during the construction phase of a project, and makes recommendations for corrective actions to protect sensitive environmental resources proximate to a construction site.
EOEEA:	Massachusetts Executive office of Energy and Environmental Affairs
EPA:	United States Environmental Protection Agency
FEMA:	Federal Emergency Management Agency
GIS:	Geographic Information System
GHG:	Greenhouse Gas
Ground Wire:	Cable/wire used to connect wires and metallic structure parts to the earth. Sometimes used to describe the lightning shield wire.
Guy Wire:	A tensioned cable designed to add stability to utility poles; extends from a pole to a ground anchor.
H-frame Structure:	A wood or steel transmission line structure constructed of two upright poles with a horizontal cross-arm and diagonal bracings.
IEEE:	Institute of Electrical and Electronic Engineers
ILSF:	Isolated Land Subject to Flooding, as defined by the Massachusetts Wetlands Protection Act
ISO-NE:	Independent Service Operator - New England, Inc. The independent system operator of New England.
IVM:	Integrated Vegetation Management
kcm:	Thousand circular mils
kV:	Kilovolt. 1 kV equals 1,000 volts.
lf:	Linear Feet
Lines	A1/B2 Transmission Lines
LOD	Limit of Disturbance
Load:	Amount of power delivered upon demand at any point or points in the electric system. Load is created by the power demands of customers' equipment (residential, commercial, and industrial).
LUW:	Land Under Waterbodies and Waterways, as defined by the Massachusetts Wetlands Protection Act
MA:	Massachusetts
MACRIS:	Massachusetts Cultural Resources Information System (*cultural resources)*
MassDEP:	Massachusetts Department of Environmental Protection

MassDEP Handbook:	MassDEP's Handbook on Delineating Bordering Vegetated Wetlands, March 1995
MassDOT:	Massachusetts Department of Transportation
MADPH EJ Tool:	Massachusetts Department of Health Environmental Justice Tool
MassGIS:	Massachusetts Geographical Information System
MBTA:	Massachusetts Bay Transportation Authority
MC-FRM:	Massachusetts Coast Flood Risk Model
MEPA:	Massachusetts Environmental Policy Act 301 CMR 11.00, as administered through EEA
MESA:	Massachusetts Endangered Species Act, as administered by NHESP
MHC:	Massachusetts Historical Commission
Monopole:	A single pole supporting overhead utility wire.
MVP:	Municipal Vulnerability Preparedness
NEP:	New England Power Company
NERC:	North American Electric Reliability Corporation
NESC:	National Electrical Safety Code
NH:	New Hampshire
NHESP:	Natural Heritage and Endangered Species Program
NHPA:	National Historic Preservation Act
NOAA:	National Oceanic and Atmospheric Administration
NPDES:	National Pollutant Discharge Elimination System
NRHP:	National Register of Historic Places
NWI:	National Wetlands Inventory
OH Line:	Overhead Line
OHWM:	Ordinary High-Water Mark
OOC:	Order of Conditions
OPGW:	Optical Primary Ground Wire
Order:	Governor Baker's Executive Order 569 (Order) set forth specific objectives to build resilience and adapt to the impacts of climate change in the Commonwealth.
ORWs:	Outstanding Resource Waters. Designated in 314 CMR 4.00 as high-quality waters with socioeconomic, recreational, ecological and/or aesthetic values. Includes Class A Public Water Supplies and their tributaries, CVPs.
PCN:	Pre-Construction Notification
PEM:	Palustrine Emergent Wetlands, Persistent – wet meadows, marshes
PFO:	Palustrine Forested, Broad-leaved Deciduous/Needle-leaved Evergreen – forested wetlands
PSS:	Palustrine Scrub-Shrub Broad Leaved Deciduous Wetlands – woody deciduous wetlands
PUB1Fb:	Palustrine Unconsolidated Bottom Semi-Permanently Flooded Beaver
PVP:	Potential Vernal Pool
RA	Riverfront Area, as defined by the Massachusetts Wetlands Protection Act
RC:	Regional Coordination
Reconductor:	Replacement of existing conductors with new conductors, and any necessary structure reinforcements or replacements.
Reliability:	A system's ability to provide power during emergencies (also known as "contingencies).
Reinforcement:	Any of a number of approaches to improve the capacity of the transmission system, including rebuilding, reconductoring, uprating, conversion and conductor bundling methods.
RMAT Tool:	Resilient Massachusetts Action Team Climate Resilience Design Tool

ROW:	Right-of-way. Corridor of land within which a utility company holds legal rights necessary to build operate and maintain power lines.
sf:	square feet
Shield Wire:	Wire strung at the top of transmission lines intended to prevent lightning from striking transmission circuit conductors. Sometimes referred to as static wire or aerial ground wire. May contain glass fibers for communication use. See also "OPGW".
SHPO:	State Historic Preservation Officer (cultural resources)
SHMCAP:	State Hazard Mitigation and Climate Adaptation Plan
SS:	Site Suitability
Steel Pole: Structure:	Transmission line structure consisting of tubular steel pole(s) with arms or other components to support insulators and conductors.
Substation:	A fenced-in yard containing switches, power transformers, line terminal structures, and other equipment enclosures and structures. Voltage change, adjustments of voltage, monitoring of circuits and other service functions take place in this installation.
SWCA:	SWCA Environmental Consultant
SWPPP:	Stormwater Pollution Prevention Plan
Terminal Structure:	Structure typically within a substation that ends a section of transmission line.
Transmission Line:	An electric power line operating at 69,000 or more volts.
USACE:	United States Army Corps of Engineers
USFWS:	United States Fish and Wildlife Service
USGS:	United States Geological Survey
VHB:	Vanessa Hangen Brustlin, Inc
VMP:	Five Year Vegetation Management Plan (2019-2023), as approved by the Massachusetts Department of Agriculture.
Voltage:	A measure of the electrical pressure that transmits electricity. Usually given as the line-to-line root-mean square magnitude for three-phase systems.
Voltage Collapse:	A condition where voltage drops to unacceptable levels and cascading interruptions of transmission system elements occur resulting in widespread blackouts.
VT:	Vermont
Watercourse:	Rivers, streams, brooks, waterways, lakes, ponds, marshes, swamps, bogs, and all other bodies of water, natural or artificial, public or private.
Wetland:	Land, including submerged land, which consists of any of the soil types designated as poorly drained, very poorly drained, alluvial or flood plain by the U.S. Department of Agriculture, Natural Resources Conservation Service. Wetlands include federally jurisdictional wetlands of the U.S. and navigable waters, freshwater wetlands or coastal resources regulated by a state or local regulatory authority. Jurisdictional wetlands are classified based on a combination of soil type, wetland plants, and hydrologic regime, or state-defined wetland types.
Wire:	See Conductor
WMA:	Wildlife Management Area
WPA	Wetlands Protection Act: G.L. c. 131, §40 and implementing regulations (310 CMR 10.00)
WQC: (permit/consultation requirement table)	Water Quality Certificate

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SEPTEMBER 12, 2022

Bethany A. Card, Secretary
Executive Office of Energy and Environmental Affairs
Attn: MEPA Office
100 Cambridge Street, Suite 900
Boston, MA 02114

RE: **A1/B2 Asset Condition Refurbishment Project**
Expanded Environmental Notification Form

Dear Secretary Card,

On behalf of the New England Power Company (NEP), BSC Group, Inc. is pleased to submit this Expanded Environmental Notification Form (EENF) for various refurbishment activities and system improvements for 733 structures and the installation of six (6) new structures along approximately 54 circuit miles along the A1/B2 Lines which extend from Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, Athol, and Sterling to Pratts Junction Substation in Sterling, Massachusetts (the "Project"). The proposed Project includes required maintenance and system improvements to mitigate potential risks of electrical failure and to provide reliable delivery of electrical service.

The Project site is an active utility Right-of-Way (ROW) and contains existing utility structures, historically used access routes, and managed vegetation areas along the A1/B2 main line and three (3) tap lines, the Athol Taps 1 and 2, Gardner Tap (Crystal Lake Tap) and the East Westminster Tap. The Project is consistent with existing facilities and activities. Project impacts are construction related and include permanent land alteration due to tree removal on the ROW, access road establishment and improvements, and installation of concrete caisson foundations as well as temporary impacts related to construction matting for access, work envelopes and pull pads. Permanent fill within Bordering Vegetated Wetlands and the FEMA 100-yr Floodplain is anticipated. The Project has been designed to avoid adverse impacts to the greatest extent practicable.

NEP is submitting this EENF because the Project requires several state agency actions and exceeds four (4) MEPA thresholds for an Environmental Impact Report (EIR) and several ENF thresholds. NEP respectfully requests that MEPA allow a Single EIR filing in accordance with 301 CMR 11.06(8).

The Project will improve transmission system infrastructure and comply with comprehensive regional plans for improving electric transmission reliability in New England. Benefits of the Project include the following:

- Increased resiliency of the overall transmission line due to improved foundations and more robust structures that are better suited to withstand strong winds and storm events.

- The new overhead lines will be thicker, which will allow more electricity to flow during times of high usage, such as extreme heat events, which are anticipated to increase in frequency due to climate change.

- The installation of Optical Primary Ground Wire (OPGW) will allow better communication between substations, resulting in improved response time during storm-related emergencies and outages, which will increase public safety.

- Reduce overall disturbance to adjacent landowners, wetland resource areas, and rare species habitat over time by planning for the future and reducing the likelihood of multiple repeat projects, thereby reducing environmental impacts, and reducing costs to NEP's customers.

- The replacement of the Lines will have the added benefit of allowing more renewable energy resources to connect into the system. Addressing the climate change crisis requires a major expansion of renewable energy and the infrastructure necessary to support and deliver that energy. NEP is actively taking steps to ensure that its system is ready to meet this critical challenge. Replacing infrastructure like the A1/B2 Lines helps to accomplish this goal. The replacement lines will have higher kilovolt ratings that will support higher volumes of currently active and forecasted renewable energy resources in this region. This longer-term view is supported by the recently shared initial results of the ISO-NE 2050 study, where an upgrade to 115 kV would be necessary based on the current study assumptions and long-term forecasts for the Commonwealth.

Please publish the Notice of Availability for this ENF in the September 16th Environmental Monitor to initiate the 30-day public review and comment period. Electronic copies have been distributed to public agencies and town officials in accordance with 301 CMR 11.16(2) (see Appendix B MEPA EENF Circulation List). The Public Notice of Environmental Review will be published in local newspapers on September 16, 2022 in accordance with 301 CMR 11.15(1).

Please do not hesitate to contact me at (617) 896-4519 or hgraf@bscgroup.com with any questions or comments.

Sincerely,

BSC Group, Inc.

Heidi Graf
Associate Project Manager

cc: Mike Tyrrell, NEP
EENF Circulation List (see Appendix B)

Commonwealth of Massachusetts

Executive Office of Energy and Environmental Affairs
Massachusetts Environmental Policy Act (MEPA) Office

Project Name: A1/B2 Asset Condition Refurbishment (ACR) Project		
Street Address: Existing overhead electric transmission right-of-way crossing multiple public ways		
Municipality: Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster,Athol, and Sterling	Watershed: Nashua, Millers, & Connecticut	
Universal Transverse Mercator Coordinates: UTM Easting UTM Northing Start: 713043.97 4733532.97 End: 274818.53 4705826.34	Latitude: start: 42° 43' 29.1"N end: 42°28'19.4"N Longitude: start: -72° 23' 52.4N end: -71°44'21.3"W	
Estimated commencement date: 2025	Estimated completion date: 2031	
Project Type: Utility: Overhead Transmission Line	Status of project design: 50 % complete	
Proponent: New England Power Company ("NEP")		
Street Address: 40 Sylvan Road		
Municipality: Waltham	State: MA	Zip Code: 02451
Name of Contact Person: Heidi Graf		
Firm/Agency: BSC Group, Inc.	Street Address: 1 Mercantile Street, Suite 610	
Municipality: Worcester	State: MA	Zip Code: 01608
Phone: 617-896-4519	Fax:	E-mail: hgraf@bscgroup.com

Does this project meet or exceed a mandatory EIR threshold (see 301 CMR 11.03)?
☒Yes ☐No

If this is an Expanded Environmental Notification Form (ENF) (see 301 CMR 11.05(7)) or a Notice of Project Change (NPC), are you requesting:

a Single EIR? (see 301 CMR 11.06(8)) ☒Yes ☐No

a Rollover EIR? (see 301 CMR 11.06(13)) ☐Yes ☒No

a Special Review Procedure? (see 301CMR 11.09) ☐Yes ☒No

a Waiver of mandatory EIR? (see 301 CMR 11.11) ☐Yes ☒No

a Phase I Waiver? (see 301 CMR 11.11) ☐Yes ☒No
(Note: Greenhouse Gas Emissions analysis must be included in the Expanded ENF.)

Which MEPA review threshold(s) does the project meet or exceed (see 301 CMR 11.03)?

This Project exceeds or potentially exceeds the following MEPA EIR and ENF thresholds:

MEPA EIR Threshold
EIR: Land: *Direct alteration of 50 or more acres of land, unless the Project is consistent with an approved conservation farm plan or forest cutting plan or other similar generally accepted agricultural or forestry practices. (301 CMR 11.03(1)(a))*
EIR: Wetlands, Waterways and Tidelands: *Alteration of one or more acres of bordering vegetated wetlands (BVW). (301 CMR 11.03(3)(a)(1)(a))*
EIR: Wetlands, Waterways and Tidelands: *Alteration of ten or more acres of any other wetlands. (301 CMR 11.03(3)(a)(1)(b))*
EIR: Environmental Justice: *The Secretary shall require an EIR for any Project that is located within a Designated Geographic Area around an Environmental Justice Population. (301 CMR 11.06(7)(b))*
MEPA ENF Thresholds
ENF: Wetlands, Waterways and Tidelands*:* *Alteration of 500 or more linear feet of bank along a fish run or inland bank. (301 CMR 11.03(3)(b)(1)(b))*
ENF: Wetlands, Waterways and Tidelands: *Alteration of one half or more acres of any other wetlands. (301 CMR 11.03(3)(b)(1)(f))*
ENF: Rare Species: *Taking of an endangered or threatened species or species of special concern, provided that the Project site is two or more acres and includes an area mapped as a Priority Site of Rare Species Habitats and Exemplary Natural Communities. (301 CMR 11.03(2)(b)(2)).(Potential- consultation with NHESP ongoing.)*

Which State Agency Permits will the project require?

The following State Agency Permit or Approvals are anticipated:

- ***Massachusetts Department of Environmental Protection ("MassDEP") Section 401 Water Quality Certificate and Variance;***
- ***Natural Heritage and Endangered Species Program ("NHESP") Conservation Management Permit (potential);***
- ***Massachusetts Department of Transportation ("MassDOT") Permit to Access State Highway/Non-Municipal Utility Permits for Crossing Over of State Roads with Utility Lines and Permanent Access Permit;***
- ***Massachusetts Energy Facilities Siting Board ("EFSB"), G.L. c. 164 §69J Petition for Approval to Construct New Transmission Lines;***
- ***Massachusetts Department of Public Utilities ("DPU"), G.L. c. 164, §72 Petition for Determination of Public Necessity and Convenience; and G.L. c. 40A, §3 Petition for Zoning Exemption;***

Please refer to Project Narrative, Section 1, Table 3: Permit/Consultation Requirements

Identify any financial assistance or land transfer from an Agency of the Commonwealth, including the Agency name and the amount of funding or land area in acres:

Not applicable: no financial assistance or land transfer will be associated with this Project.

Summary of Project Size & Environmental Impacts	*Existing*	**Change**	**Total**
LAND			
Total site acreage	~1047 +/-		
New acres of land altered		~216+/-[1]	
Acres of impervious area	41+/-[2]	N/A	
Square feet of new bordering vegetated wetlands alteration		2,868,580[3]	
Square feet of new other wetland alteration[4]		BLSF:95,593[5] RA: 2,614,816[6] Bank: 94,526[7] LUW: 32,364[8] Isolated Wetland:85,021[9]	
Acres of new non-water dependent use of tidelands or waterways		N/A	
STRUCTURES			
Gross square footage	N/A	N/A	N/A
Number of housing units	N/A	N/A	N/A
Maximum height (feet)[10]	51	39-45	~90

1 Includes all new areas of disturbance for tree removal (164 acres) and construction of access roads (52 acres). See Sections 1.6.2, 1.6.3, 1.6.4 and Section 4 for more detail.
2 Includes paved areas and substations within Project ROW.
3 Bordering Vegetated Wetland includes approximately 1,896 sf of permanent fill due to concrete caissons; approximately 666,032 sf of wetland conversion due to tree removal; and approximately 2,200,651 sf of temporary construction matting impact during construction.
4 BLSF- Bordering Land Subject to Flooding; RA- Riverfront Area; Bank- Inland Bank. LUW- Land Under Water.
Note that impacts located within the limits of RFA overlap with impacts to BLSF, BVW and the 100-ft Buffer Zone. Therefore, the total impacts to the Project Site are not equal to the sum of the alterations.
5 BLSF includes approximately 632 sf of new concrete caissons; 81,022 sf of tree removals; and 13,939 sf of temporary construction matting. Overexcavation for work envelopes, pull pads and access, 293,924 sf not included in total as no loss in flood storage will occur.
6 RA includes approximately 3,479 sf of new concrete caissons; 1,177,862 sf for grading and retaining walls; 171,544 sf of new and/or re-establishment of access roads; 748,796 sf of tree removals; and 513,137 sf of temporary construction matting.
7 Bank includes approximately 26,572 sf of tree removals (overhead line clearance and Limit of Disturbance) and 67,954 sf of temporary construction matting. In most cases, construction mat crossing will span the Bank of rivers and stream; however, the potential for alteration has been accounted for in the review of MEPA Thresholds.
8 LUW includes approximately 158 sf of new concrete caissions on the Crystal Lake Tap Line and 32,206 sf of construction matting in open water where spanning is not feasible.
9 Isolated wetland impacts includes approximately 73,181 sf of temporary construction matting; and 11,840 sf of permanent impacts (79 sf of fill for caisson foundation and 11,761 sf of forested wetland conversion to PSS.)
10 Mainline structure heights are approximately 51-ft and tap line structures are approximately 45-ft. Replacement and new structures for the mainline and tap lines will be approximately 90-ft.

TRANSPORTATION			
Vehicle trips per day	N/A	N/A	N/A
Parking spaces	N/A	N/A	N/A
WASTEWATER			
Water Use (Gallons per day)	N/A	N/A	N/A
Water withdrawal (GPD)	N/A	N/A	N/A
Wastewater generation/treatment (GPD)	N/A	N/A	N/A
Length of water mains (miles)	N/A	N/A	N/A
Length of sewer mains (miles)	N/A	N/A	N/A
Has this project been filed with MEPA before? ☐ Yes (EEA #_________) ☒No			
Has any project on this site been filed with MEPA before? ☒ Yes (EEA # 15432) ☐No			

GENERAL PROJECT INFORMATION – all proponents must fill out this section

PROJECT DESCRIPTION:

Describe the existing conditions and land uses on the project site:__________________________

A detailed description of the existing conditions and land uses on the project site is provided in the Project Narrative (Section 1: Project Overview and Summary and Section 3: Land Use)

Describe the proposed project and its programmatic and physical elements: _

NOTE: The project description should summarize both the project's direct and indirect impacts (including construction period impacts) in terms of their magnitude, geographic extent, duration and frequency, and reversibility, as applicable. It should also discuss the infrastructure requirements of the project and the capacity of the municipal and/or regional infrastructure to sustain these requirements into the future.

Within MA, the A1/B2 ACR Project (or "the Project") will be located within existing electric transmission ROW containing the existing 69 kV A1 and B2 Lines, also referred to as "the mainline" and three (3) intersecting tap lines. The A1/B2 mainline extends from the Massachusetts border in Warwick through Royalston, Winchendon, Gardner, Westminster, Fitchburg, and Leominster to the Pratts Junction #255 Substation in Sterling. The tap lines consist of the existing Athol Taps 1 and 2 in Athol and Royalston, the existing Crystal Lake Tap in Gardener, and the existing East Westminster Tap in Westminster. The Project is part of a larger refurbishment effort that continues through NH and terminates at the Vernon #12 Switchyard located in Vernon, Vermont.

Please refer to the Locus Map in Appendix A: Figures for more information.

Project Need: ***The A1/B2 Lines were originally constructed in 1909 and the original lattice structures remain. The Lines were reconductored in the 1920s and were reinsulated in 2004. Structures and wires are in need of replacement due to asset condition and aging infrastructure. In addition, the access conditions vary considerably throughout the ROW. Existing access is present in some areas, but in others, the historic access route is in need of significant repair and does not meet NEP's standard to safely support specialized equipment. As such, the Project's primary objective is to complete required system improvements that will address poor asset condition, mitigate potential risks of electrical failure, and to provide long-term reliable delivery of electrical service and maintenance of the lines. As part of the proposed refurbishment, fiber optic ground wire will be used to replace the existing shield wire to provide high speed communications between substations.***

Secondarily, the initial results of the Independent System Operator – New England ("ISO-NE") 2050 Transmission Study ("Study") support upgrading the line to 115 kV. Based on current Study assumptions and forecasts, renewable energy connections and customer needs will ultimately require the system operate at the higher voltage at some point in the future. In an effort to reduce the impacts of a second large-scale refurbishment on the environment, the community and its customers, NEP proposes to "future proof" the A1/B2 mainline and tap lines as part of this Project constructing lines with 115 kV capacity but operating the lines at 69 kV until the additional capacity is needed.

Project Description:

The Project includes various refurbishment activities and system improvements for 711 structures and the installation of six (6) new vertical jumper switch structures along the mainline and tap lines in MA. Activities will occur within an existing ROW and all efforts will be made to minimize the need for construction activities outside the easement.

Along the A1/B2 ROW and the Athol, Crystal Lake, and East Westminster Tap Lines, the 711 proposed structure replacements will entail removing the existing structure and installing a replacement structure in an adjacent location. Based on the current Project design, it is assumed 305 of the replacement structures will be on concrete caisson foundations, due to the tension on the structure. The remaining 406 poles will be directly embedded into the ground and will not require caisson foundations.
The Project will be reconductored with 795 Aluminum-conductor steel-supported conductor("ACSS") and existing shield wire will be replaced with two (2) Optical Primary Ground Wires ("OPGW"). In certain situations where a replacement structure is proposed 25-ft or more from the existing structure, a temporary structure will be installed to facilitate the new structure, conductor and OPGW installation. Additionally, in approximately 30 locations, temporary structures may be required to increase the height of the conductor during construction so that construction vehicles and "live line" work (construction activities conducted while the lines are energized) can occur at a safe distance from the conductor. The temporary structures will then be removed along with the existing structures once the reconductoring is complete.

The existing ROW width varies from 100 ft - 125-ft. The existing cleared ROW width also varies along the length of the transmission and tap lines. In order to obtain the required clearances under all weather conditions, the Project proposes the ROW be consistently cleared to 100-ft on the mainline and Crystal Lake Tap Line, and 125-ft on the Athol Tap Line. Some additional tree removal may be required to accommodate Project access since construction of new and/or re-establishment of access roads is proposed along the majority of the Project route.

<u>Proposed Conditions:</u>

The means and methods of construction to facilitate general maintenance and system improvement activities for the purpose of refurbishment work is given below. Details on each activities are provided in the Project Narrative (Section 1.6: Proposed Conditions).

- *a. Structures*
- *b. Construction Access and Limit of Disturbance:*
- *c. Vegetation Management*
- *d. Access Routes, Work Pads and Envelopes and Pull Pads*
  - *Access Road Routes*
  - *Work Envelopes and Pull Pads*
  - *Retaining Walls*

<u>Impacts:</u> The Project has been designed to avoid adverse impacts where feasible. As an active ROW, most of the Project area is already disturbed and maintained. Both potential and temporary impacts to various resource categories are summarized in <u>Table 2: Summary of A1/B2 Transmission Lines Refurbishment Impacts</u> in Section 1 of the Project Narrative and discussed in Sections 3 through 8.

Project impacts include tree removal in excess of regular vegetation management; work within wetland resource areas; work within mapped rare species habitat. Most wetland impacts are temporary and are related to the use of construction matting and the temporary use of stabilizing material within work areas during construction. Permanent wetland impacts are primarily associated with the conversion of forested wetland to scrub-shrub wetland due to tree removal, which is anticipated to create a benefit to successional wildlife (please refer to Appendix F Wildlife Habitat Evaluation). New structures in BVW and BLSF will result in minimal amounts of permanent fill relative to the total extent of resource areas on the Project site. Please refer to Appendix C: National Grid Environmental Guidance Document ("EG-303NE") for additional information on procedures and policies implemented during construction for ROW access, maintenance and construction best management practices.

MEPA: The Project exceeds or potentially exceeds the MEPA thresholds identified on Pages ii

and iii this EENF.

Describe the on-site project alternatives (and alternative off-site locations, if applicable), considered by the proponent, includi at least one feasible alternative that is allowed under current zoning, and the reasons(s) that they were not selected as the preferred alternative:

NOTE: *The purpose of the alternatives analysis is to consider what effect changing the parameters and/or siting of a project, or components thereof, will have on the environment, keeping in mind that the objective of the MEPA review process is to avo or minimize damage to the environment to the greatest extent feasible. Examples of alternative projects include alternative si locations, alternative site uses, and alternative site configurations.*

Alternatives:

i. No Build Alternative

As required by 301 CMR 11.07(6)(f)(2), a No Build Alternative must be evaluated to establish a baseline against which the Project can be evaluated. However, in this instance, the No Build Alternative does not achieve the Project's goals and benefits. This Project consists of refurbishment and improvements to existing assets. If no action is taken, deteriorating structures will pose a safety risk to NEP personnel and will affect NEP's ability to provide reliable electrical service to members of the public. Given the condition of the existing circuits and the need to provide high speed communications between the substations these circuits serve, this is not a feasible alternative and was not evaluated further.

ii. 69 kV Rebuild Alternative

As stated above, future proofing the Lines for a 115 kV carrying capacity allows NEP to minimize the likelihood of repeat impacts to adjacent landowners and environmentally sensitive areas as customer and renewable energy needs continue to grow in the region. Refurbishing the Lines to operate with a 69 kV carrying capacity would not meet the identified need and therefore, was not considered a feasible alternative.

Additionally, due to the outage constraints associated with the A1/B2 Lines, the Project would need to utilize live line construction techniques. As such, the proposed replacement structures would be installed at a height above the existing structures, regardless of proposed voltage. Should the existing structures be replaced to meet 69 kV standards, this would only result in a decrease of approximately 5.5-ft in structure height from those proposed. Therefore, the minimum horizontal clearance requirements would be the same at 69 kV as they are for the proposed 115 V, and tree removal requirements on ROW would not be reduced. Refurbishing the Lines at 69 kV would not reduce environmental impacts and would not provide the benefit of operating the Lines at 115 kV in the future.

iii. Critical Asset Repair Alternative

A critical asset repair alternative was considered to address only the most critical asset related issues. However, this would require returning to the A1/B2 Lines repeatedly over time to complete less critical maintenance and improvement activities. This would result in repeated access and temporary impacts including temporary construction matting, within Public Open Space and Recreational Areas, adjacent Watershed Areas, BVW and other environmental resources and rare species habitat. Additionally, this alternative would not address the quantity of asset condition concerns, would not improve the reliability of existing communications between the substations served by the circuits, and would result in inefficiencies in revisiting the same ROW within a short time span. This alternative was deemed infeasible and not analyzed further.

iv. 115 kV Structure Design Alternatives

Double-circuit davit arm structures are proposed for the mainline and single-circuit davit arm structures are proposed for the tap lines; however, alternative structure types were evaluated. For the A1/B2 mainline, alternative structure type, davit arm length and installation method were evaluated and determined to be infeasible due to increased footprint, ice jump

condition[11], soil conditions and safe clearance distance, respectively. For the tap lines, alternative structure types were evaluated and determined to be infeasible due to outage constraints, reliability concerns, and limiting risk of tree contact, respectively.

Conclusion:

As described above, alternative concepts, including a No Build Alternative, were initially considered to meet the identified needs, but ultimately rejected. The No Build Alternative was rejected because it would not address asset reliability and repair requirements. Partial refurbishment and rebuilding to 69 kV standards would require supplemental projects to adequately reinforce the A1/B2 Lines over the next decade. The proposed Project is the only alternative that meets the identified needs while minimizing overall project impacts. See Section 2 for additional detail on the described alternatives.

Summarize the mitigation measures proposed to offset the impacts of the preferred alternative:
Mitigation:

NEP follows a set of policies for ROW access, maintenance, and construction best management practices ("BMPs"). By consistently implementing these procedures, NEP ensures that transmission lines are maintained and constructed by trained personnel in a manner that minimizes potential impacts to the environment, adheres to permit conditions, and meets industry standards. Key elements of the construction policy include pre-construction field investigations, field inspections during construction, and postconstruction inspections.

Throughout construction, appropriate consideration will be given to Project implementation in a manner consistent with conditions of permits/authorizations and approved mitigation measures.
To minimize Project impacts, NEP has incorporated the following actions and considerations throughout the planning and design phases:

Several asset condition and reliability needs were combined into one project scope in an effort to reduce the need for repeat disturbances to wetlands and adjacent property owners in this shared ROW;

- ***Existing ROW and access roads are being used to avoid new land disturbance, where feasible;***
- ***Field investigations were completed to assess constructability and avoid/mitigate sensitive resources;***
- ***Agency consultations are in progress;***
- ***Replacement structures are being located outside of BVW where feasible; and***
- ***Temporary construction mat BMPs will be utilized to minimize wetland impacts.***

11 The maximum jump height of a transmission line after ice-shedding. Ice-shedding from conductors can cause significant vertical vibration of the transmission line.

Additional mitigation measures will be implemented as required by state, federal and local requirements. NEP anticipates that the final mitigation package will be developed during the federal, state, and local permitting processes outlined in the next section, and that the package will fully address the required permit conditions and agency concerns. NEP anticipates that mitigation will demonstrate no net loss of existing wetland functions, values, and statutory interests within the watersheds.

____

If the project is proposed to be constructed in phases, please describe each phase:

Not applicable.

AREAS OF CRITICAL ENVIRONMENTAL CONCERN:

Is the project within or adjacent to an Area of Critical Environmental Concern?

☐ Yes (Specify________________________________)
☒ No

if yes, does the ACEC have an approved Resource Management Plan? ___ Yes ___ No;
If yes, describe how the project complies with this plan.

____

Will there be stormwater runoff or discharge to the designated ACEC? ___ Yes ___ No;
If yes, describe and assess the potential impacts of such stormwater runoff/discharge to the designated ACEC.

____

RARE SPECIES:

Does the project site include Estimated and/or Priority Habitat of State-Listed Rare Species? (see http://www.mass.gov/dfwele/dfw/nhesp/regulatory_review/priority_habitat/priority_habitat_home.htm)

☒ Yes (Specify___ see below_____)
☐ No

Three (3) bird, three (3) herptile, two (2) insect, and one (1) plant species are mapped along portions of the Project route Warwick, Royalston, Winchendon, Athol, Fitchburg, and Leominster.
The names and locations of these species are not provided, as requested by MA NHESP.)
See Project Narrative, Section 5: Rare Species.

HISTORICAL /ARCHAEOLOGICAL RESOURCES:

Does the project site include any structure, site or district listed in the State Register of Historic Place or the inventory of Historic and Archaeological Assets of the Commonwealth?

☒ Yes (Specify: See below) ☐ No

NEP's cultural resource consultant, SWCA Environmental Consultants has conducted a cultural resources due diligence and sensitivity assessment and are conducting an archeological survey and historic architectural properties assessment,

under a permit issued by the Massachusetts Historical Commission ("MHC"). See Project Narrative Section 6: Historical/Archaeological Resources.

If yes, does the project involve any demolition or destruction of any listed or inventoried historic or archaeological resources? ☐Yes (Specify________________________________) ☒No

WATER RESOURCES:

Is there an Outstanding Resource Water (ORW) on or within a half-mile radius of the project site? ___Yes **X** No;
if yes, identify the ORW and its location. ____

- ***Notown Reservoir, Leominster, MA***
- ***Fall Brook Reservoir, Leominster, MA***
- ***Goodfellow Pond, Leominster, MA***
- ***Simonds Pond, Leominster, MA***
- ***Distributing Reservoir, Leominster, MA***
- ***Morse Reservoir, Leominster, MA***
- ***Parleys Brook Reservoir, Gardner, MA***

Approximately 40 Certified Vernal Pools (CVPs) are located within a half-mile radius of the ROW in Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, and Sterling. There are no CVPs mapped within the ROW.

(NOTE: Outstanding Resource Waters include Class A public water supplies, their tributaries, and bordering wetlands; active and inactive reservoirs approved by MassDEP; certain waters within Areas of Critical Environmental Concern, and certified vernal pools. Outstanding resource waters are listed in the Surface Water Quality Standards, 314 CMR 4.00.)

Are there any impaired water bodies on or within a half-mile radius of the project site?

X Yes__No: if yes, identify the water body and pollutant(s) causing the impairment: ***See Table Below.***

Impaired Waterways in MA[12] (on or within 0.5-mile radius of the Project site)					
Waterbody	**Watershed**	**Water Type Category**	**Category # & Classification**	**Pollutant Causing Impairment**	**TMDL Cou**
Millers River	Millers	River	5 Impaired - TMDL Requir	PCBs in Fish Tissue	0
Lawrence Brook	Millers	River	5 Impaired - TMDL Requir	PCBs in Fish Tissue	0
Boyce Brook	Millers	River	5 Impaired - TMDL Requir	PCBs in Fish Tissue	0
West Gulf Brook	Millers	River	5 Impaired - TMDL Requir	PCBs in Fish Tissue	0
Stockwell Brook	Millers	River	5 Impaired - TMDL Requir	PCBs in Fish Tissue	0
East Branch Tully River	Millers	River	5 Impaired - TMDL Requir	PCBs in Fish Tissue	0
Flag Brook	Nashua	River	2 Unimpaired for Some Uses	N/A	0
Fall Brook	Nashua	River	2 Unimpaired for Some Uses	N/A	0
Unnamed Tributary Burnt Mill Pond Brook	Nashua	River	3 No Uses Assessed	N/A	0
Richards Reservoir	Millers	Freshwater Lake	3 No Uses Assessed	N/A	0
Stoddard Pond	Millers	Freshwater Lake	4C Impairment Not Caused by a Pollutant	N/A	0

Fall Brook Reservoir	Nashua	Freshwater Lake	3 No Uses Assessed	N/A	0
Notown Reservoir	Nashua	Freshwater Lake	3 No Uses Assessed	N/A	0
Sawmill Pond	Nashua	Freshwater Lake	4C Impairment Not Caused by a Pollutant	N/A	0
Otter River	Millers	River	5 Impaired - TMDL Requir	PCBs in Fish Tissue	0
Priest Brook	Millers	River	2 Unimpaired for Some Uses	N/A	0
Mahoney Brook	Millers	River	5 Impaired - TMDL Requir	PCBs in Fish Tissue	0
Wekepeke Brook	Nashua	River	5 Impaired - TMDL Requir	*Escherichia Coli* (E.coli)	0
Beaver Flowage Pond	Millers	Freshwater Lake	3 No Uses Assessed	N/A	0
Crystal Lake	Millers	Freshwater Lake	3 No Uses Assessed	N/A	0
Lake Denison	Millers	Freshwater Lake	4A Impaired - TMDL Completed	N/A	2
Little Pond	Millers	Freshwater Lake	3 No Uses Assessed	N/A	0
Perley Brook Reservoir	Millers	Freshwater Lake	3 No Uses Assessed	N/A	0
Haynes Reservoir	Nashua	Freshwater Lake	3 No Uses Assessed	N/A	0
Morse Reservoir	Nashua	Freshwater Lake	3 No Uses Assessed	N/A	0
Round Meadow Lake	Nashua	Freshwater Lake	3 No Uses Assessed	N/A	0
Lake Samoset	Nashua	Freshwater Lake	4C Impairment Not Caused by a Pollutant	N/A	0

Is the project within a medium or high stress basin, as established by the Massachusetts Water Resources Commission? **X** Yes __ No

STORMWATER MANAGEMENT:

Generally describe the project's stormwater impacts and measures that the project will take to comply with the standards found in MassDEP's Stormwater Management Regulations:

NEP will submit a Stormwater Pollution Prevention Plan ("SWPPP") for the Project in compliance with the EPA's National Pollutant Discharge Elimination System (NPDES) program under the Stormwater Construction General Permit. The SWPPP establishes a construction period contact list, presents a description of the proposed work, and identifies stormwater controls, spill prevention, and inspection practices to be implemented for the management of construction-related stormwater discharges from the Project. The SWPPP clearly identifies parties responsible for monitoring and reporting any activities out of compliance with the SWPPP or other environmental permits or approvals, and for handling extraordinary situations. The SWPPP also defines monitoring to occur until all disturbed areas on the site have been stabilized using standard BMPs. In this manner, the potential impacts

12 MassGIS (Bureau of Geographic Information), December 2020, URL: https://www.mass.gov/info-details/massgis-data-massdep-2016-integrated-list-of-waters-305b303d

associated with land disturbance (e.g. erosion and sedimentation) will be proactively managed so that impacts can be avoided. Please refer to Appendix C.

MASSACHUSETTS CONTINGENCY PLAN:

Has the project site been, or is it currently being, regulated under M.G.L.c.21E or the Massachusetts Contingency Plan? Yes X No ___ ; if yes, please describe the current status of the site (including Release Tracking Number (RTN), cleanup phase, and Response Action Outcome classification):____***see below***_____________

RTN	Site Name	Site Address	Municipality	Compliance Status	Compliance Date
2-0012349	Pratts Junction Substation	Pratts Junction Rd	Sterling	RAO	8/9/2002

RTN 2-0012349 included as work will be conducted within the limits of the Disposal Site Boundary; however, it will not disturb the subsurface as only overhead work is proposed.

Is there an Activity and Use Limitation (AUL) on any portion of the project site? Yes **X** No___;
if yes, describe which portion of the site and how the project will be consistent with the AUL:

An AUL was identified with the Pratts Junction Substation in Sterling, MA. However, no work is proposed within the limits of the AUL, nor will there be subsurface work within the Substation.

Are you aware of any Reportable Conditions at the property that have not yet been assigned an RTN?
Yes ___ No **X** if yes, please describe:__________________________________

SOLID AND HAZARDOUS WASTE:

If the project will generate solid waste during demolition or construction, describe alternatives considered for re-use, recycling, and disposal of, e.g., asphalt, brick, concrete, gypsum, metal, wood:______________________

The intent is for all existing wood and steel towers proposed for removal to be transported to an appropriate recycling facility. The removal and recycling will be consistent with all applicable regulations.

(NOTE: Asphalt pavement, brick, concrete and metal are banned from disposal at Massachusetts landfills and waste combustion facilities and wood is banned from disposal at Massachusetts landfills. See 310 CMR 19.017 for the complete list of banned materials.)

Will your project disturb asbestos containing materials? Yes ___ No **X** ;
if yes, please consult state asbestos requirements at http://mass.gov/MassDEP/air/asbhom01.htm

Describe anti-idling and other measures to limit emissions from construction equipment:

NEP will comply with state laws regulating the use of diesel-powered equipment and vehicle idling times during construction. NEP will also take measures to limit vehicle idling times and to reduce air emissions, including the following:

Any diesel-powered non-road construction equipment with engine horsepower ratings of 50 and above to be used for 30 or more days over the course of construction will either be USEPA Tier 4-compliant or will be retrofitted with USEPA-verified (or equivalent) emission control devices such as oxidation catalysts or other comparable technologies (to the extent that they are commercially available) and installed on the exhaust system side of the diesel combustion engine.

NEP requires the use of ultra-low sulfur diesel fuel in its diesel-powered construction equipment and limits idling time to five (5) minutes except when engine power is necessary for the delivery of materials or to operate accessories to the vehicle such as power lifts.

Vehicle idling is to be minimized during construction activities, in compliance with Massachusetts Anti-idling Law, G.L. c. 90 § 16A, c. 111 §§ 142A – 142M, and 310 CMR 7.11.

DESIGNATED WILD AND SCENIC RIVER:

Is this project site located wholly or partially within a defined river corridor of a federally designated Wild and Scenic River or a state designated Scenic River? Yes ___ No **X;**
if yes, specify name of river and designation:

The closest designated scenic river to the Project site is the Nashua River which lies approximately four (4) miles away.

The mainstem of the Nashua River from the confluence of the North and South Nashua Rivers in Lancaster, Massachusetts, extends north to the Massachusetts-New Hampshire border, excluding:

- ***From 700-ft upstream of the crest of Ice House Hydroelectric Project Dam to 500-ft downstream.***
- ***From 9,240-ft upstream from the crest of the Pepperell Hydroelectric Project Dam to 1,000-ft downstream.***

If yes, does the project have the potential to impact any of the "outstandingly remarkable" resources of a federally Wild and Scenic River or the stated purpose of a state designated Scenic River?
Yes ___ No ___ ; if yes, specify name of river and designation: ____________;
if yes, will the project will result in any impacts to any of the designated "outstandingly remarkable" resources of the Wild and Scenic River or the stated purposes of a Scenic River.
Yes ___ No ___ ; if yes, describe the potential impacts to one or more of the "outstandingly remarkable" resources or stated purposes and mitigation measures proposed.

ATTACHMENTS:

1. List of all attachments to this document.
    a. *Cover Letter*
    b. *Appendix A: Project Figures*
        i. *USGS Site Locus*
        ii. *MEPA General Purpose Plans (Sheets 1-168)*
        iii. *Structure Details*
    c. *Appendix B: MEPA EENF Circulation List*
    d. *Appendix C: National Grid Environmental Guidance Document (EG-303NE)*
    e. *Appendix D: 2019-2023 Vegetation Management Plan*
    f. *Appendix E: Supplemental Wetlands Information*
    g. *Appendix F: Wildlife Habitat Evaluation*
    h. *Appendix G: RMAT Tool Output Report*
    i. *Appendix H: EJ Community Locus Map, Environmental Justice Screening Form, Reference List, Public Meeting Invitation, Potential Pollution Sources Enforcement History*
    j. *Appendix I: Agency Correspondence*
2. U.S.G.S. map (good quality color copy, 8-½ x 11 inches or larger, at a scale of 1:24,000) indicating the project location and boundaries. ***See Appendix A, Locus Map.***

3.. Plan, at an appropriate scale, of existing conditions on the project site and its immediate environs, showing all known structures, roadways and parking lots, railroad rights-of-way, wetlands and water bodies, wooded areas, farmland, steep slopes, public open spaces, and major utilities. ***See Appendix A, MEPA General Purpose Plans.***

4 Plan, at an appropriate scale, depicting environmental constraints on or adjacent to the project site such as Priority and/or Estimated Habitat of state-listed rare species, Areas of Critical Environmental Concern, Chapter 91 jurisdictional areas, Article 97 lands, wetland resource area delineations, water supply protection areas, and historic resources and/or districts. ***See Appendix A, MEPA General Purpose Plans.***

5. Plan, at an appropriate scale, of proposed conditions upon completion of project (if construction of the project is proposed to be phased, there should be a site plan showing conditions upon the completion of each phase). ***See Appendix A, MEPA General Purpose Plans.***

6. List of all agencies and persons to whom the proponent circulated the ENF, in accordance with 301 CMR 11.16(2). ***See Cover Letter and Attached Circulation List.***

7. List of municipal and federal permits and reviews required by the project, as applicable. ***See Table 3: Permit Consultation Requirements*** **in the** ***Project Narrative, Section 1: Project Information*****.**

8. Printout of output report from RMAT Climate Resilience Design Standards Tool, available here. ***See Appendix G.***

9. Printout from the EEA EJ Maps Viewer showing the project location relative to Environmental Justice (EJ) Populations located in whole or in part within a 1-mile and 5-mile radius of the project site. ***See Appendix H.***

LAND SECTION – all proponents must fill out this section

I. Thresholds / Permits

A. Does the project meet or exceed any review thresholds related to **land** (see 301 CMR 11.03(1) **X** Yes ___ No; if yes, specify each threshold:

Direct alteration of 50 or more acres of land, unless the Project is consistent with an approved conservation farm plan or forest cutting plan or similar. (301 CMR 11.03(1)(a)).

Approximately 216 acres of permanent impacts is proposed, which comprises of 164 acres of tree removal proposed to obtain minimum horizontal clearances with the overhead line and tree removals within the Limit of Disturbance associated with preliminarily assumed secondary impacts from grading activities, and approximately, 51 acres will result from the proposed access routes anticipated to be cleared.

II. Impacts and Permits

A. Describe, in acres, the current and proposed character of the project site, as follows:

	Existing	Change	Total
Footprint of buildings	N/A	N/A	N/A
Internal roadways	N/A	N/A	N/A
Parking and other paved areas	N/A	N/A	N/A
Other altered areas (see Note 1)	~844	~216	~1060
Undeveloped areas (see Note 2)	~79	~19	~79
Total: Project Site Acreage	**~1047**	**N/A**	**~1047**

(1) This number reflects the existing ROW, with change due to tree removal and access road establishment/re-establishment. The utility ROW has been utilized for decades, and much of the land has been previously used and/or disturbed by utility-related activities, including the installation and maintenance of existing utility structures, access roads, and vegetation management for safety clearance.

(2) The existing undeveloped areas consist of the DCR property where tree removal is required to maintain sufficient clearances. Existing trails will be improved outside of the ROW. Tree removal and construction activities will remain within NEP's easement in Article 97 Land; thus, no change in Land Use is proposed.

Please refer to Section 3: Land Use in the Project Narrative.

B. Has any part of the project site been in active agricultural use in the last five years?
X Yes ___ No; if yes, how many acres of land in agricultural use (with prime state or locally important agricultural soils) will be converted to nonagricultural use?

No land in agricultural use will be converted to nonagricultural use.

C. Is any part of the project site currently or proposed to be in active forestry use?
___ Yes **X** No; if yes, please describe current and proposed forestry activities and indicate whether any part of the site is the subject of a forest management plan approved by the Department of Conservation and Recreation:

D. Does any part of the project involve conversion of land held for natural resources purposes in accordance with Article 97 of the Amendments to the Constitution of the Commonwealth to any purpose not in accordance with Article 97? Yes __ No **X**; if yes, describe:

E. Is any part of the project site currently subject to a conservation restriction, preservation restriction, agricultural preservation restriction or watershed preservation restriction? **X** Yes___ No; if yes, does the project involve the release or modification of such restriction? ___ Yes _X__ No; if yes, describe:

F. Does the project require approval of a new urban redevelopment project or a fundamental change in an existing urban redevelopment project under M.G.L.c.121A? ___ Yes **X** No; if yes, describe:

G. Does the project require approval of a new urban renewal plan or a major modification of an existing urban renewal plan under M.G.L.c.121B? ____Yes **X** No; if yes, describe:

III. Consistency

A. Identify the current municipal comprehensive land use plan
Title:_See below_________ Date: See below

The current municipal comprehensive land use plans are:

- ***Town of Athol – Athol Master Plan, November 2002***
- ***Town of Winchendon - Community Master Plan, 2020***
- ***City of Fitchburg - Vision 2020 - Fitchburg's Comprehensive Master Plan***
- ***Town of Westminster Master Plan, 2014***
- ***Town of Sterling Master Plan, March 2022 Final Draft***
- ***Gardner Community Development Plan, 2006***

The Towns of Warwick and Royalston and the City of Leominster do not have comprehensive plans, and therefore, are not cited.

B. Describe the project's consistency with that plan with regard to:

1) economic development ______***See below***________________

2) adequacy of infrastructure ______***See below***_______________

3) open space impacts __________***See below***________________

4) compatibility with adjacent land uses______***See below***_________

The Project consists of upgrades to an existing utility line which will facilitate regional system electrical reliability. Therefore, it is consistent with the local planning documents.

Town of Athol

The Town of Athol Master Plan describes the Town's plans specific to Land Use and Zoning, Community Facilities and Housing, Economic Development, Historic and Scenic Resources, Transportation, Capital Improvement and Recreation.

A review of Athol's economic goals has concluded that the Project corresponds with the implementation of this Plan. One of the major economic goals in the Master Plan is to encourage economic development in the town without any destruction of natural resources and cultural landscape. As noted previously, the purpose of this Project is to undertake necessary upgrades and improvements to the existing electrical transmission system so it may continue to provide safe, reliable electric power, and to maintain compliance with regional and national electric standards. The Project is within an existing ROW, and no new cross-country ROWs are proposed. Similarly, the Project helps strengthen the infrastructure of Athol by providing reliable sources of electric power that are vital for the well-being of this community.

The Project is proposed to be constructed on NEP-owned land or easement, and within an existing transmission line ROW, and necessary measures will be taken to ensure no damage to the natural, historical, and open space resources, therefore it is not anticipated that the Project will have any impact on Land Use, Community Facilities and Housing, Economic Development, Historic and Scenic Resources, Transportation and Recreation.

__Town of Winchendon__

The Town of Winchendon Master Plan describes the Town's plans specific to Land Use, Open Space, Economic Development, Housing, Historic and Cultural Resources, Transportation and Circulation, Service and facilities, Community Health and Well-being.

A review of Winchendon's land use goals has concluded that the Project corresponds with the implementation of this Plan. The town's Master Plan outlines sets of land use goals that aim at promoting greener living and preservation of natural resources and wildlife habitats and protecting environmentally sensitive areas, along with the maintenance of open space and recreation lands. Similarly, economic development goals in the Master Plan summarize the goals of the town to develop an environmentally sound economy by promoting development and redevelopment of economic infrastructures. The Project complies and corresponds with the Master Plan as the purpose of this Project is to undertake necessary upgrades and improvements to the existing electrical transmission system so it may continue to provide safe, reliable electric power and to maintain compliance with regional and national electric standards. Furthermore, the work is within the existing ROW, and no new cross-country ROWs are proposed. The Project will implement, assess, and monitor work within sensitive areas such as wetland, conservation land, etc. and best management practices will be implemented to ensure protection and preservation of the resource areas.

The Project is proposed to be constructed on NEP-owned land or easement, and within an existing transmission line ROW, and necessary measures will be taken to ensure no damage to the natural, historical, and open space resources, therefore it is not anticipated that the Project will have any impact on Land Use, Open Space, Economic Development, Housing, Historic and Cultural Resources, Transportation and Circulation, Service and facilities, Community Health and Well-being.

__City of Fitchburg__

The City of Fitchburg Master Plan describes plans specific to Land Use, Economic Development, Housing, Natural Cultural and Historic Resources, Transportation and Circulation, and Open Space and Recreation.

A review of Fitchburg's economic goals has concluded that the Project corresponds with the implementation of this Plan. The main city character goal reviewed in the Master Plan outlines the protection of existing land uses, historic structures, landscapes, and environmentally sensitive areas. The Project has adapted recommendations listed in the land use section of the Plan. Reasonable site plan review will be done to ensure safety, aesthetic impacts, and environmental impacts of the Project. The economic goals and objectives in the document explicitly highlight the maintenance of utility systems which will support the businesses running in the city. The Project complies and corresponds with the Master Plan as the purpose of this Project is to undertake necessary upgrades and improvements to the existing electrical transmission system so it may continue to provide safe, reliable electric power and to maintain compliance with regional and national electric standards.

The Project is proposed to be constructed on NEP-owned land or easement, and within an existing transmission line ROW, and necessary measures will be taken to ensure no damage to the natural, historical, and open space resources, therefore it is not anticipated that the Project will have any

impact on Land Use, Economic Development, Housing, Natural Cultural and Historic Resources, Transportation and Circulation, and Open Space and Recreation.

Town of Westminster

The Town of Westminster Master Plan describes the Town's plans specific to Land Use and Zoning, Economic Development, Housing, Transportation and Circulation, and Open Space and Recreation.

The Westminster Master Plan sets forth a community goal and provides an outline on the development strategies to implement which strengthen the economy and promote sustainable and environmentally sound utilization of open space and recreation.

A review of Westminster's economic goals has concluded that the Project corresponds with the implementation of this Plan. Plans developed by the Town of Westminster for their economic development encourage the upgrade and expansion of infrastructures that are necessary for new economic development, as well as capitalizing the existing open spaces and community resources. The Project complies and corresponds with the Master Plan as the purpose of this Project is to undertake necessary upgrades and improvements to the existing electrical transmission system so it may continue to provide safe, reliable electric power and to maintain compliance with regional and national electric standards.

Additionally, the Plan sets forth open space and recreational objectives and goals. To comply with the open space and recreation objectives of maintaining coordination among the Town boards and the residents, the Project will take necessary steps to notify the Conservation Commission, and the town's Planning Board. Furthermore, the Project is proposed to be constructed on NEP-owned land or easement, and within an existing transmission line ROW, and necessary measures will be taken to ensure no damage to the natural, historical, and open space resources, therefore it is not anticipated that the Project will have any impact on Land Use, Economic Development, Housing, Transportation and Circulation, and Open Space and Recreation.

Town of Sterling

The Town of Sterling Draft Master Plan describes the Town's plans specific to Land Use and Development, Economic Development, Housing, Natural, Historic, and Cultural Resources, Transportation and Circulation, and Open Space and Recreation.

A review of Sterling's land use and open space goals has concluded that the Project corresponds with the implementation of this Plan. The Town of Sterling works in concert alongside their residents, business owners, officials, and organizations to facilitate land use planning which capitalizes on the region's most important assets. The Plan developed review growth trends within the region and outline sets of strategic goals and policies aimed at promoting sound land use planning that protects the town's rural and scenic character. Utility facilities or services are not explicitly addressed.

As noted previously, the purpose of the Project is to undertake necessary upgrades and improvements to the existing electrical transmission system so it may continue to provide safe, reliable electric power and to maintain compliance with regional and national electric standards. Additionally, the Project is proposed to be constructed on NEP-owned land or easement, and within an existing transmission line ROW, and necessary measures will be taken to ensure no damage to

the natural, historical, and open space resources, therefore it is not anticipated that the Project will have any impact on Land Use, Economic Development, Housing, Natural, and Historic, and Cultural Resources, Transportation and Circulation, and Open Space and Recreation.

C. Identify the current Regional Policy Plan of the applicable Regional Planning Agency (RPA)
RPA: ____***Montachusett Regional Planning Commission***______________

Title:__ Montachusett Regional Strategic Framework Plan Date__ April 2011

D. Describe the project's consistency with that plan with regard to:
1) economic development _______ S*ee below*__
2) adequacy of infrastructure ________ S*ee below*
3) open space impacts ___________ S*ee below*

The Project is located within the areas covered by the Montachusett Regional Planning Commission ("MRPC"). Montachusett Regional Strategic Framework Plan describes the Region's plans specific to Housing, Land Use, Economic Development, Historic Preservation, Open Space Preservation, Community Development, Energy and Water Management. Policy documents developed by this Commission reviewed growth trends within the region and outlined sets of strategic goals and policies aimed at promoting sound land use planning. They evaluated how growth trends are likely to affect development within their regions as well as in each subregion in the future. The regional objective and goals in the document are primarily concerned with promoting equal housing rights, promoting economic activity that retains and attracts income, and preserving and enhancing the availability of open space. Utility facilities or services are not explicitly addressed.

As noted previously, the purpose of this Project is to undertake necessary upgrades and improvements to the existing electrical transmission system so it may continue to provide safe, reliable electric power and to maintain compliance with regional and national electric standards. The Project is within an existing ROW, and no new cross-country ROWs are proposed. As a result, this Project is consistent with the policies contained in the planning documents, and a safe, reliable source of electric power is vital to the overall well-being of these communities.

RARE SPECIES SECTION

I. Thresholds / Permits

A. Will the project meet or exceed any review thresholds related to **rare species or habitat** (see 301 CMR 11.03(2))? **X** Yes ___ No; if yes, specify, in quantitative terms:

ENF: Rare Species - taking of an endangered or threatened species or species of special concern, provided that the Project site is two or more acres and includes an area mapped as a Priority Site of Rare Species Habitats and Exemplary Natural Communities. (301 CMR 11.03(2)(b)(2)).

Consultations are ongoing with NHESP but a take is anticipated.

(NOTE: If you are uncertain, it is recommended that you consult with the Natural Heritage and Endangered Species Program (NHESP) prior to submitting the ENF.)

B. Does the project require any state permits related to **rare species or habitat**? **X** Yes __ No

C. Does the project site fall within mapped rare species habitat (Priority or Estimated Habitat?) in the current Massachusetts Natural Heritage Atlas (attach relevant page)? **X** Yes ___ No.

D. If you answered "No" to <u>all</u> questions A, B and C, proceed to the **Wetlands, Waterways, and Tidelands Section**. If you answered "Yes" to <u>either</u> question A or question B, fill out the remainder of the Rare Species section below.

II. Impacts and Permits

A. Does the project site fall within Priority or Estimated Habitat in the current Massachusetts Natural Heritage Atlas (attach relevant page)? **X** Yes ___ No. If yes,

1. Have you consulted with the Division of Fisheries and Wildlife Natural Heritage and Endangered Species Program (NHESP)? **X** Yes ___No; if yes, have you received a determination as to whether the project will result in the "take" of a rare species? ___ Yes **X** No; if yes, attach the letter of determination to this submission.

Consultations with NHESP are ongoing for the Project. A MESA Checklist, NHESP File No: 22-41082 for Access Road Upgrades and Geotechnical Borings was issued on 6/5/2022.

2. Will the project "take" an endangered, threatened, and/or species of special concern in accordance with M.G.L. c.131A (see also 321 CMR 10.04)? ___ Yes ___ No; if yes, provide a summary of proposed measures to minimize and mitigate rare species impacts

Consultations with NHESP are ongoing for the Project. A MESA Checklist, NHESP File No: 22-41082 for Access Road Upgrades and Geotechnical Borings was issued on 6/5/2022.

3. Which rare species are known to occur within the Priority or Estimated Habitat?

The Project area overlaps with Estimated and/or Priority Habitat for three (3) bird, three (3) herptile, two (2) insect, and one (1) plant species. The names and locations of these species are not provided, as requested by MA NHESP.

4. Has the site been surveyed for rare species in accordance with the Massachusetts Endangered Species Act? ___ Yes _X__No

4. If your project is within Estimated Habitat, have you filed a Notice of Intent or received an Order of Conditions for this project? ___ Yes _X__ No; if yes, did you send a copy of the Notice of Intent to the Natural Heritage and Endangered Species Program, in accordance with the Wetlands Protection Act regulations? ___ Yes ___ No

Notices of Intent will be submitted at a later date to each municipality as required under the WPA. Copies of the Notice of Intent ("NOI") will be provided to the NHESP in accordance with the regulations at that time.

B. Will the project "take" an endangered, threatened, and/or species of special concern in accordance with M.G.L. c.131A (see also 321 CMR 10.04)? ___ Yes ___ No; if yes, provide a summary of proposed measures to minimize and mitigate impacts to significant habitat:

Consultations with NHESP are ongoing for the Project. A MESA Checklist, NHESP File No: 22-41082 for Access Road Upgrades and Geotechnical Borings was issued on 6/5/2022.

WETLANDS, WATERWAYS, AND TIDELANDS SECTION

I. Thresholds / Permits

A. Will the project meet or exceed any review thresholds related to **wetlands, waterways, and tidelands** (see 301 CMR 11.03(3))? **X** Yes ___ No; if yes, specify, in quantitative terms:

MEPA Threshold	Project Triggering Activity [13]
EIR: Wetlands, Waterways and Tidelands: Alteration of one or more acres of bordering vegetated wetlands (BVW). *(301 CMR 11.03(3)(a)(1)(a))* **EIR: Wetlands, Waterways and Tidelands**: A*lteration of ten or more acres of any other wetlands. (301 CMR 11.03(3)(a)(1)(b))* **ENF: Wetlands, Waterways and Tidelands:** Alteration of 500 or more linear feet of bank along a fish run or inland bank. *(301 CMR 11.03(3)(b)(1)(b))* **ENF: Wetlands, Waterways and Tidelands:** Alteration of one half or more acres of any other wetlands. *(301 CMR 11.03(3)(b)(1)(f))*	Bordering Vegetated Wetland: 2,868,580 sf (~66 acres) *Temporary- approximately 2,200,651 sf construction matting (~51 acres)* *Permanent- approximately 1,896 sf fill from new/or replacement structure foundations. Approximately, 666,032 sf (~15 acres) of forested wetland conversion due to tree removals.* Riverfront Area: 2,614,816 sf (~60 acres) *Temporary - approximately 513,137 sf (~12 acres) construction matting.* *Permanent – approximately 3,476 sf fill from new/or replacement structure foundations; 1,349,406 sf (~31 acres) for cut/fill for work envelopes, pull pads, access and retaining walls; and 748,796 sf (~17 acres) tree removals.* Bordering Land Subject to Flooding: 389,517 sf (~9 acres) [14] *Temporary – approximately 13,939 sf construction matting.* *Permanent – approximately 632 sf of fill from structure foundations; and 81,022 sf (~2 acre) of tree removals; and 237,402 sf (~5 acres) of cut and fill; 56,522 sf (~ 1 acre) of road building.* Isolated Wetlands: 85,021 sf (~2 acres) *Temporary – approximately 73,181 construction matting* *Permanent - approximately 79 sf of fill from one (1) structure foundation. Approximately, 11,761 sf of forested wetland conversion due to tree removals.* Inland Bank: 94,526 sf *Temporary[15] – approximately 67,954 sf of construction matting which is anticipated to span the stream bank and not result in an impact.*

13 Note that impacts located within the limits of Riverfront Area overlap with impacts to BLSF, BVW, and the 100-ft Buffer Zone. Therefore, the total impacts to the Project Site are not equal to the sum of alterations.

14 56,521 sf of access road and 237,402 sf of cut associated with work envelopes, pull pads and access proposed in BLSF; however, areas will be overexcavated and not result in fill.

15 In most cases, construction mat crossing will span the Bank of rivers and stream; however, the potential for alteration has been accounted for in the review of MEPA Thresholds.

	Permanent – approximately 26,572 sf of tree removals.

B. Does the project require any state permits (or a local Order of Conditions) related to **wetlands, waterways, or tidelands**? **X** Yes ___ No; if yes, specify which permit:

- ***Individual Section 401 Water Quality Certification ("WQC") and Variance from MassDEP.***
- ***Orders of Conditions from local Conservation Commissions.***

C. If you answered "No" to both questions A and B, proceed to the **Water Supply Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Wetlands, Waterways, and Tidelands Section below.

II. Wetlands Impacts and Permits

A. Does the project require a new or amended Order of Conditions under the Wetlands Protection Act (M.G.L. c.131A)? **X** Yes ___ No; if yes, has a Notice of Intent been filed? ___ Yes **X** No;

Note: while Notices of Intent have not yet been submitted for this specific Project, several have been filed for geotechnical borings which will be used to inform the final scope and design.

if yes, list the date and MassDEP file number: ______;
if yes, has a local Order of Conditions been issued? ___ Yes ___ No;
Was the Order of Conditions appealed? ___ Yes ___ No.
Will the project require a Variance from the Wetlands regulations? ___ Yes **X** No.

B. Describe any proposed permanent or temporary impacts to wetland resource areas located on the project site:

Impacts are proposed within Bordering Vegetated Wetland, Inland Bank, Riverfront Area and Bordering Land Subject to Flooding delineated within the Project area. In addition, intermittent and perennial streams were also identified on site. See the wetland resource area descriptions in Section 4: Wetlands and Wildlife and Appendix F: Supplemental Wetlands Information. The MEPA General Purpose Plans in Appendix A depict these resource areas on the Project plans. The temporary and permanent impacts are identified in Section 4.

C. Estimate the extent and type of impact that the project will have on wetland resources, and indicate whether the impacts are temporary or permanent:

Coastal Wetlands	Area (square feet) or Length (linear feet)	Temporary or Permanent Impact?

Land Under the Ocean ________________ __________________

Designated Port Areas ________________ __________________

Coastal Beaches ________________ ___________________

Coastal Dunes ________________ ___________________

Barrier Beaches ________________ ___________________

Coastal Banks ________________ ___________________

Rocky Intertidal Shores ________________ ___________________

Salt Marshes ________________ ___________________

Land Under Salt Ponds ________________ ___________________

Land Containing Shellfish ________________ __________________

Fish Runs ________________ ___________________

Land Subject to Coastal Storm Flowage ________________ ___________________

Inland Wetlands

Bank (lf) ~8,599 lf; ~ 4,180 lf temporary; permanent

Bordering Vegetated Wetlands ~2,200,651 sf; ~667,928 sf temporary; permanent

Isolated Vegetated Wetlands ~73,181 sf; 11,840 sf temporary; permanent

Land under Water ~32,206 sf; 158 sf temporary; permanent

Isolated Land Subject to Flooding ______N/A_________ ________N/A_________

Bordering Land Subject to Flooding ~13,939 sf; ~375,578 sf temporary; permanent

Riverfront Area ~513,137 sf; ~2,101,679 sf temporary; permanent

D. Is any part of the project:

1. proposed as a **limited project**? **X** Yes ___ No; if yes, what is the area (in sf)?

The entire project can be considered a limited project.

2. the construction or alteration of a **dam**? ___ Yes **X** No; if yes, describe:

3. fill or structure in a **velocity zone** or **regulatory floodway**? **X** Yes ___ No

4. dredging or disposal of dredged material? ___ Yes **X** No; if yes, describe the volume of dredged material and the proposed disposal site:

5. a discharge to an **Outstanding Resource Water (ORW)** or an **Area of Critical Environmental Concern (ACEC)**? **X** Yes ___ No

6. subject to a wetlands restriction order? ___ Yes **X** No; if yes, identify the area (in sf):

7. located in buffer zones? **X** Yes ___No; if yes, how much (in sf) ______

4,699,005 sf (approximately 108 acres); Primarily due to cut/fill for work envelopes, and access road establishment and improvements. All areas altered will be revegetated with native vegetation.

E. Will the project:

1. be subject to a local wetlands ordinance or bylaw? **X** Yes ___ No

2. alter any federally-protected wetlands not regulated under state law? **X** Yes ___ No; if yes, what is the area (sf)?

For the purpose of this filing, it assumed that all Isolated Vegetated Wetlands not meeting the criteria for Isolated Land Subject to Flooding are federally jurisdictional. Temporary impacts total approximately 73,181 sf and permanent impacts total approximately 11,840 sf.

III. Waterways and Tidelands Impacts and Permits

A. Does the project site contain waterways or tidelands (including filled former tidelands) that are subject to the Waterways Act, M.G.L.c.91? **X** Yes ___ No; if yes, is there a current Chapter 91 License or Permit affecting the project site? ___ Yes _X_ No; if yes, list the date and license or permit number and provide a copy of the historic map used to determine extent of filled tidelands:

Pursuant to 310 CMR 9.05(3)(g)(1), because a final Order of Conditions issued under M.G.L. c. 131, §40 and 310 CMR 10.00 will be issued for all Project waterways crossing, the crossings do not require authorization under c. 91. Please refer to Section 11: Regulatory Compliance in the Project Narrative for additional detail.

B. Does the project require a new or modified license or permit under M.G.L.c.91? Yes _X_ No; if yes, how many acres of the project site subject to M.G.L.c.91 will be for non-water-dependent use?
Current ___ Change ___ Total ___
If yes, how many square feet of solid fill or pile-supported structures (in sf)?

C. For non-water-dependent use projects, indicate the following:

Area of filled tidelands on the site:___N/A

Area of filled tidelands covered by buildings N/A

For portions of site on filled tidelands, list ground floor uses and area of each use:

____

Does the project include new non-water-dependent uses located over flowed tidelands?
___Yes **X** No

Height of building on filled tidelands_____N/A

Also show the following on a site plan: Mean High Water, Mean Low Water, Water-dependent Use Zone, location of uses within buildings on tidelands, and interior and exterior areas and facilities dedicated for public use, and historic high and historic low water marks.

D. Is the project located on landlocked tidelands? ___ Yes _**X** No; if yes, describe the project's impact on the public's right to access, use and enjoy jurisdictional tidelands and describe measures the project will implement to avoid, minimize or mitigate any adverse impact:

E. Is the project located in an area where low groundwater levels have been identified by a municipality or by a state or federal agency as a threat to building foundations? ___Yes **X** _No; if yes, describe the project's impact on groundwater levels and describe measures the project will implement to avoid, minimize or mitigate any adverse impact:

F. Is the project non-water-dependent **and** located on landlocked tidelands **or** waterways or tidelands subject to the Waterways Act **and** subject to a mandatory EIR? ___ Yes **X** No;

(NOTE: If yes, then the project will be subject to Public Benefit Review and Determination.)

G. Does the project include dredging? ___ Yes **X** No; if yes, answer the following questions:

What type of dredging? Improvement ___ Maintenance ___ Both ____

What is the proposed dredge volume, in cubic yards (cys) _________

What is the proposed dredge footprint ____length (ft) ___width (ft)____depth (ft);

Will dredging impact the following resource areas?

Intertidal Yes__ No__; if yes, ___ sq ft

Outstanding Resource Waters Yes__ No__; if yes, ___ sq ft

Other resource area (i.e. shellfish beds, eel grass beds) Yes__ No__; if yes __ sq ft

If yes to any of the above, have you evaluated appropriate and practicable steps to: 1) avoidance; 2) if avoidance is not possible, minimization; 3) if either avoidance or minimize is not possible, mitigation?

If no to any of the above, what information or documentation was used to support this determination?

Provide a comprehensive analysis of practicable alternatives for improvement dredging in accordance with 314 CMR 9.07(1)(b). Physical and chemical data of the sediment shall be included in the comprehensive analysis.

Sediment Characterization

Existing radation analysis results? __Yes ___No: if yes, provide results.

Existing chemical results for parameters listed in 314 CMR 9.07(2)(b)6? ___Yes ____No; if yes, provide results.

Do you have sufficient information to evaluate feasibility of the following management options for dredged sediment? If yes, check the appropriate option.

Beach Nourishment ___

Unconfined Ocean Disposal ___

Confined Disposal:

Confined Aquatic Disposal (CAD) ___

Confined Disposal Facility (CDF) ___

Landfill Reuse in accordance with COMM-97-001 ___

Shoreline Placement ___

Upland Material Reuse____

In-State landfill disposal____

Out-of-state landfill disposal ____

(NOTE: This information is required for a 401 Water Quality Certification.)

IV. Consistency:

A. Does the project have effects on the coastal resources or uses, and/or is the project located within the Coastal Zone? ___ Yes **X** No; if yes, describe these effects and the projects consistency with the policies of the Office of Coastal Zone Management:

B. Is the project located within an area subject to a Municipal Harbor Plan? ___ Yes **X** No; if yes, identify the Municipal Harbor Plan and describe the project's consistency with that plan:

WATER SUPPLY SECTION

I. Thresholds / Permits

A. Will the project meet or exceed any review thresholds related to **water supply** (see 301 CMR 11.03(4))? ___ Yes **X** No; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **water supply**? ___ Yes **X** No; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Wastewater Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Water Supply Section below.

II. Impacts and Permits

A. Describe, in gallons per day (gpd), the volume and source of water use for existing and proposed activities at the project site:

	Existing	Change	Total
Municipal or regional water supply	________	________	________
Withdrawal from groundwater	________	________	________
Withdrawal from surface water	________	________	________
Interbasin transfer	________	________	________

(NOTE: Interbasin Transfer approval will be required if the basin and community where the proposed water supply source is located is different from the basin and community where the wastewater from the source will be discharged.)

B. If the source is a municipal or regional supply, has the municipality or region indicated that there is adequate capacity in the system to accommodate the project? ___ Yes ___ No

C. If the project involves a new or expanded withdrawal from a groundwater or surface water source, has a pumping test been conducted? ___ Yes ___ No; if yes, attach a map of the drilling sites and a summary of the alternatives considered and the results. ______________

D. What is the currently permitted withdrawal at the proposed water supply source (in gallons per day)? _____Will the project require an increase in that withdrawal? ___Yes ___No; if yes, then how much of an increase (gpd)? ___________________

E. Does the project site currently contain a water supply well, a drinking water treatment facility, water main, or other water supply facility, or will the project involve construction of a new facility? ___ Yes ___No. If yes, describe existing and proposed water supply facilities at the project site:

Permitted	Existing	Avg	Project Flow	Total

	Flow	Daily Flow		
Capacity of water supply well(s) (gpd)	_______	________	________	________
Capacity of water treatment plant (gpd)	_______	________	________	________

F. If the project involves a new interbasin transfer of water, which basins are involved, what is the direction of the transfer, and is the interbasin transfer existing or proposed?

G. Does the project involve:

1. new water service by the Massachusetts Water Resources Authority or other agency of the Commonwealth to a municipality or water district? ___ Yes ___ No

2. a Watershed Protection Act variance? ___ Yes ___ No; if yes, how many acres of alteration?
3. a non-bridged stream crossing 1,000 or less feet upstream of a public surface drinking water supply for purpose of forest harvesting activities? ___ Yes ___ No

III. Consistency

Describe the project's consistency with water conservation plans or other plans to enhance water resources, quality, facilities and services:

WASTEWATER SECTION

I. Thresholds / Permits

A. Will the project meet or exceed any review thresholds related to **wastewater** (see 301 CMR 11.03(5))? ___ Yes **X** No; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **wastewater**? ___ Yes **X** No; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Transportation -- Traffic Generation Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Wastewater Section below.

II. Impacts and Permits

A. Describe the volume (in gallons per day) and type of disposal of wastewater generation for existing and proposed activities at the project site (calculate according to 310 CMR 15.00 for septic systems or 314 CMR 7.00 for sewer systems):

	Existing	Change	Total
Discharge of sanitary wastewater	________	________	________
Discharge of industrial wastewater	________	________	________
TOTAL	________	________	________

	Existing	Change	Total
Discharge to groundwater	________	________	________
Discharge to outstanding resource water	________	________	________
Discharge to surface water	________	________	________
Discharge to municipal or regional wastewater facility	________	________	________
TOTAL	________	________	________

B. Is the existing collection system at or near its capacity? ___ Yes ___ No; if yes, then describe the measures to be undertaken to accommodate the project's wastewater flows:

C. Is the existing wastewater disposal facility at or near its permitted capacity? ___ Yes___ No; if yes, then describe the measures to be undertaken to accommodate the project's wastewater flows:

D. Does the project site currently contain a wastewater treatment facility, sewer main, or other wastewater disposal facility, or will the project involve construction of a new facility? ___ Yes

___ No; if yes, describe as follows:

	Permitted	Existing Avg Daily Flow	Project Flow	Total
Wastewater treatment plant capacity (in gallons per day)	_______	________	________	________

E. If the project requires an interbasin transfer of wastewater, which basins are involved, what is the direction of the transfer, and is the interbasin transfer existing or new?

(NOTE: Interbasin Transfer approval may be needed if the basin and community where wastewater will be discharged is different from the basin and community where the source of water supply is located.)

F. Does the project involve new sewer service by the Massachusetts Water Resources Authority (MWRA) or other Agency of the Commonwealth to a municipality or sewer district? ___ Yes ___ No

G. Is there an existing facility, or is a new facility proposed at the project site for the storage, treatment, processing, combustion or disposal of sewage sludge, sludge ash, grit, screenings, wastewater reuse (gray water) or other sewage residual materials? ___ Yes ___ No; if yes, what is the capacity (tons per day):

	Existing	Change	Total
Storage	________	________	________
Treatment	________	________	________
Processing	________	________	________
Combustion	________	________	________
Disposal	________	________	________

H. Describe the water conservation measures to be undertaken by the project, and other wastewater mitigation, such as infiltration and inflow removal.

III. Consistency

A. Describe measures that the proponent will take to comply with applicable state, regional, and local plans and policies related to wastewater management:

B. If the project requires a sewer extension permit, is that extension included in a comprehensive wastewater management plan? ___ Yes ___ No; if yes, indicate the EEA number for the plan and whether the project site is within a sewer service area recommended or approved in that plan:

TRANSPORTATION SECTION (TRAFFIC GENERATION)

I. Thresholds / Permit

A. Will the project meet or exceed any review thresholds related to **traffic generation** (see 301 CMR 11.03(6))? ___ Yes **X** No; if yes, specify, in quantitative terms:

C. Does the project require any state permits related to **state-controlled roadways**? **X** Yes ___ No; if yes, specify which permit:

State Highway Access Permit for Non-Municipal Utility

- ***Winchendon, Baldwinville State Road (Route 202)***
- ***Westminster, State Road East***
- ***Westminster, Depot Road/Narrows Road***
- ***Westminster, Route 2***
- ***Westminster/ Fitchburg, Route 2 and associated ramps (Exit 27)***
- ***Fitchburg, Route 2 and associated ramps and Princeton Road (Exit 28)***
- ***Fitchburg/Leominster, Route 2***
- ***Leominster, Central Street***

State Highway Permanent Access Permit for Non-Municipal Utility

- ***Proposed structures within Highway Layout***[16]
- ***Proposed access road within a DOT owned parcel***

MassDOT is expected to review the Project for:

- ***Overhead wire crossings of state highways***
- ***Temporary access during construction onto the NEP Project ROW from state highways***
- ***Permanent Access Permit for new access road and proposed structures within the Highway Layout***

C. If you answered "No" to both questions A and B, proceed to the **Roadways and Other Transportation Facilities Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Traffic Generation Section below.

II. Traffic Impacts and Permits

A. Describe existing and proposed vehicular traffic generated by activities at the project site:

	Existing	Change	Total
Number of parking spaces	N/A	N/A	N/A
Number of vehicle trips per day	N/A	N/A	N/A
ITE Land Use Code(s):	N/A	N/A	N/A

16 NEP is evaluating the location of replacements structures along Depot Road in Westminster. The original easement CRT 87 (*Charles H. Dupee et ux*), granted rights to NEP that allow the structure relocation. In addition, the highway taking/relocation in 1985 reserved the rights of all electric transmission easements. The structure relocation is being proposed as an "in-kind" replacement. Should MassDOT deem it to be otherwise, a permanent access permit may be required. NEP will consult with MassDOT.

The Project will not cause permanent traffic impacts and is not anticipated to cause significant temporary traffic impacts. During construction, the shield wires and conductors will be installed using tensioning equipment to pull the conductors through the stringing blocks. When this activity occurs near state roadways, temporary guard structures or boom trucks may be placed at road and highway crossings to ensure public safety. NEP is reviewing the proposed location of guard structures.

Proposed construction traffic will be temporary in nature, occurring along different sections of NEP's Project ROW during the various stages of construction. Traffic will be limited to construction-related vehicles accessing the utility ROW using existing routes off state highways. Traffic volume during construction or maintenance of the utility line will not significantly affect existing volumes or adversely impact the ability of existing traffic to safely navigate the roadway.

B. What is the estimated average daily traffic on roadways serving the site?

	Roadway	Existing	Change	Total
1.	__________________	_______	_______	_______
2.	__________________	_______	_______	_______
3.	__________________	_______	_______	_______

Intermittent construction-related traffic associated with Project construction will occur over the entire construction period. Construction equipment typically will gain access to the ROWs from public roadways crossing the ROWs in various locations along the route. Because each of the construction tasks will occur at different times and locations over the course of the construction, traffic will be intermittent at these entry roadways. Traffic will consist of vehicles ranging from pick-up trucks to heavy construction equipment to large trailers delivering materials.

Proposed construction traffic will be temporary in nature, occurring along different sections of NEP's Project ROW during the various stages of construction. Traffic will be limited to construction-related vehicles accessing the utility ROW using existing routes off state highways. Traffic volume during construction or maintenance of the utility line will not significantly affect existing volumes or adversely impact the ability of existing traffic to safely navigate the roadway. A detailed description on traffic on roadways is provided in the Project Narrative (Section 10.4 Construction Traffic and Equipment).

C. If applicable, describe proposed mitigation measures on state-controlled roadways that the project proponent will implement:

MassDOT Districts 2 & 3 will be contacted to discuss specific design information and anticipated Project activities within highway jurisdiction. With MassDOT's input, Traffic Management Plans with complete details of proposed work will be developed and submitted to MassDOT for review and approval prior to the start of Project construction. Enforceable commitments in the Traffic Management Plans will be carried out by NEP to ensure that all proposed traffic mitigation strategies will be implemented as the Project proceeds. Such strategies may include, as appropriate, traffic management procedures; construction time restrictions; signage; installation of track pads to minimize soil in roadways; and/or restoration of vegetation along soft shoulders after construction. All work will occur in accordance with NEP Policy for ROW Access, Maintenance and Construction

Best Management Practices (please refer to the Project Narrative, and Appendix C: National Grid Environmental Guidance Document ("EG-303")).

D. How will the project implement and/or promote the use of transit, pedestrian and bicycle facilities and services to provide access to and from the project site?

Not applicable.

C. Is there a Transportation Management Association (TMA) that provides transportation demand management (TDM) services in the area of the project site? ____ Yes ____ No; if yes, describe if and how will the project will participate in the TMA:

Not applicable.

D. Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation facilities? **X** Yes ____No; if yes, generally describe:

Project activities will occur in the immediate vicinity of the following rail lines:

- ***CSX Fitchburg Line - Sterling, MA***
- ***Patriot Corridor Line - Athol & Gardner, MA***

E. If the project will penetrate approach airspace of a nearby airport, has the proponent filed a Massachusetts Aeronautics Commission Airspace Review Form (780 CMR 111.7) and a Notice of Proposed Construction or Alteration with the Federal Aviation Administration (FAA) (CFR Title 14 Part 77.13, forms 7460-1 and 7460-2)?

The A1/B2 ROW is approximately 3.25 miles away from the nearest airport ("Fitchburg Municipal Airport"). Since Project activities are greater than two (2) miles from the nearest Municipal Airport Runway, a Massachusetts Aeronautics Commission Airspace Review Form is not required. Project activities are greater than four (4) miles from a major airport that has a runway long enough to trigger a Federal Aviation Administration ("FAA") review.

III. Consistency

Describe measures that the proponent will take to comply with municipal, regional, state, and federal plans and policies related to traffic, transit, pedestrian and bicycle transportation facilities and services:

Project construction will not affect transit, pedestrian, or bicycle transportation facilities since work will primarily occur on a cross-country NEP ROW, which is not designated for public use. The Project is consistent with federal, state, regional and local plans and policies; minimal, if any, impacts related to roadways or other transportation facilities are anticipated.

TRANSPORTATION SECTION (ROADWAYS AND OTHER TRANSPORTATION FACILITIES)

I. Thresholds

A. Will the project meet or exceed any review thresholds related to **roadways or other transportation facilities** (see 301 CMR 11.03(6))? ___ Yes **X** No; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **roadways or other transportation facilities**? __ Yes **X** No; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Energy Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Roadways Section below.

II. Transportation Facility Impacts

A. Describe existing and proposed transportation facilities in the immediate vicinity of the project site:

B. Will the project involve any

1. Alteration of bank or terrain (in linear feet)? ___________
2. Cutting of living public shade trees (number)? ___________
3. Elimination of stone wall (in linear feet)? ___________

III. Consistency -- Describe the project's consistency with other federal, state, regional, and local plans and policies related to traffic, transit, pedestrian and bicycle transportation facilities and services, including consistency with the applicable regional transportation plan and the Transportation Improvements Plan (TIP), the State Bicycle Plan, and the State Pedestrian Plan:

ENERGY SECTION

I. Thresholds / Permits

A. Will the project meet or exceed any review thresholds related to **energy** (see 301 CMR 11.03(7))?

___ Yes **X** _No; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **energy**? _X_Yes No; if yes, specify which permit:

Energy Facilities Siting Board, Approval under M.G.L. c.164 § 69J

Department of Public Utilities, Approval to Construct under M.G.L. c.164 § 72

C. If you answered "No" to both questions A and B, proceed to the **Air Quality Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Energy Section below.

II. Impacts and Permits

A. Describe existing and proposed energy generation and transmission facilities at the project site:

	Existing	Change	Total
Capacity of electric generating facility (megawatts)	N/A	N/A	N/A
Length of fuel line (in miles)	N/A	N/A	N/A
Length of transmission lines (in miles)	54 Miles	N/A	54 Miles
Capacity of transmission lines (in kilovolts)	69 kV	115kV	115kV

B. If the project involves construction or expansion of an electric generating facility, what are:

1. the facility's current and proposed fuel source(s)? N/A
2. the facility's current and proposed cooling source(s)? N/A

C. If the project involves construction of an electrical transmission line, will it be located on a new, unused, or abandoned right of way? ___Yes _X__No; if yes, please describe:

D. Describe the project's other impacts on energy facilities and services:

The Project proposes complete asset refurbishment, system improvements and the capacity to accommodate forecasted customer and renewable interconnection needs. The purpose is to ensure reliable and continuous electricity is provided to its customers within Worcester County. Although the Project will continue to transmit electricity at 69 kV, NEP has planned and designed the Project to support transmission of a higher voltage since it is anticipated 115 kV will be needed to support higher volumes of currently active and forecasted renewable energy resources in this region, within the lifetime

of the structures. NEP will also be installing OPGW, which serves a dual purpose by providing the necessary electrical grounding in the event of lightning strikes with the additional feature of enabling telecommunication along the mainline, tap lines, and between substations. This telecommunication is critical to identifying problems, such as damage to the infrastructure from storm events or storm related outages, enabling NEP to respond quickly to any problems with the transmission of electricity. In addition, due to poor access along most of the ROW corridors, access improvements or re-establishment and construction of new access will be undertaken to conduct the proposed work and support future maintenance of the proposed infrastructure.

III. Consistency

Describe the project's consistency with state, municipal, regional, and federal plans and policies for enhancing energy facilities and services:

The Project, addressing asset conditions and the need for system improvements, includes refurbishment activities to the existing electrical structures, improvements to access, installation of stormwater management features, and the installation of six (6) vertical jumper switch structures. As a result, the Project will result in the following impacts with regard to enhanced energy facilities and services:

- ***Safe and reliable access to each transmission structure.***
- ***Reliable and continuous electricity supply for customers, including increased reliability during extreme weather events, such as storms.***
- ***Lowered probability of flashover of the insulation[17] during lightning strikes.***
- ***Enabling telecommunication along the transmission lines and between substations.***
- ***Capacity for transmission of electricity at 115 kV to accommodate forecasted regional and customer needs within the lifetime of the structures. This includes currently active and forecasted renewable energy resources in this region.***
- ***Support for future interconnections from renewable energy projects.***

These impacts align with the following regional, state, and municipal plans and policies for enhancing energy facilities and services:

- ***Federal***

The Project will provide more reliable and safe electric service in the region as well as create capacity for clean energy distribution in the future. The Energy Policy Act of 2005 provides specific incentives for the generation and use of clean energy sources such as wind power and tidal power. While much of the Act pertains to gasoline sales and production of oil and gas, the Project shows alignment with the provisions of the Act which foster the development of renewable energies and the development of an overall stronger energy infrastructure.

Additionally, the Project is consistent with the Inflation Reduction Act of 2022; while newly signed into law, various Inflation Reduction Act provisions incentivize consumers' use of clean energy to

17 An unintended high voltage electric discharge over or around an insulator, or sparking between two or more adjacent conductors that might cause frequent outages.

power their homes and vehicles while other provisions enable the reduction of greenhouse gas emissions. Therefore, the Project's goal of building capacity to provide more consumers with clean energy (which is classified as zero-emission) to power their homes and vehicles shows alignment with this federal policy.

- *State*

The Global Warming Solutions Act: On August 7, 2008, Governor Patrick signed into law the Global Warming Solutions Act ("GWSA"). The GWSA established aggressive greenhouse gas ("GHG") emissions reduction targets of 25% from 1990 levels by 2020 and 80% from 1990 levels by 2050. Pursuant to the GWSA, the Secretary of EEA issued the Clean Energy & Climate Plan for 2020 in December of 2010. Among other provisions, the GWSA obligates administrative agencies such as the EFSB, in considering and issuing permits, to consider reasonably foreseeable climate change impacts (e.g., additional GHG emissions) and related effects (e.g., sea level rise).

The Project will have no adverse climate change impacts or negative effects on sea levels. Consequently, the Project is consistent with the GWSA.

Massachusetts Clean Energy and Climate Plan: Pursuant to the GWSA, as amended in 2021 by An Act Creating A Next-Generation Roadmap for Massachusetts Climate Policy, the Secretary of the Executive Office of Energy and Environmental Affairs ("EEA") has adopted the interim 2025 statewide greenhouse gas emissions and the interim 2030 greenhouse gas emissions; the emissions limits increased to at least 50% below the 1990 baseline by 2030, at least 75% below the 1990 baseline by 2040, and at least 85% below the 1990 baseline by 2050. The Plan expresses the State's vision for a future in which there is minimal reliance on fossil fuels, as well as the State's confidence that Massachusetts can help lead the clean energy transition which will mean more well-paying jobs, improved public health, reduced consumer costs, and better quality of life for all residents. As the Project will increase capacity for transmission of energy from renewable sources, the Project is consistent with the 2025/2030 CECP.

An Act Driving Clean Energy and Offshore Wind: On August 12, 2022, Governor Baker signed An Act Driving Energy and Offshore Wind into law, which, among other provisions, set an offshore wind development minimum target. As the Project will increase capacity for transmission of energy from renewable sources such as wind energy, the Project is consistent with the Act.

- *Regional*

Regional Greenhouse Gas Initiative: In January 2007, Massachusetts joined the Regional Greenhouse Gas Initiative ("RGGI"), a cooperative effort by Northeast and Mid-Atlantic States to reduce CO2 emissions from large fossil-fueled power plants. In 2018, Massachusetts joined eight other states in developing amendments to revise the RGGI, including reductions to the regional cap and other programmatic changes. As the Project will increase capacity for transmission of energy from renewable sources, which do not produce carbon emissions as part of the electricity generation process, the Project is consistent with the RGGI.

- *Municipal*

The Green Communities Act: On July 2, 2008, Massachusetts Governor Deval Patrick signed into law the Green Communities Act. The Green Communities Act is a comprehensive, multi-faceted energy reform bill that encourages energy and building efficiency, promotes renewable energy, creates green communities, implements elements of the Regional Greenhouse Gas Initiative, and provides market incentives and funding for various types of energy generation. The Green Communities Act (as amended and supplemented by St. 2012, c. 209, An Act Relative to Competitively Priced Electricity) can be expected to result in greater renewable supplies and substantial new conservation initiatives in future years.

In order to achieve Green Community Designation, municipalities must meet five criteria: (1) Criterion 1 is met by passing zoning in designated locations for the as-of-right siting of renewable or alternative energy generating facilities, research and development facilities, or manufacturing facilities; (2) Criterion 2 is met by adopting an expedited application and permitting of one year at most, under which facilities interested in locating their facility in a designated renewable zone may be sites within the municipality; (3) Criterion 3 is met by (i) establishing an energy baseline inventory for municipal buildings and facilities, and (ii) adopting an Energy Reduction Plan demonstration a reduction of 20% of energy use after five years of implementation; (4) Criterion 4 is met if all departments within a Green Community purchase fuel-efficient vehicles for municipal use, whenever such vehicles are commercially available and practicable; and (5) Criterion 5 is met if municipalities minimize the life-cycle cost of all newly constructed homes and buildings.

Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, Athol, and Sterling are all designated Green Communities.

The improvements to the transmission system in the region will further the goals of the Green Communities Act by assuring reliable, efficient energy supply. The Project also supports the communities' interest in an energy supply from renewable energy sources. The Project, therefore, advances the important policy objectives of the Green Communities Act.

The Massachusetts Municipal Vulnerability Preparedness ("MVP") Grant Program : The MVP Grant Program was created in 2017, as result of Executive Order No. 569, signed by Governor Charlie Baker on September 16, 2016. The Program provides support for cities and towns in Massachusetts to identify climate hazards, assess vulnerabilities, and develop action plans to improve resilience to climate change. Communities that complete the MVP Planning Grant process become designated as an MVP Community and are eligible for MVP Action Grant funding to implement the priority actions identified through the planning process.

Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, Athol, and Sterling have all achieved MVP designation. All nine, through their planning processes, identified power outages as vulnerabilities in their communities. Additionally, some of the plans also addressed transitions to clean energy sources.

As the Project will increase reliability and decrease likelihood of outages during extreme weather events, as well as capacity for transmission of energy from renewable sources, the Project is consistent with MVP.

AIR QUALITY SECTION

I. Thresholds

A. Will the project meet or exceed any review thresholds related to **air quality** (see 301 CMR 11.03(8))? ___ Yes **X** _No; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **air quality**? ___ Yes **X** _No; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Solid and Hazardous Waste Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Air Quality Section below.

II. Impacts and Permits

A. Does the project involve construction or modification of a major stationary source (see 310 CMR 7.00, Appendix A)? ___ Yes ___ No; if yes, describe existing and proposed emissions (in tons per day) of:

	Existing	Change	Total
Particulate matter	________	________	________
Carbon monoxide	________	________	________
Sulfur dioxide	________	________	________
Volatile organic compounds	________	________	________
Oxides of nitrogen	________	________	________
Lead	________	________	________
Any hazardous air pollutant	________	________	________
Carbon dioxide	________	________	________

B. Describe the project's other impacts on air resources and air quality, including noise impacts:

III. Consistency

A. Describe the project's consistency with the State Implementation Plan:

B. Describe measures that the proponent will take to comply with other federal, state, regional, and local plans and policies related to air resources and air quality:

SOLID AND HAZARDOUS WASTE SECTION

I. Thresholds / Permits

A. Will the project meet or exceed any review thresholds related to **solid or hazardous waste** (see 301 CMR 11.03(9))? ___ Yes **X** No; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **solid and hazardous waste**? __Yes **X** No; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Historical and Archaeological Resources Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Solid and Hazardous Waste Section below.

II. Impacts and Permits

A. Is there any current or proposed facility at the project site for the storage, treatment, processing, combustion or disposal of solid waste? ___ Yes ___ No; if yes, what is the volume (in tons per day) of the capacity:

	Existing	Change	Total
Storage	________	________	________
Treatment, processing	________	________	________
Combustion	________	________	________
Disposal	________	________	________

B. Is there any current or proposed facility at the project site for the storage, recycling, treatment or disposal of hazardous waste? ___ Yes ___ No; if yes, what is the volume (in tons or gallons per day) of the capacity:

	Existing	Change	Total
Storage	________	________	________
Recycling	________	________	________
Treatment	________	________	________
Disposal	________	________	________

C. If the project will generate solid waste (for example, during demolition or construction), describe alternatives considered for re-use, recycling, and disposal:

D. If the project involves demolition, do any buildings to be demolished contain asbestos?

___ Yes ___ No

E. Describe the project's other solid and hazardous waste impacts (including indirect impacts):

III. Consistency

Describe measures that the proponent will take to comply with the State Solid Waste Master Plan:

HISTORICAL AND ARCHAEOLOGICAL RESOURCES SECTION

I. Thresholds / Impacts

A. Have you consulted with the Massachusetts Historical Commission? **X** Yes ___ No; if yes, attach correspondence.

See *Appendix I: Correspondence.*

For project sites involving lands under water, have you consulted with the Massachusetts Board of Underwater Archaeological Resources? ____Yes **X** No; if yes, attach correspondence

Not applicable.

B. Is any part of the project site a historic structure, or a structure within a historic district, in either case listed in the State Register of Historic Places or the Inventory of Historic and Archaeological Assets of the Commonwealth? **X** Yes __No; if yes, does the project involve the demolition of all or any exterior part of such historic structure? ___ Yes **X** No; if yes, please describe:

C. Is any part of the project site an archaeological site listed in the State Register of Historic Places or the Inventory of Historic and Archaeological Assets of the Commonwealth? **X** Yes ___ No; if yes, does the project involve the destruction of all or any part of such archaeological site? __Yes **X** No; if yes, please describe:

SWCA Environmental Consultants identified 102 inventoried historic properties and 12 historic areas in the Study Area of the Project. One property is eligible for listing in the NRHP due to its significance to the history of electric engineering and power transmission in New England. As the Project proposed to replace existing electrical structures with similar electrical structures, the Project is unlikely to cause an effect on this historic property.

SWCA Environmental Consultants initiated consultation with the MHC by submitting a Project Notification Form, a Cultural Resources Due Diligence Report, and a State Archaeologist's permit application. Additional testing was completed in 2022. None of the sites in Massachusetts are considered significant and no further survey was recommended. See Project Narrative, Section 6.

D. If you answered "No" to all parts of both questions A, B and C, proceed to the **Attachments and Certifications** Sections. If you answered "Yes" to any part of either question A or question B, fill out the remainder of the Historical and Archaeological Resources Section below.

II. Impacts

Describe and assess the project's impacts, direct and indirect, on listed or inventoried historical and archaeological resources:

As noted above, assessment of the Project's potential to adversely impact significant cultural resources is ongoing and NEP will continue to consult with the MHC to implement appropriate mitigation measures and continuing archaeological investigations.

III. Consistency

Describe measures that the proponent will take to comply with federal, state, regional, and local plans and policies related to preserving historical and archaeological resources:

NEP will coordinate with MHC such that the Project shall avoid adverse impacts to historic and/or prehistoric cultural resources to the greatest practicable extent. Should avoidance be impossible, NEP will consult with the MHC to implement appropriate mitigation measures and continuing archaeological investigations.

CLIMATE CHANGE ADAPTATION AND RESILIENCY SECTION

This section of the Environmental Notification Form (ENF) solicits information and disclosures related to climate change adaptation and resiliency, in accordance with the MEPA Interim Protocol on Climate Change Adaptation and Resiliency (the "MEPA Interim Protocol"), effective October 1, 2021. The Interim Protocol builds on the analysis and recommendations of the 2018 Massachusetts Integrated State Hazard Mitigation and Climate Adaptation Plan (SHMCAP), and incorporates the efforts of the Resilient Massachusetts Action Team (RMAT), the inter-agency steering committee responsible for implementation, monitoring, and maintenance of the SHMCAP, including the "Climate Resilience Design Standards and Guidelines" project. The RMAT team recently released the RMAT Climate Resilience Design Standards Tool, which is available here.

The MEPA Interim Protocol is intended to gather project-level data in a standardized manner that will both inform the MEPA review process and assist the RMAT team in evaluating the accuracy and effectiveness of the RMAT Climate Resilience Design Standards Tool. Once this testing process is completed, the MEPA Office anticipates developing a formal Climate Change Adaptation and Resiliency Policy through a public stakeholder process. Questions about the RMAT Climate Resilience Design Standards Tool can be directed to rmat@mass.gov.

All Proponents must complete the following section, referencing as appropriate the results of the output report generated by the RMAT Climate Resilience Design Standards Tool and attached to the ENF. In completing this section, Proponents are encouraged, but not required at this time, to utilize the recommended design standards and associated Tier 1/2/3 methodologies outlined in the RMAT Climate Resilience Design Standards Tool to analyze the project design. However, Proponents are requested to respond to a respond to a user feedback survey on the RMAT website or to provide feedback to rmat@mass.gov, which will be used by the RMAT team to further refine the tool. Proponents are also encouraged to consult general guidance and best practices as described in the RMAT Climate Resilience Design Guidelines.

Climate Change Adaptation and Resiliency Strategies

I. Has the project taken measures to adapt to climate change for all of the climate parameters analyzed in the RMAT Climate Resilience Design Standards Tool (sea level rise/storm surge, extreme precipitation (urban or riverine flooding), extreme heat)? **X** Yes __ No

Note: Climate adaptation and resiliency strategies include actions that seek to reduce vulnerability to anticipated climate risks and improve resiliency for future climate conditions. Examples of climate adaptation and resiliency strategies include flood barriers, increased stormwater infiltration, living shorelines, elevated infrastructure, increased tree canopy, etc. Projects should address any planning priorities identified by the affected municipality through the Municipal Vulnerability Preparedness (MVP) program or other planning efforts, and should consider a flexible adaptive pathways approach, an adaptation best practice that encourages design strategies that adapt over time to respond to changing climate conditions. General guidance and best practices for designing for climate risk are described in the RMAT Climate Resilience Design Guidelines.

A. If no, explain why.

B. If yes, describe the measures the project will take, including identifying the planning horizon and climate data used in designing project components. If applicable, specify the return period and design storm used (e.g., 100-year, 24-hour storm).

NEP has taken steps to promote climate change adaptation and resiliency in the design of the Project. The Project will result in a more climate-ready and resilient transmission system that can

withstand more extreme weather events; address existing system capacity shortages and increased demand; and support future interconnections from renewable energy projects. In addition, NEP's preferred solution uses substantial portions of existing ROW, thereby minimizing alteration of new land resources to construct the Project. See Project Narrative, Section 7.

C. Is the project contributing to regional adaptation strategies? **X** Yes __ No; If yes, describe.

All nine municipalities have achieved MA MVP designation. All nine identified power outages as a vulnerability in their communities during Community Resilience Building workshops and associated Summary of Findings reports and sought to identify ways to improve power utility resilience. Vulnerability due to high winds, snow and ice loads, and trees were common concerns resulting in frequent and/or long duration power outages. While this project does not address local distribution, transmission line and structure replacements are intended to result in a more reliable and resilient transmission system supporting these communities.

II. Has the Proponent considered alternative locations for the project in light of climate change risks?

___ Yes X No

A. If no, explain why.

The proposed Project location, within the existing ROW, is the only location that meets the identified Project need and reliability, addresses the various regulatory objectives, minimizes environmental impacts, and provides a cost-effective solution to customers. Also, the Project is located outside of areas identified as vulnerable to sea level rise and coastal flooding.

B. If yes, describe alternatives considered.

III. Is the project located in Land Subject to Coastal Storm Flowage (LSCSF) or Bordering Land Subject to Flooding (BLSF) as defined in the Wetlands Protection Act? **X** Yes ____No

If yes, describe how/whether proposed changes to the site's topography (including the addition of fill) will result in changes to floodwater flow paths and/or velocities that could impact adjacent properties or the functioning of the floodplain. General guidance on providing this analysis can be found in the CZM/MassDEP Coastal Wetlands Manual, available here.

The Project is not located within LSCSF; however, it is within areas of BLSF. Where new access roads are proposed within BLSF, the area will be over excavated resulting in no loss of flood storage. Concrete caisson foundations are proposed within BLSF. NEP will provide compensatory flood storage as required under state and local requirements. See Project Narrative, Section 12.

ENVIRONMENTAL JUSTICE SECTION

I. Identifying Characteristics of EJ Populations

A. If an Environmental Justice (EJ) population has been identified as located in whole or in part within 5 miles of the project site, describe the characteristics of each EJ populations as identified in the EJ Maps Viewer (i.e., the census block group identification number and EJ characteristics of "Minority," "Minority and Income," etc.). Provide a breakdown of those EJ populations within 1 mile of the project site, and those within 5 miles of the site.

Within the designated geographic area ("DGA") ("1-mile"), NEP identified 18 EJ Populations within five (5) municipalities, within Athol, Fitchburg, Gardner, Lancaster and Leominster. All these municipalities are located in Worcester County. Three (3) of these EJ Populations meet the EJ characteristic of "Minority and Income", six (6) EJ Populations meet the EJ characteristic of "Minority", and nine (9) meet the EJ characteristic of "Income".

Within 5-miles of the Project, NEP identified 65 EJ Populations within eight (8) municipalities, within Athol, Clinton, Fitchburg, Gardner, Lancaster, Leominster, Orange and Winchendon. All municipalities are located within Worcester County except for Orange and Winchendon which are part of Franklin County. 26 of these EJ Populations meet the EJ characteristic of "Minority and Income", 23 EJ Populations meet the characteristic of "Minority", 15 meet the EJ characteristic of "Income", and one (1) meets the characteristic of "Minority, Income and English Isolation". See the table below census block group identification number and EJ characteristics.

EJ Population Characteristics 1 and 5 Miles from A1/B2 Lines[18]

Distance from Project	Municipality	Census Track	Category	Minority Population %	Median Income	% Language Isolation
1 Mile	Athol	Block Group 1, Census Tract 7033	Income	3.5	$42,292: this is 49.3 % of the MA median.	1.2
		Block Group 2, Census Tract 7031	Income	5.5	$43,938: this is 51.2 % of the MA median.	1.8
		Block Group 1, Census Tract 7031	Income	8.4	$35,556: this is 41.4 % of the MA median.	2.3
		Block Group 3, Census Tract 7032	Minority	33.4	0$	0.0
5 Mile	Clinton	Block Group 3, Census Tract 7163	Minority and Income	51.3	$46,534: this is 54.2 % of the MA median.	8.6
		Block Group 2, Census Tract 7161	Minority and Income	38.2	$55,536: this is 64.7 % of the MA median.	0.0
		Block Group 3, Census Tract 7161	Minority	36.6	0$	0.0
		Block Group 2, Census Tract 7162	Minority and Income	25.5	$42,900: this is 50.0 % of the MA median.	7.8
1 Mile	Fitchburg	Block Group 2, Census Tract 7103	Minority	27.5	$62,353: this is 72.6 % of the MA median.	1.5

18 Data was obtained from https://www.mass.gov/info-details/massgis-data-2020-us-census-environmental-justice-populations

5 Mile	Fitchburg	Block Group 3, Census Tract 7105	Minority and Income	35.1	$50,163: this is 58.4 % of the MA median.	4.1
		Block Group 2, Census Tract 7105	Minority and Income	50.0	$ 27,031: this is 31.5 % of the MA median.	4.3
		Block Group 1, Census Tract 7105	Minority and Income	51.9	$54,931: this is 64.0 % of the MA median.	7.1
		Block Group 5, Census Tract 7106	Minority and Income	53.5	$44,175: this is 51.5 % of the MA median.	0.0
		Block Group 3, Census Tract 7108	Minority and Income	47.1	$28,750: this is 33.5 % of the MA median.	3.9
		Block Group 2, Census Tract 7108	Minority and Income	56.9	$37,188: this is 43.3 % of the MA median.	0.0
		Block Group 4, Census Tract 7101	Minority and Income	53.0	$48,227: this is 56.2 % of the MA median.	9.7
		Block Group 1, Census Tract 7104	Minority	51.7	$56,932: this is 66.3 % of the MA median.	4.4
		Block Group 4, Census Tract 7106	Minority	58.7	$86,168: this is 100.4 % of the MA median.	2.0
		Block Group 3, Census Tract 7106	Minority	56.8	0$	16.3
		Block Group 2, Census Tract 7107	Minority and Income	41.0	$18,958: this is 22.1 % of the MA median.	11.6
		Block Group 1, Census Tract 7107	Minority and Income	61.3	$12,418: this is 14.5 % of the MA median.	17.1
		Block Group 1, Census Tract 7108	Minority	40.3	$60,313: this is 70.3 % of the MA median.	15.3
		Block Group 2, Census Tract 7106	Minority	57.6	$80,526: this is 93.8 % of the MA median.	11.1
		Block Group 3, Census Tract 7110	Minority	54.2	0$	3.8
		Block Group 2, Census Tract 7110	Minority and Income	35.1	$49,517: this is 57.7 % of the MA median.	3.8
		Block Group 1, Census Tract 7110	Income	14.8	$51406: this is 59.9 % of the MA median.	0.0
		Block Group 1, Census Tract 7101	Minority	46.8	$75,714: this is 88.2 % of the MA median.	8.2
		Block Group 3, Census Tract 7101	Minority	42.4	$63,433: this is 73.9 % of the MA median.	1.5
		Block Group 1, Census Tract 7106	Minority and Income	52.3	$39,045: this is 45.5 % of the MA median.	2.8
		Block Group 4, Census Tract 7102	Minority and Income	34.8	$55,160: this is 64.3 % of the MA median.	3.4
		Block Group 2, Census Tract 7101	Minority and Income	71.7	$41,800: this is 48.7 % of the MA median.	0.0
		Block Group 1, Census Tract 7102	Minority	30.8	$90,078: this is 104.9 % of the MA median.	12.6
		Block Group 2, Census Tract 7102	Minority	25.7	$68,818: this is 80.2 % of the MA median.	3.10
1 Mile	Gardner	Block Group 1, Census Tract 7075	Income	13.9	$56,023: this is 65.3 % of the MA median.	4.7
		Block Group 2, Census Tract 7075	Minority	32.9	$63,401: this is 73.9 % of the MA median.	1.6
		Block Group 3, Census Tract 7075	Minority	34.3	$80,221: this is 93.5 % of the MA median.	0.0

		Block Group 1, Census Tract 7072	Income	18.4	$32,746: this is 38.1 % of the MA median.	4.9
		Block Group 1, Census Tract 7071	Income	0.6	$41,397: this is 48.2 % of the MA median.	1.3
		Block Group 3, Census Tract 7073	Minority and Income	40.4	$40,486: this is 47.2 % of the MA median.	0.0
		Block Group 2, Census Tract 7074	Income	17.5	$51,635: this is 60.2 % of the MA median.	0.0
		Block Group 1, Census Tract 7073	Income	21.4	$42,608: this is 49.6 % of the MA median.	3.9
		Block Group 2, Census Tract 7073	Income	14.3	$45,188: this is 52.6 % of the MA median.	1.2
5 Mile	Gardner	Block Group 2, Census Tract 7071	Income	23.8	$32,390: this is 37.7 % of the MA median.	1.5
1 Mile	Lancaster	Block Group 4, Census Tract 7131	Minority	29.6	$95,278: this is 111.0 % of the MA median.	0.0

1 Mile	Leominster	Block Group 2, Census Tract 7092.02	Minority and Income	40.4	$44,659: this is 52.0 % of the MA median.	10.1
		Block Group 3, Census Tract 7092.01	Minority and Income	30.3	$55,938: this is 65.2 % of the MA median.	2.8
		Block Group 1, Census Tract 7092.02	Minority	32.6	$59,896: this is 69.8 % of the MA median.	6.8
5 Mile	Leominster	Block Group 2, Census Tract 7092.01	Minority	31.4	$62,802: this is 73.2 % of the MA median.	0.0
		Block Group 3, Census Tract 7095.02	Minority and Income	38.4	$54840: this is 63.9 % of the MA median.	0.0
		Block Group 3, Census Tract 7092.01	Minority and Income	30.3	$55,938: this is 65.2 % of the MA median.	2.8
		Block Group 1, Census Tract 7097.01	Minority, Income and English Isolation	50.6	$41,506: this is 48.4% of the MA median.	31.8
		Block Group 2, Census Tract 7097.01	Minority	58.9	$62,551: this is 72.9 % of the MA median.	22.7
		Block Group 2, Census Tract 7095.02	Minority	30.3	$95,524: this is 111.3 % of the MA median.	2.1
		Block Group 3, Census Tract 7096	Minority and Income	55.6	$44,554: this is 51.9 % of the MA median.	10.8
		Block Group 1, Census Tract 7096	Minority	33.8	$70,000: this is 81.5 % of the MA median.	15.5
		Block Group 1, Census Tract 7094	Minority and Income	38.7	$22907: this is 26.7 % of the MA median.	19.5
		Block Group 1, Census Tract 7095.02	Minority	36.8	$84,188: this is 98.1 % of the MA median.	0.0
		Block Group 3, Census Tract 7091	Minority and Income	47.7	$47,934: this is 55.8 % of the MA median.	6.7
		Block Group 3, Census Tract 7092.02	Minority and Income	44.5	$35,500: this is 41.5 % of the MA median.	6.5

		Block Group 2, Census Tract 7094	Minority and Income	37.0	$52,140: this is 60.7 % of the MA median.	6.8

5 Mile	Orange	Block Group 1, Census Tract 405.01	Income	5.6	$50,35: this is 58.8 % of the MA median.	0.0
		Block Group 3, Census Tract 405.02	Income	7.6	$28,692: this is 33.4 % of the MA median.	0.0
		Block Group 2, Census Tract 405.01	Income	7.2	$49,805: this is 58.0 % of the MA median.	0.0
5 Mile	Winchendon	Block Group 3, Census Tract 7011	Minority	24.9	$97,803: this is 114 % of the MA median.	0.0
		Block Group 2, Census Tract 7011	Income	14.5	$38,542: this is 44.9 % of the MA median.	0.0

B. Identify all languages identified in the "Languages Spoken in Massachusetts" tab of the EJ Maps Viewer as spoken by 5 percent or more of the EJ population who also identify as not speaking English "very well." The languages should be identified for each census tract located in whole or in part within 1 mile and 5 miles of the project site, regardless of whether such census tract contains any designated EJ populations.

See the table below for all identified Census Tracts within 5 miles of the Project that have at least 5% of the Census Tract who do not speak English well. Spanish or Spanish Creole was identified as the Primary Language by 11 Census Tracts in three (3) municipalities.

Languages Spoken by at least 5% of the Census Tract Population[19]

Distance from Project	EJ or Non-EJ Populations	Municipality	Census Track	Language Spoken
5 Mile	EJ and Non-EJ	Clinton	7162	Spanish or Spanish Creole: 5.7%
5 Mile	EJ	Fitchburg	7105	Spanish or Spanish Creole: 10.2%
			7106	Spanish or Spanish Creole: 9.2%
			7108	Spanish or Spanish Creole: 9.2%
			7101	Spanish or Spanish Creole: 8.6%
			7107	Spanish or Spanish Creole: 13.9%
5 Mile	EJ and Non-EJ	Fitchburg	7104	Spanish or Spanish Creole: 5.7%
1 Mile	EJ	Leominster	7092.02	Spanish or Spanish Creole: 7.7%
5 Mile	EJ and Non-EJ	Leominster	7096	Spanish or Spanish Creole: 10.1%
			7097.01	Spanish or Spanish Creole: 6.6%
5 Mile	EJ and Non-EJ	Leominster	7094	Spanish or Spanish Creole: 11.6%

[19] Data for languages spoken was obtained from the American Community Survey 2011-2015 5-year estimates, Table B16001.

C. If the list of languages identified under Section I.B. has been modified with approval of the EEA EJ Director, provide a list of approved languages that the project will use to provide public involvement opportunities during the course of MEPA review. If the list has been expanded by the Proponent (without input from the EEA EJ Director), provide a list of the additional languages that will be used to provide public involvement opportunities during the course of MEPA review as required by Part II of the MEPA Public Involvement Protocol for Environmental Justice Populations ("MEPA EJ Public Involvement Protocol"). If the project is exempt from Part II of the protocol, please specify.

Not applicable.

II. Potential Effects on EJ Populations

A. If an EJ population has been identified using the EJ Maps Viewer within 1 mile of the project site, describe the likely effects of the project (both adverse and beneficial) on the identified EJ population(s).

The Project will occur within the existing ROW, thereby minimizing adverse environmental impacts. Due to the nature of the Project, outage constraints in the region, and NEP's efforts to reduce impacts to the natural and human environment, Project activities will be sequenced in both the mainline and tap lines. No long-term impacts on soil, bedrock, vegetation, surface water, groundwater, wetland resources or air quality will occur.

Short-term impacts related to construction are anticipated; however, through best management practices there are no anticipated adverse effects on on the identified EJ populations. Refer to Section 8.3.1.1 for the anticipated temporary impacts on Air Quality, Water Quality, Land Protection and Open Space, Noise, and Traffic and the proposed mitigation.

B. If an EJ population has been identified using the EJ Maps Viewer within 5 miles of the project site, will the project: (i) meet or exceed MEPA review thresholds under 301 CMR 11.03(8)(a)-(b) __ Yes **X** No; or (ii) generate 150 or more new average daily trips (adt) of diesel vehicle traffic, excluding public transit trips, over a duration of 1 year or more. ___ Yes **X** No

C. If you answered "Yes" to either question in Section II.B., describe the likely effects of the project (both adverse and beneficial) on the identified EJ population(s).

Not applicable.

III. Public Involvement Activities

A. Provide a description of activities conducted prior to filing to promote public involvement by EJ populations, in accordance with Part II of the MEPA EJ Public Involvement Protocol. In particular:

1. If advance notification was provided under Part II.A., attach a copy of the Environmental Justice Screening Form and provide list of CBOs/tribes contacted (with dates). Copies of email correspondence can be attached in lieu of a separate list.

Refer to Appendix H.

2. State how CBOs and tribes were informed of ways to request a community meeting, and if any meeting was requested. If public meetings were held, describe any issues of concern that were raised at such meetings, and any steps taken (including modifications to the project design) to address such concerns.

Per 301 CMR 11.05(4), Advance Notification of the Project was sent via electronic mail on June 14, 2022 by BSC to all contacts on the EJ Reference List, provided by the MEPA Office on February 23, 2022.

The Advance Notification consisted of the EJ Screening Form, as provided by the MEPA Office in the Public Involvement Protocol; a copy is provided in Appendix H. Efforts were made to ensure that language in the EJ Screening Form was understandable to the reader; that is, "technical" language was replaced with layperson terms, and legalese was omitted to the extent feasible.

NEP has undertaken measures to incorporate community involvement into the MEPA process. These community engagement strategies were determined based upon existing NEP stakeholder outreach methods and community engagement strategies provided in the Public Involvement Protocol. These involvement methods were discussed and supported by the MEPA Office during a Pre-Filing Consultation held on April 7, 2022.

A public website ("www.newenglandA1B2.com"), available in Spanish and English, is available which provides details of the Project, an interactive mapper, and contact information. This website address was also provided on the EJ Screening Form along with a contact number to request information or public meetings. Additionally, NEP hosted a virtual public meeting on July 11, 2022; information pertaining to this meeting was advertised in the Athol Daily News, Sentinel & Enterprise (Fitchburg and Leominster), Gardner Magazine and The Gardner News, Winchendon Recorder, Worcester Telegram & Gazette, and the Greenfield Recorder, and was also provided to the EJ Reference list via electronic mail and to the abutters of the A1/B2 Lines within EJ Populations via mail, see Appendix H. NEP contacted the town identified that fell within the 5% or more category to ensure that the languages spoken were not limited to Spanish. Given this information, the EJ Screening Form, meeting invitation and meeting invitation advertisement were translated into Spanish. Interpretation services were provided at the public meeting. For anyone who may have additional queries about the project an email address ("info@newenglandA1B2.com") has been provided to reach out with their concerns.

No issues were raised during the virtual public meeting.

3. If the project is exempt from Part II of the protocol, please specify.

Not applicable.

B. Provide below (or attach) a distribution list (if different from the list in Section III.A. above) of CBOs and tribes, or other individuals or entities the Proponent intends to maintain for the notice of the MEPA Site Visit and circulation of other materials and notices during the course of MEPA review.

Refer to Appendix H.

C. Describe (or submit as a separate document) the Proponent's plan to maintain the same level of community engagement throughout the MEPA review process, as conducted prior to filing.

NEP will maintain the distribution list of contacts from the EJ Reference List and any additional contacts that are identified during the virtual meetings and public engagement process. Contacts will receive notifications of the MEPA site visit, summaries of supplemental information submitted to the MEPA office and any other relevant notices or materials issued during the course of the MEPA review. NEP will continue to host a project website, which is available in Spanish. Repositories for hard copies of Project materials have been established at public libraries within each of the nine (9) municipalities within the Project Site in the Commonwealth of Massachusetts, which will be updated regularly as additional Project documents become available.

CERTIFICATIONS:

1. The Public Notice of Environmental Review has been/will be published in the following newspapers in accordance with 301 CMR 11.15(1):

(Name) Athol Daily News, Greenfield Recorder; Sentinel and Enterprise; Gardner News; Worcester Telegram and Gazette; The Item (Date) 9/9/2022 (All in same date)

2. This form has been circulated to Agencies and Persons in accordance with 301 CMR 11.16(2).

Signatures:

Date	Signature of Responsible Officer	Date	Signature of person preparing or Proponent ENF (if different from above)

Mike Tyrell	Heidi Graf
Name (print or type)	Name (print or type)
New England Power Company (NEP)	BSC Group Inc.
Firm/Agency	Firm/Agency
40 Sylvan Road	1 Mercantile Street, Suite 610
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Waltham MA 02451	Worcester, MA, 01608
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603-801-4140	617-896-4519
Phone	Phone

1.0 PROJECT OVERVIEW AND SUMMARY

1.1 INTRODUCTION

New England Power Company ("NEP") is proposing a refurbishment of the A1 and B2 69 kilovolt ("kV") double circuit overhead electrical utility lines ("A1/B2 Lines" or "the Lines"). The A1/B2 Lines are located within an existing Right-of-Way ("ROW") corridor which begins at Vernon #12 Switchyard in Vernon, Vermont, crosses through a portion of New Hampshire ("NH"), enters Massachusetts ("MA") in Warwick, and terminates at the Pratts Junction #225 Substation located in Sterling (refer to Figure 1 below). *Table 1* summarizes the approximate mileage of the entire A1/B2 ROW in each state.

Table 1: A1/B2 Lines by State

State	Municipality	Approx. Mileage
Vermont	Vernon	2.5
New Hampshire	Hinsdale and Winchester	4
Massachusetts	Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, Athol and Sterling	54
		Approx. Total – 60.5

In MA, the A1/B2 Asset Condition Refurbishment Project ("A1/B2 ACR" or "the Project") includes the complete refurbishment of the existing A1/B2 Lines, also referred to as the "mainline", and three (3) intersecting tap lines.

1.2 PROJECT NAME AND PROPONENT

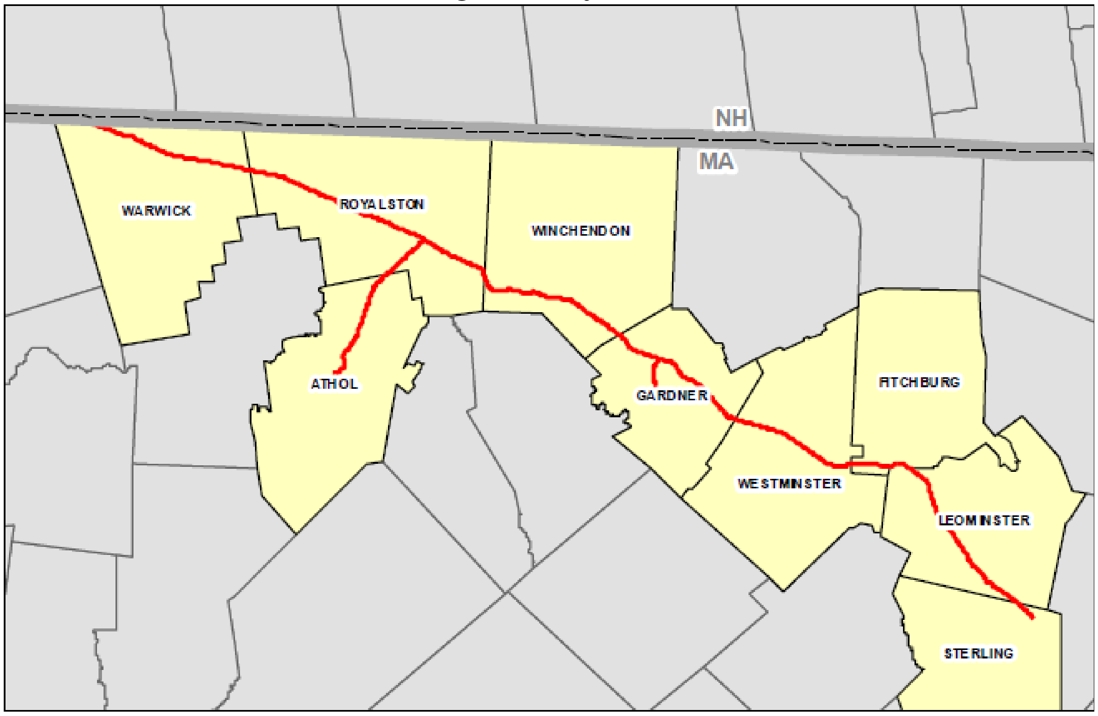
Project Name: A1/B2 Asset Condition Refurbishment Project in Massachusetts ("A1/B2 ACR Project", the "Project" or "A1/B2 ACR")

Project Proponent: New England Power Company ("NEP" or "the Proponent")

1.3 PROJECT LOCATION

All Project activities in MA will be located within the municipalities of Warwick, Royalston, Athol, Winchendon, Gardner, Westminster, Fitchburg, Leominster, and Sterling. Refer to the provided Environmental Resources Map in *Appendix A*. The Project ROW is generally oriented northwest-to-southeast from Warwick to Sterling, MA. The existing A1/B2 mainline consists of two (2) 69 kV overhead electric transmission lines ("wires") that are supported primarily on lattice towers ("structures"). The existing 69 kV tap lines consist of the existing Athol Taps 1 and 2 in Athol and Royalston, the existing Crystal Lake Tap in Gardener, and the existing East Westminster Tap in Westminster. Tap lines are comprised of wood pole structures.

Figure 1: Project Route



The A1/B2 ROW is generally 100-ft in easement width. However, in Sterling and Leominster, the A1/B2 Lines are co-located with the I135S/J136S Lines and the ROW is wider in these locations to accommodate required clearances, see *Appendix A: MEPA General Purpose Plans*. Along the Athol Tap Lines, the ROW is generally 125ft wide and the Crystal Lake Tap Line ROW is generally 100-ft wide. The East Westminster Tap is a two (2) structure Tap line located within the A1/B2 ROW. The Project ROW[1] is generally comprised of moderately level terrain, as well as steeply sloping river terraces and cliffs. Most of the upland within the maintained portion of the ROW consists of a closed-scrub and open heath communities interspersed with a herbaceous pioneering community. Where undeveloped, the vegetative community occupying the edge of the ROW is best characterized as typical southern New England transitional upland forest and forested wetland.

Adjacent land uses include agricultural, recreational, as well as commercial and residential development. The ROW crosses multiple reservoirs, rivers, ponds, as well as numerous streams and wetland systems in MA. Throughout the Project ROW there is some variation in drainage patterns, with shallow to bedrock areas creating a steep hydrologic gradient resulting with slope discharge wetland systems, but the ROW generally drains toward wetlands and streams located in the low-lying topography producing classic toe-of-slope wetlands along the Project route.

1.4 PROJECT NEED AND BENEFITS

Project Need: The A1/B2 Lines were originally constructed in 1909 and the original lattice structures remain. The Lines were reconductored in the 1920s and were reinsulated in 2004. The existing structures and wires are in need of replacement due to asset condition and aging infrastructure. In addition, the access conditions vary considerably throughout the ROW. Existing access is present in some areas, but in others,

1 Henceforth, Project ROW refers to the Mainline and Tap Line ROWs, unless otherwise noted.

the historic access route is in need of significant repair and does not meet NEP's standard to safely support specialized equipment. As such, the Project's primary objective is to complete the required system improvements to address the poor asset condition, mitigate potential risks of electrical failure, and to provide long-term reliable delivery of electrical service and maintenance of the line. As part of the proposed refurbishment, fiber optic ground wires will replace the existing shield wire to provide high speed communications between substations.

Secondarily, the initial results of the Independent System Operator – New England ("ISO-NE") 2050 Transmission Study ("Study") support upgrading the line to 115 kV. Since the Project proposes a complete refurbishment, all new or replacement structures will be constructed at a 115 kV capacity but operated at 69 kV. Based on current Study assumptions and forecasts, renewable energy connections and customer needs will ultimately require the system to operate at the higher voltage at some point in the future. In an effort to reduce the impacts of a large-scale refurbishment on the environment, the community and its customers, NEP proposes to "future proof" the A1/B2 Lines as part of this Project constructing lines with 115 kV capacity but operating the lines at 69 kV until the additional capacity is needed.

Project Benefits: The Project will improve transmission system infrastructure and comply with comprehensive regional plans for improving electric transmission reliability in New England. Benefits of the Project include the following:

- Increased resiliency of the mainline and tap lines. By installing improved foundations, more robust structures with improved lightning protection, and higher strength conductor and OPGW, the proposed infrastructure will be better suited to withstand strong winds and storm events.
- The new overhead lines will be larger in capacity and size which will allow more electricity to flow during times of high usage, such as extreme heat events, which are anticipated to increase in frequency due to climate change.
- The installation of OPGW will allow better communication between substations, resulting in improved response time during storm-related emergencies and outages, which will increase public safety.
- Designing for future needs reduces the frequency of disturbance to wetland resource areas, rare species habitat and adjacent landowners over time by reducing the likelihood of multiple repeat projects, thereby reducing environmental impacts and costs to NEP's customers.
- The comprehensive refurbishment will have the added benefit of allowing more renewable energy resources to connect into the system. Addressing the climate change crisis requires a major expansion of renewable energy and the infrastructure necessary to support and deliver that energy. NEP is actively taking steps to ensure that its system is ready to meet this critical challenge, and refurbishing aging infrastructure helps to accomplish this goal. Although the operation on the Line will remain at 69 kV for the foreseeable future, the 115 kV capacity proposed for the Project can support higher volumes of renewable energy resources in the future.

1.5 PROJECT DESCRIPTION

The Project includes various refurbishment activities and system improvements for 711 structures and the installation of six (6) new vertical jumper switch structures along the mainline and tap lines in MA. Activities will occur within an existing ROW and all efforts will be made to minimize the need for construction activities outside the easement. Access improvements or re-establishment and construction of new access, including vegetation removal, will be required to accommodate the proposed infrastructure. The full extent of the Project is shown in *Appendix A*.

To address the poor asset condition, The Project proposes the following activities:

- Replacement of 711 structures which will entail removing the existing structure and installing a replacement structure in an adjacent location. Based on the current Project design, it is anticipated 305 of the replacement structures will be on concrete caisson foundation, due to tension on the structure._The remaining 406 will be directly embedded into the ground and will not require caisson foundations.
- Installation of six (6) new direct embed vertical jumper switch structures along the tap lines.
- Reconductoring of all circuits with 795 Aluminum-conductor steel-supported conductor ("ACSS") and replacing existing shield wire with two (2) OPGWs. In certain situations where a replacement structure is proposed 25-ft or more from the existing structure, a temporary structure will be installed to facilitate the new structure, conductor and OPGW installations. Additionally, in approximately 30 locations, temporary structures may be required to increase the height of the conductor during construction so that construction vehicles and "live line" work (construction activities conducted while the overhead lines are energized) can occur at a safe distance from the conductor. The temporary structures will then be removed along with the existing structure.
- Realignment of approximately 5.2 miles of the A1/B2 mainline, where there is sufficient space to accommodate longer spans and fewer structures, as well as safer and more efficient construction methodologies. In this location, the mainline will be shifted approximately 41.5 ft north towards the existing I135S/J136S Lines.
- Vegetation removal to obtain a minimum horizontal clearance of 30-ft to the edge of ROW/easement under all weather conditions. On average, the existing cleared ROW is 85-ft, with the minimum cleared width being 75-ft and the maximum approximately 100-ft. The Project proposes clearing to 100-ft on the mainline and Crystal Lake Tap Line, and 125 ft on the Athol Tap Line to obtain the necessary horizontal clearance requirements.
- Construction of new and/or re-establishment of existing access roads to provide safe access for construction and the future operation and maintenance of the lines. Vegetation mowing on the ROW and tree removals will be required to accommodate construction access. Where necessary, grading and stormwater BMPs may be required to control runoff and mitigate erosion of the constructed access roads.

Additionally, due to outage constraints in the region, Project construction activities will be generally sequenced as follows:

- Vegetation Management
- Access road re-establishment/improvement
- Matting Installation
- Foundation Installation
- Installation of Pole Bases
- Installation of Pole Tops and Arms
- Installation of new conductor and OPGW on the A1 circuit
- Pulling of new conductor and OPGW on the B2 circuit
- Removal of existing structures
- Removal of temporary structures.
- ROW restoration where required

1.6 PROPOSED CONDITIONS

1.6.1. Structures

The existing Project ROW is currently used for utility activities, including existing utility structures, access roads, and active vegetation management. Structure improvements consist of replacing wood and steel suspension structures with direct embedded engineered steel structures. Wood and steel deadend structures will be replaced with engineered steel structures on larger caisson foundations. All new and/or replacement structures will be constructed at a 115 kV capacity and operated at 69 kV until customer needs dictate the system operate at a higher voltage.

All lines will be reconductored with 795 thousand circular mils ("kcm") ACSS 26/7 Drake conductor. The replacement and new structure height for the mainline and tap lines is approximately 93-ft above ground (110-ft direct embed structure), which is approximately twice as tall as the existing structures standing at 51-ft and 45-ft, respectively. Due to the outage constraints associated with the A1/B2 Lines, construction will occur with energized lines and utilize live line construction techniques. As such, the proposed replacement structures must be installed at a height above the existing structures that ensures worker and equipment safety.

The overhead structures currently support conductors in a triangular configuration along with one (1) shield wire at the top of the structure. The existing shield wire, which functions as lightning protection, will be replaced with two OPGWs to provide grounding and support high-speed relay and system communication requirements. This includes two (2) OPGW to be installed between the Vernon No. 12 Switchyard in Vernon, VT, and the Pratts Junction No. 225 Substation in Sterling, MA. Similarly, for the tap lines, OPGW will be installed from the Athol Tap Line to the Chestnut Hill No. 702 Substation and from the A1/B2 mainline to the Crystal Lake No. 607 Substation.

In East Westminster, the two (2) single span tap lines will be replaced with engineered steel H-Frame terminal structures on caisson foundations and reconductored with 795 kcm ACSS 26/7 Drake conductor. Six (6) new steel pole vertical jumper switch structures are proposed to be installed, one (1) in Winchendon and five (5) in Westminster. Due to the topographic constraints on the Athol Tap Line, the engineering team is evaluating the viability of installing new structures within the ROW. Reconfiguration of the existing structures may be necessary to facilitate the necessary upgrades.

1.6.2 Limit of Disturbance

Construction activities and materials will be confined to the Limit of Disturbance (LOD) as shown on the MEPA General Purpose Plans in *Appendix A.* The LOD zone represents the additional work area beyond the limits of grading which is also shown on the MEPA General Purpose Plans *in Appendix A.* Within the LOD, equipment access, the placement of temporary BMPs, soil stockpiling and equipment maneuvering is anticipated. In addition, where applicable, tree removals are preliminarily assumed within the LOD zone due to the anticipated secondary impacts from grading activities. Temporary construction matting is assumed to be utilized where access is necessary in wetlands. NEP is working toward solutions to reduce the extent of the LOD throughout the Project ROW. NEP will coordinate with landowners as necessary for temporary construction access as the plans are refined.

1.6.3. Vegetation Management

To provide a safe area for construction, future maintenance, and operation, and to ensure the reliability of the proposed lines, vegetation on the existing ROW will continue to be maintained to prevent the growth of tall woody species. In addition, to obtain the minimum horizontal clearance of 30-ft to the edge of ROW under all weather conditions, the existing cleared portion of the ROW will need to be expanded, as necessary. The existing maintained ROW on the mainline, the Crystal Lake Tap Line and the Athol Tap Line is roughly 85-ft, 75-ft, and 100-ft, respectively. To provide the necessary clearances for the replacement and new structures, the mainline and Crystal Lake Tap ROWs will be cleared to 100-ft, and the Athol Tap ROW will be cleared to 125-ft. Following the completion of construction, maintenance activities will be consistent with the Five-Year Vegetation Management Plan ("VMP") (2019-2023), and subsequent approved plans, presented in *Appendix D*.

1.6.4 Access Routes, Work Pads and Envelopes, and Pull Pads

1.6.4.1 Access Road Routes

Efforts were made during planning and design to align access with previously utilized roads or pathways along and adjacent to the ROW where feasible. Being among NEP's oldest assets, access conditions vary considerably throughout the ROW, in many cases, historic access roads/paths will require significant improvement to meet the access requirements for the Project. These roads are categorized as either "Standard Road Type 1-2" or "Designed Road Type 3-5" which includes the refurbishment of an existing access road, and Designed Road Type 3-5, which ranges from an entirely new road to a complete reconstruction of an existing access road. Unless otherwise noted on the MEPA General Purpose Plans presented in *Appendix A*, work pads/envelopes and pull pads will be graded and stoned as necessary to establish a level access.

Where existing access does not exist along the ROW, new access is proposed and categorized as either Standard Road Type 1-2 or Designed Road Type 3-5. New access in upland areas is assumed to include import, placement, and compaction of gravel to create a new road to access structures for construction. Standard Road Type 1-2, access roads include upland areas where the terrain is relatively level and will not require significant cut/fill to construct. In these areas, if required, soft surface material (e.g., topsoil) will be stripped and replaced with suitable gravel to provide a stable road base. If existing surface material is suitable as a base (e.g., sand/gravel), imported gravel will be placed without stripping existing surface material. Standard access roads may include stormwater Best Management Practices ("BMPs") to control runoff and mitigate erosion of the constructed access roads.

Designed Road Type 3-5, access roads are proposed where the existing terrain is steeper and will in-turn require additional cut/fill to construct. The limit of cut/fill associated with designed access roads is shown on the attached MEPA General Purpose Plans in *Appendix A*. In addition, designed roads include stormwater BMPs to control runoff and mitigate erosion of the constructed roads and/or adjacent slopes.

Stormwater BMPs such as swales, stone check dams, water bars, or other similar measures will be installed as necessary based on the access road design. These measures are intended to reduce adverse impacts from stormwater flows, maintain the longevity of the roads, and reduce overall maintenance needs. New access roads were sited within the existing ROW easement to the extent feasible; however, due to existing site constraints (e.g., steep slopes, rocky outcrops, proximity to wetland resource areas), some access routes are sited beyond the existing easement boundaries see MEPA General Purpose Plans in *Appendix A*. All new access roads (including those which extend beyond the existing easement) will be maintained by NEP.

1.6.4.2 Work Pads/Envelopes and Pull Pads

Work envelopes will be placed at all structures where work is proposed. Pull pads are required where reconductoring and OPGW pulling activities are proposed (see *Appendix A:* MEPA General Purpose Plans). Within wetlands and agricultural fields, construction matting will be utilized to provide a safe work area. In the remaining upland work areas, stone work pads will be constructed. In general, the work envelopes have been designed to be up to approximately 157-ft by 80 to 100-ft depending on the width of the ROW and extent of grading required to create the level work area and provide adequate space for the typical live line construction associated with the Project's scope of work. Similarly, pull pads may require grading or temporary construction mats in specific locations to support pulling of conductors and/or OPGW.

Work envelopes will be constructed to provide a stable and safe work area to conduct the proposed Project. Permanent work pad construction is proposed predominantly in upland areas (i.e., beyond the limits of Bordering Vegetated Wetland "BVW"). Given the steep and rocky terrain to effectively establish work envelopes at several of the structures extensive grading and establishment of retaining walls will be required in select locations. As shown in *Appendix A*, temporary work envelopes formed from construction matting will be utilized to the maximum extent practicable in wetland resource areas.

1.6.4.3 Retaining Walls

The majority of the proposed access road improvements, temporary pulling pads, and permanent gravel work pads will be constructed by cutting and/or filling existing grade as required to meet the design grade. However, there are several field conditions identified during design that warrant use of a retaining wall. The current design proposes retaining walls in the municipalities of Winchester, Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, and Athol (See MEPA General Purpose Plans on *Appendix A*). These walls are proposed to protect existing structures and/or features, as well as adjacent wetland resource areas, in areas where permanent work pads are required. Similarly, retaining walls are proposed along the limits of the ROW in areas where surface grading would encroach on abutting properties. This is especially critical in areas of state forests and other recreational lands.

The following types of retaining wall were considered to be appropriate for use on this Project. During construction, a retaining wall type will be selected based on local geotechnical conditions and other site constraints.

- Gabion Basket Retaining Wall (permanent installation)
- Large Block Gravity Retaining Wall (permanent installation)
- Mechanically Stabilized Earth ("MSE") Retaining Wall (permanent installation)
- Sheet Pile Retaining Wall (temporary/permanent installation)
- Construction Mat Retaining Wall (temporary installation)

1.7 SUMMARY OF IMPACTS

Table 2: Summary of A1/B2 Transmission Lines Refurbishment Impacts presents an overview of the impacts anticipated to result from the Project. As an active ROW, the Project area is already disturbed and maintained.

Table 2: Summary of A1/B2 Transmission Lines Refurbishment Impacts[2]

Resource Area	Temporary Impacts	Permanent Impacts[3]
New Land Altered: See *Section 3: Land Use*	No temporary impacts	Total permanent impact – approximately 216 acres • *Tree removal approximately 164 acres* • *New/improved access approximately 52 acres[4]*

2 Note that impacts located within the limits of Riverfront Area overlap with impacts to BLSF, BVW, and the 100-foot Buffer Zone. Therefore, the total impacts to the Project Site are not equal to the sum of alterations.

3 Work envelopes will consist of temporary construction matting within BVW and BLSF and will consist of gravel elsewhere. Where BVW and BLSF overlap with Riverfront Area, these impacts will be temporary; otherwise, work envelope construction will be permanent.

4 Calculated at a 12-ft wide travel lane.

Resource Area	Temporary Impacts	Permanent Impacts[3]
Bordering Vegetated Wetland ("BVW") See *Section 4: Wetlands and Wildlife*	Total Temporary – *approximately 2,200,651 sf (51 acres)*[5] • *Construction mats for access roads where BVW crossings could not be avoided.* • *Construction mats for construction work envelopes and pull pad work envelopes that overlap with BVW.* • *Construction mats within Limit of Disturbance only*[6]	Total Permanent – *approximately 667,928 sf (15 acres)* • *Fill for replacement structure foundations in BVW* • *Tree removal will result in conversion of PFO to PSS*
Other Wetland Resource Areas *See Section 4: Wetlands and Wildlife*		
Inland Bank ("Bank")	Total Temporary – *approximately 67,954 sf* • *Construction mats where access roads cross Bank.*[7]	Total Permanent – *approximately 26,572 sf* • *Selective tree pruning over portions of Bank that are currently forested.*[8]
Riverfront Area ("RA")	Total Temporary – *approximately 513,137 sf (12 acres)* • *Approved VMP activities only (mowing)* • *Construction mats for access roads, work pads and pull pad envelopes where RA overlaps with BVW, residential lawn or agricultural land.*	Total Permanent—*approximately* 2,101,679 *sf (48 acres)* • *New/or replacement structure foundations* • *Cut/fill for access roads, work envelopes, pull pads and retaining walls as identified on the MEPA General Purpose Plans* • *New/improved access roads* • *Stabilization material in improved/expanded sections of existing access roads.* • *Tree removal*
Bordering Land Subject to Flooding ("BLSF")[9]	Total Temporary —*approximately 13,939 sf* • *Approved VMP activities only (mowing)* • *Construction mats for access roads, work pads and pull pad envelopes where BLFS overlaps with residential lawn or agricultural land.*	Total Permanent—*approximately:* 389,517 *sf and 76.6 cubic yards ("cy") fill* • *Fill for structure foundations* • *Cut/fill for work envelopes, pull pads and access roads. Areas will be over-excavated so that no loss in flood storage occurs.* • *Tree removal*

5 Approximately 122 acres of BVW total in Project.
6 20-ft Limit of Disturbance is utilized for Project impacts as described above, except where retaining walls are constructed and the Limit of Disturbance is 10-ft.
7 In most cases, construction mat crossing will span the Bank of rivers and stream; however, the potential for alteration has been accounted for in the Project impact calculations.
8 Includes canopy removal for vegetation clearance for the overhead line and tree removals within the Limit of Disturbance
9 as identified on the MEPA General Purpose Plans. Work areas will be graded such that no flood storage is displaced. (~293,924 sf)

Resource Area	Temporary Impacts	Permanent Impacts[3]
Land Under Water ("LUW")	Total Temporary– *approximately 32,206 sf* • *Construction mats for access roads, work pads and pull pad envelopes where spanning open water was not feasible.*	Total Permanent – *approximately 158 sf* • *Fill for two (2) new/or replacement structure foundations*
Isolated Wetland	Total Temporary – approximately *73,181 sf (~1 acres)* • *Approved VMP activities only (mowing)* • *Construction mats for access roads, work envelopes, and pull pad work envelopes that overlap with Isolated Wetlands.*	Total Permanent - *approximately 11,840 sf* • *Fill for new/or replacement structure foundations in Isolated Wetlands* • *Tree removal will result in conversion of PFO to PSS.*
Resource Area	**Impacts**	
Waterways	Two (2) concrete foundations are proposed within a waterway along the Crystal Lake Tap in Gardner, MA. Temporary and permanent impacts to LUW are anticipated, see above. Waterways crossings do not involve structures within the waterways, and they will be designed to allow unimpeded access by foreseeable watercraft. No adverse impacts are anticipated from waterways crossings.	
Rare Species Impacts *See Section 5: Rare Species*	Rare Species may have potential impacts where construction-related activities occur within designated habitat. A "take" has the potential to occur due to road improvement activities; consultations with Natural Heritage and Endangered Species Program ('NHESP") are in progress to identify areas of concern, and to identify appropriate avoidance measures, which will be implemented, as required.	
Historical/ Archaeological Impacts *See Section 6: Historic and Archaeological Resources*	Historical/ Archaeological areas may have potential impacts where construction-related activities occur within areas of high archaeological sensitivity. Surveys are ongoing by SWCA Environmental Consultants to identify areas of concern, and to identify appropriate avoidance measures, which will be implemented, as required.	

1.8 SUMMARY OF MITIGATION

NEP follows a set of policies for ROW access, maintenance, and construction BMPs. By consistently implementing these procedures, NEP ensures that transmission lines are maintained and constructed by trained personnel in a manner that minimizes potential impacts to the environment, adheres to permit conditions, and meets industry standards. Key elements of the construction policy include pre-construction field investigations, field inspections during construction, and post-construction inspections.

Throughout construction, appropriate consideration will be given to Project implementation in a manner consistent with conditions of permits/authorizations and approved mitigation measures. (*See Section 12 and*

Appendix C). To minimize Project impacts, NEP has incorporated the following actions and considerations throughout the planning and design phases:

Several asset condition and reliability needs were combined into one Project scope in an effort to reduce the need for repeat disturbances to wetlands, other environmental resource areas and adjacent property owners in this shared ROW:

- Existing ROW and access roads are being used to avoid new land disturbance, where feasible;
- Field investigations were completed to assess constructability and avoid/mitigate sensitive resources;
- Agency consultations are in progress;
- Replacement structures are being located outside of BVW where feasible;
- Temporary construction mat BMPs will be utilized to minimize wetland impacts; and
- Work areas within wetlands will be temporary only; no permanent fill within wetlands is proposed for access, work envelopes or pull pads.

Additional mitigation measures are discussed in *Sections 3 through 11* of this Project Narrative and summarized in *Section 12: Mitigation Overview and Section 61 Findings*. Additional mitigation measures will be implemented as required by state, federal and local requirements. NEP anticipates that the final mitigation package will be developed during the federal, state and local permitting processes outlined in the next section, and that the package will fully address the required permit conditions and agency concerns. NEP anticipates that mitigation will demonstrate no net loss of existing wetland functions, values, and statutory interests within the watershed.

1.9 PROJECT ALTERNATIVES

Several project alternatives were analyzed and eliminated as they did not meet the Project needs. See *Section 2: Alternatives Analysis* for project alternatives.

1.10 PROJECT PERMITTING REQUIREMENTS

NEP will obtain all approvals and permits required by federal, state, and local agencies for the Project, and the Project will be constructed and operated to comply fully with state and local environmental policies (*See Section 11: Regulatory Compliance*). The Project will contribute to a reliable, low cost, diverse energy supply for the Commonwealth with minimal environmental impact. *Table 3: Permit/Consultation Requirements* summarizes the federal, state, and local permits and approvals required or potentially required for the Project in Massachusetts.

Table 3: Permit/Consultation Requirements

Agency	Permit/Review/Approval
Federal	
U.S. Army Corps of Engineers ("USACE")	Section 404 PCN Permit and consultations under Section 106 of National Historic Preservation Act and Section 7 of the Endangered Species Act
United States Environmental Protection Agency ("EPA")	National Pollutant Discharge Elimination System ("NPDES") General Permit for Stormwater Discharges and Construction Dewatering Activities/Stormwater Pollution Prevention Plan ("SWPPP")
State	
Executive Office of Energy and Environmental Affairs ("EEA")	MEPA Review/ Certificate of the Secretary
Massachusetts Department of Environmental Protection ("MassDEP")	Section 401 Individual Water Quality Certificate and Variance
Massachusetts Natural Heritage and Endangered Species Program ("NHESP")	Massachusetts Endangered Species Act – Determination of Take or No Take; Conservation Permit (if needed)
Massachusetts Historical Commission ("MHC")	Consultation under M.G.L. c. 9 in accordance with 950 CMR 70-71
Energy Facilities Siting Board ("EFSB")[10]	G.L. c. 164, §69J Petition for Approval to Construct Transmission Lines
Massachusetts Department of Public Utilities ("DPU")	G.L. c. 164, §72 Petition for Determination of Public Necessity and Convenience
Department of Conservation and Recreation ("DCR")	Construction Access Permit
Massachusetts Department of Transportation ("MassDOT")	Permit to Access State Highway/Non-Municipal Utility Permits for crossing over of state roads with utility lines.
Local	
Conservation Commissions in Athol, Fitchburg, Gardner, Leominster, Royalston, Sterling, Warwick, Westminster, and Winchendon	Order of Conditions per the Massachusetts Wetlands Protection Act ("MA WPA")[11] and local bylaws.
Fitchburg Commissioner of Public Works	Stormwater Permit
Fitchburg Tree Warden	Tree trimming/Removal Permit
Gardner Zoning Board of Appeals	Special Permit – Earthmoving & earth alteration
Royalston Conservation Commission	Stormwater Management Permit

10 Concurrently with its Petition to the Siting Board, NEP intends to file Petitions with the Department of Public Utilities (DPU) in accordance with G.L. c. 164, § 72 and requesting exemptions from the Zoning Ordinances of the communities pursuant to G.L. c. 40A, § 3, other than those noted above.
11 MA WPA Orders of Conditions are local permits unless and until a superseding Order of Conditions is issued by MassDEP.

Royalston Board of Selectmen	Written Permission for soil removal activities
Sterling Conservation Commission	Stormwater Management Permit
Sterling Zoning Board of Appeals	Earth Removal Permit
Westminster Zoning Board of Appeals	Earth Removal Permit
Winchendon Zoning Board of Appeals	Earth Removal Permit

1.11 CONSTRUCTION METHODS AND PROJECT SCHEDULE

Overall, NEP strives to design and implement projects to avoid or minimize adverse environmental impacts to the extent practicable. Where impact is unavoidable, minimization and mitigation techniques are employed. As such, NEP has developed procedures and policies to guide the professionals who plan and oversee implementation of Project construction. NEP's construction methods are summarized in *Section 10: General Transmission Line Construction Procedures*; please also refer to *Appendix C: National Grid Environmental Guidance Document ("EG-303NE")* for additional information on the general procedures and policies implemented during construction to identify and control environmental impacts.

NEP anticipates starting construction in 2025 which is anticipated to last at least a minimum of three years.

1.12 MEPA JURISDICTION

The Project is subject to MEPA review as it requires one or more state permits and exceeds the thresholds listed in *Table 4: MEPA Thresholds*.

Table 4: MEPA Thresholds

MEPA EIR Threshold
EIR: Land: *Direct alteration of 50 or more acres of land, unless the Project is consistent with an approved conservation farm plan or forest cutting plan or other similar generally accepted agricultural or forestry practices. (301 CMR 11.03(1)(a))*
EIR: Wetlands, Waterways and Tidelands: Alteration of one or more acres of bordering vegetated wetlands (“BVW”). *(301 CMR 11.03(3)(a)(1)(a))*
EIR: Wetlands, Waterways and Tidelands: *Alteration of ten or more acres of any other wetlands. (301 CMR 11.03(3)(a)(1)(b))*
EIR: Environmental Justice: *The Secretary shall require an EIR for any Project that is located within a Designated Geographic Area around an Environmental Justice Population. (301 CMR 11.06(7)(b)*
MEPA ENF Thresholds
ENF: Wetlands, Waterways and Tidelands: Alteration of 500 or more linear feet of bank along a fish run or inland bank. *(301 CMR 11.03(3)(b)(1)(b))* [12]
ENF: Wetlands, Waterways and Tidelands: Alteration of one half or more acres of any other wetlands. *(301 CMR 11.03(3)(b)(1)(f))*
ENF: Rare Species: Taking of an endangered or threatened species or species of special concern, provided that the Project site is two or more acres and includes an area mapped as a Priority Site of Rare Species Habitats and Exemplary Natural Communities. *(301 CMR 11.03(2)(b)(2)). (Potential-ongoing consultations.)*

This Expanded Environmental Notification Form (“EENF”) is being filed in accordance with 301 CMR 11.05(7) to provide more extensive and detailed information as part of a request for submission of a Single EIR, in accordance with 301 CMR 11.06(8).

The EENF Form included with this submission addresses all potential impacts of the Project. This narrative supplements the EENF Form and provides additional detailed information on those aspects of the Project that have the potential to adversely affect the environment and that are within the subject matter jurisdiction of the required or potentially required state permits:

- Land Use
- Wetlands and Wildlife
- Rare Species
- Historical and Archaeological Resources
- Environmental Justice Populations.

To the extent that the Secretary determines that the Scope should include additional information, we request that the information be addressed in the Single EIR.

12 In most cases, construction mat crossing will span the Bank of rivers and stream; however, the potential for alteration has been accounted for in the review of MEPA Thresholds.

1.13 SINGLE EIR OPTION

The Project exceeds the MEPA EIR threshold for Land alteration, BVW alteration, and is located within a designated geographic area around an EJ population. NEP respectfully requests that MEPA allow a Single EIR filing.

2.0 ALTERNATIVES ANALYSIS

2.1 INTRODUCTION

As noted in *Section 1*, this Project consists of refurbishment activities on the existing 69 kV Transmission Line along an existing ROW. NEP's overriding goal throughout the planning and design phases of the Project has been to select the alternative that best (A) meets the identified Project need and reliability, (B) addresses the various regulatory and permitting objectives, (C) including minimizing environmental impacts, and D) provides a cost-effective solution to customers. Several alternatives were evaluated. This alternative analysis presents a No Build Alternative and options for selective/targeted maintenance and improvements. None of the alternatives to the Project are feasible and meet the identified needs.

2.2 NO BUILD ALTERNATIVE

As required by 301 CMR 11.07(6)(f)(2), a No Build Alternative must be evaluated to establish a baseline against which the Project can be evaluated. However, in this instance, the No Build Alternative does not achieve the Project's goals and benefits.

This Project consists of refurbishment activities to existing assets. If no action is taken, deteriorating structures will pose a safety risk to NEP personnel and will affect NEP's ability to provide reliable electrical services to members of the public. Given the condition of the existing circuits and the need to provide high speed communications between the substations these circuits serve, this option was not pursued.

In summary, under the No-Build Alternative, the electric supply system in the region, would not comply with national and regional reliability standards and criteria. Given the asset condition of the existing circuits and pole deterioration, the no build alternative would leave the transmission system at risk resulting in severe reliability issues. Additionally, the no-build alternative does not satisfy the need to provide high speed communications between the substations these circuits serve. Therefore, the No-Build Alternative is not considered to be a feasible option.

2.3 CRITICAL ASSET REPAIR ALTERNATIVE

A critical asset repair alternative was considered to address only the most critical asset related issues. However, this would require returning to the A1/B2 Lines repeatedly to complete less critical maintenance and improvement activities. This would result in repeated access and temporary impacts including temporary construction matting, within Public Open Space and Recreational Areas, adjacent Watershed Areas, BVW and other environmental resources and rare species habitat. Additionally, this alternative would not address the quantity of asset condition concerns, would not improve the reliability of existing communications between the substations served by the circuits, and would result in inefficiencies in revisiting the same ROW within a short time span. This alternative was deemed infeasible and not analyzed further.

2.4 69 kV REBUILD ALTERNATIVE

As stated in *Section 1.4*, future proofing the Lines with a 115 kV carrying capacity allows NEP to minimize the likelihood of repeat impacts to adjacent landowners and environmentally sensitive areas as customer and renewable energy needs continue to grow in the region. Refurbishing the Lines to operate with a 69 kV carrying capacity would not meet the identified need and therefore, was not considered a feasible alternative.

Additionally, due to the outage constraints of the A1/B2 Lines, the Project would need to utilize live line construction techniques. As such, the proposed replacement structures would need to be installed at a height above the existing structures, regardless of proposed voltage. Should the existing structures be replaced to meet 69 kV standards, this would only result in a decrease of approximately 5.5-ft in structure height from those proposed. Therefore, the height standards for the required minimum horizontal clearance requirements would be the same at 69 kV as they are for the proposed 115 kV, and tree removal requirements on ROW would not be reduced. Refurbishing the Lines at 69 kV would not reduce environmental impacts and would not provide the benefit of operating the Lines at 115 kV in the future.

2.5 115 kV STRUCTURE DESIGN ALTERNATIVES

Double-circuit davit arms structures are proposed for the mainline and single-circuit davit arm structures are proposed for the tap lines. However, NEP evaluated alternative structures for both. In summary, for the A1/B2 mainline, alternative structure type, davit arm length and installation method were evaluated and excluded as infeasible due to increased footprint, ice jump condition[13], soil conditions and safe clearance distance, respectively. For the tap lines, alternative structure types were evaluated and excluded due to outage constraints, reliability concerns, and limiting risk of tree contact, respectively. The alternative structures evaluated, and the reason why the alternative was not selected and is not further analyzed, is given below in *Table 5.*

Table 5: 115 kV Structure Design Alternative Evaluated and Reasons for Elimination

	Alternative	Reasons for Elimination
Mainline	Two single circuit structures	Two single circuit structures were eliminated as the design for the mainline as it would have required an increase in work footprint, additional concrete caisson foundations, and doubled the number of steel poles required.
	7-ft Davit Arm	A 7-ft davit arm was evaluated and rejected for use along the mainline structures. This is due to the findings of the ice jumping study, which identified that a 10-ft middle davit arm is required to maintain adequate clearance during ice-shedding.
	Direct embed all structures	Direct embed structures were evaluated for all locations along the mainline. However, due to wide range of soil conditions on the ROW, the direct embed method will not be feasible at all locations. Where possible, structures will be direct embedded 10% of their height plus 6-ft. Where soil conditions do not support direct embed structures, concrete caissons will be utilized.
	Light Duty Steel Poles	Due to the proximity of the proposed A1 structure to the existing B2 line, the diameter of light duty poles would not maintain safe clearance distance.
Athol Tap	Delta davit arm configuration structures	The Athol Tap #2 Line was first proposed as delta configuration structures since the line is being rebuilt in place and will allow this type. This scope was changed to a vertical configuration to match the structures on the Athol #1 Tap. Reliability of inward facing circuits are believed to be better than delta by limiting risk of tree contact. 2 single circuit H-frames would require 150-ft of ROW width vs the proposed 125-ft total.

13 The maximum jump height of a transmission line after ice-shedding. Ice-shedding from conductors can cause significant vertical vibration of the transmission line.

		Vertical: both circuits will be the same height, better visually, would require taller structures and caisson foundations. Delta: Structures are shorter, but less visually pleasing. If skipping structures, direct embed foundations may be similar in cost to caisson foundations.
Athol and Crystal Lake Tap Lines	Double circuit structures	Because of reliability concerns associated with having both tap lines on the same structure, it was preferred to install single circuit structures.

2.6 PREFERRED ALTERNATIVE: COMPREHENSIVE REFURBISHMENT (THE PROJECT)

The Preferred Alternative, as described in *Section 1.5,* proposes various refurbishment activities and system improvements for 711 structures and the installation of six (6) new vertical jumper switch structures along the mainline and tap lines in MA. Access improvements or re-establishment and construction of new access, vegetation removal and the installation of OPGW is also proposed. Providing an efficient means of addressing asset condition concerns, replacing the deteriorating structures, and allowing high speed communications between substations, addresses the need without repeat impacts to wetland resource areas, rare species habitat, and adjacent homeowners. Therefore, this full-scale refurbishment meets all project objectives and reduces long term environmental impacts.

2.7 CONCLUSION

As described above, NEP analyzed the ability of several project alternatives to meet the identified needs. The No Build Alternative was rejected because it would not meet the identified need of addressing asset reliability and repair requirements. The Critical Asset Repair Alternative and the 69 kV Alternative would require supplemental projects (with additional environmental impacts) to adequately reinforce the A1/B2 Lines over the next decade. Access alone would result in approximately 49 acres of repeat temporary impacts to the same BVWs for each additional mobilization due to temporary construction matting. As such, the Project will best address the identified needs with the least impact to the natural and human environment.

3.0 LAND USE

3.1 INTRODUCTION

This section provides a description of existing land use along the Project ROW, as well as potential impacts and proposed mitigation measures associated with land alteration along the Project route. Existing conditions information for land use was obtained using MassGIS Standardized Assessors' Parcel Use Codes for each community.

The MEPA General Purpose Plans in *Appendix A* depict areas of proposed land alteration (e.g., structure locations, access roads, work envelopes, tree removals, etc.) associated with the Project.

3.2 EXISTING CONDITIONS

3.2.1 Land Use

The land area of the Project ROW is approximately 844.4 acres. Using current MassGIS data layers, land use characteristics were evaluated for the existing ROW and a 300-ft buffer on either side of the ROW.

Land use within the ROW and adjacent uses within 300-ft of the ROW edge consists of predominantly Exempt Property[14], with Residential being the second most common parcel designation. Because this Project is a refurbishment of an existing transmission line, area residents and businesses will benefit directly from the upgrades through increased system reliability. The land within the ROW has been actively utilized and maintained as a transmission line corridor since the 1910s. *Table 6* summarizes the MassGIS land use information for the ROW and adjacent uses within 300-ft of the ROW edge.

Table 6: Land Use

Land Use				
Land Use Type	**Acres Within ROW**	**% Within ROW**	**Acres Within 300ft Buffer**	**% Within 300ft Buffer**
Mixed Use	66.32	7.85%	264.08	5.89
Residential	234.62	27.79%	1434.17	31.96
Commercial	3.37	0.40%	43.33	0.97
Industrial	82.41	9.76%	349.90	7.80
Forest Property	32.21	3.81%	227.00	5.06
Agricultural/ Horticultural	2.01	0.24%	21.31	0.47
Recreational Property	1.47	0.17%	9.90	0.22
Exempt Property	391.65	46.38%	1933.12	43.08
Unknown	5.05	0.60%	19.31	0.43
Transportation	20.11	2.38%	143.48	3.20
Water	5.18	0.61%	41.66	0.93
Total	**844.41**		**4354.73**	

Source: MassGIS (Bureau of Geographic Information), June 2022. Used 2020/2021/2022 parcel data from each town and used their use codes as land use type. Percent rounded to closest 100th.

Exempt Property constitutes 46.38% within the ROW and 43.08% within the 300-ft buffer. This category of land use includes federal, state, and local land (municipal and authorities); charitable (hospitals, cemeteries); religious organizations (churches); and educational institutions. For this Project, Exempt

14 Exempt Property are properties that qualify from exemption from taxation under various provisions of the law and include public land and facilities, hospitals, schools, churches and cultural institutions, M.G.L. Chp. 59 §5.

Property is found along the ROW where the municipalities own most of the property. The DCR owns large acres of land around Leominster, Royalston, and Winchendon that fall within the 300-ft buffer. These lands comprise acres of state forests including Royalston State Forest, Warwick State Forest, Leominster State Forest, and Otter River State Forest. The Town of Leominster owns reservoirs and conservation lands that fall within the 300-ft buffer. Other Exempt Property includes conservation land such as Bailey Brook Conservation Area in the City of Gardner, Minnie French Conservation Area in Town of Athol, Nashua Valley, Elm Street and Hill Street Conservation Area in the City of Leominster, and Shenk Farm Conservation Area in the Town of Westminster. The U.S. Fish and Wildlife Service has Exempt Property in the municipalities of Athol, Royalston, and Westminster. Mount Wachusett Community College property is within a half mile buffer of the ROW, and the parking lot of the college is within 300-ft buffer in the City of Gardner.

Residential land use comprises just over 27% of the ROW, and approximately 32% of the 300-ft buffer. After Residential land use, the next highest category of land use is Industrial land use. Industrial land use comprises 9.76% of the ROW, and 7.80% within the 300-ft buffer.

After Residential and Industrial land uses, the next highest category of use is "Mixed Use". Mixed use constitutes over 7.85% of the ROW and 5.89% of the 300-ft buffer. These land uses are concentrated where the transmission ROW crosses major highways and primary roads. The Transportation category constitutes about 5.5% of the land use in the study area and includes highway and railroad corridors. These include State Highway Route 2, Massachusetts Bay Transportation Authority ("MBTA"), Fitchburg Railway, and DOT roads.

3.2.2. Sensitive Receptors

The 300-ft study buffer contains three (3) sensitive receptors – a fire station, a police station, and recreational land[15]. The town of Royalston has a police station and a fire station, located in the same building, within the 300-ft buffer. The distance from the edge of the stations to the 300-ft buffer is approximately 55-ft. The recreational land within the 300-ft buffer is located along Mellen Road, Winchendon. In addition, the Mount Wachusett Community College property parcel is located within the 300-ft buffer. The distance from the edge of the college parking lot to the edge of the ROW is approximately 150-ft. However, there are no Mount Wachusett Community College buildings within the 300-ft buffer.

3.2.3 Public Open Space

Public open space resources adjacent to the Project are listed in *Table 7*. The primary purposes of these protected lands include state parks and recreation, conservation, and habitat protection. Many of these areas provide year-round recreational opportunities such as hiking and nature study, and seasonal activities such as fishing. The majority of the open space areas located adjacent to the Project ROW provide scenic views and are often associated with rivers, reservoirs, wetlands, streams, rivers, and state forests.

Table 7: Open Space and Recreation Resources

Open Space and Recreation Resources[16]		
Municipality	**Site Name**	**Owner**
ATHOL	Millers River WMA	Department of Fish and Game
	Minnie French Conservation Area	Town of Athol
FITCHBURG	Leominster State Forest	DCR - Division of State Parks and Recreation

15 Recreation Land is Land that has been designated under Chapter 61B.
16 MassGIS (Bureau of Geographic Information); December 2021

GARDNER	Crystal Lake West	City of Gardner
	Municipal Golf Course	City of Gardner
	Bailey Brook Conservation Area	City of Gardner
	Gardner Water Supply Land	City of Gardner
	North County Land Trust CR	North County Land Trust
	Crystal Lake Cemetery	City of Gardner
LEOMINSTER	Nashua Valley Conservation Area	City of Leominster
	Notown Reservoir Watershed	City of Leominster
	Notown Reservoir	City of Leominster
	Fall Brook Reservoir	City of Leominster
	Notown Reservoir	City of Leominster
	Leominster State Forest	DCR - Division of State Parks and Recreation
	Cutler Conservation Area	City of Leominster
	Notown Reservoir	City of Leominster
	Elm Street Conservation Area	Leominster Land Trust
	City of Leominster CR/APR	City of Leominster
	Powers Lawrence APR	Powers Lawrence and Sharon
	Hill Street Conservation Area	Leominster Land Trust
ROYALSTON	Royalston State Forest	DCR - Division of State Parks and Recreation
	Chase Memorial Forest	New England Forestry Foundation
	Fish Brook WCE	Corser R.
	Jacobs Hill Reservation	The Trustees of Reservations
	Stockwell & Tully CR	Mount Grace Land Conservation Trust
	Chase Memorial Forest	New England Forestry Foundation
	Otter River State Forest	DCR - Division of State Parks and Recreation
	Davis Hill Farm CR	Longsworth Charles R and Mary O
	Lawrence Brook WCE	Byers Frank H.
	Millers River WMA	Department of Fish and Game
	Birch Hill WMA	Department of Fish and Game
	Tully Lake	Army Corps of Engineers
WARWICK	Jay CR	Jay Ralph L
	Warwick State Forest	DCR - Division of State Parks and Recreation
WESTMINSTER	Conservation Area	Town of Westminster
	Schenk Farm Conservation Area	Town of Westminster
	High Ridge WMA	Department of Fish and Game
	Tophet Swamp Conservation Area	North County Land Trust
WINCHENDON	Lake Dennison Recreation Area	Army Corps of Engineers
	Unnamed	Army Corps of Engineers
	Bailey Brook Conservation Area	City of Gardner
	Otter River State Forest	DCR - Division of State Parks and Recreation

3.3 LAND USE IMPACTS

As detailed in *Sections 1 and 2,* the proposed Project was selected to meet the identified refurbishment needs and minimize permanent impacts to environmental resources without repeat impacts to wetland resource areas, rare species habitat, and public open space. The majority of new land alteration will occur as a result of the construction of new access roads and the modification of previously existing access roads as necessary to facilitate the refurbishment effort and required tree removals to obtain required horizontal clearances from the edge of ROW under all weather conditions. This will result in approximately 216 acres of permanent disturbance. Within reason, the use of existing access roads and routes has been prioritized so as to reduce new alterations.

Proposed work includes refurbishment activities and system improvements for 711 structures and the installation of six (6) new direct embed vertical jumper switch structures along the mainline and tap lines in MA. Additional refurbishment work includes the installation of new conductor, insulators and associated hardware, and installation of OPGW along the entire length of the Project. Concrete caisson foundations will be installed at 305 structure locations; the remaining 406 structures will be installed via direct embed methods.

The means and methods of construction resulting in potential impacts and alterations is detailed in the sections below. The ROW and the existing access routes have been previously disturbed due to normal utility activities. Construction and operation of transmission lines and tap lines along the Project route will not conflict with or impact the use or accessibility of adjacent open space and recreational land, primarily because the proposed transmission lines will be located within an existing ROW.

3.3.1 DCR Property

The A1/B2 Lines, cross four (4) DCR Properties, the Leominster State Forest in Leominster and Fitchburg, the Royalston State Forest in Royalston, the Otter River State Forest in Royalston and Winchendon, and the Warwick State Forest in Warwick. NEP's easements for the A1/B2 Lines in these areas predate the establishment of DCR properties and state forests. *Table 8,* below, describes the parcel, structure segments and ROW area in each property. On ROW, these properties account for 78.54 acres of land, approximately 9.3% of the Project area.[17] NEP has initiated discussions with DCR.

17 Land Use Code 900, 901, 910, 920V classified as Article 97 State Property.

Table 8: Project Areas within DCR Property

Property	Municipality	Parcel Number	ROW Segment[18]	ROW Acreage[19]
Leominster State Forest	Fitchburg	S53 10 0	543 to 540	3.03
	Leominster	458_6	554 to 555	1.09
		458_7_A	553	1.09
		119R 7 A	555 to 550-2	3.84
Royalston State Forest	Royalston	10-50	249 to 248;	1.66
		6-2	248 to 237-1	3.92
Otter River State Forest	Royalston	15-31	323-1 to 316	6.14
		15-27	315 to 313	2.29
	Winchendon	10 0 3	325-1 to 323-1	0.78
		10 0 47	347 (south)	0.23
		10 0 48	347 to 346E	3.21
		N/A	347 (north)	0.32
		10 0 51	349 to 348	1.22
Warwick State Forest	Warwick	312/404.0-0000-0029.0	191 to 186	4.15
		312/404.0-0000-0026.0	186 to 177	8.48
		312/404.0-0000-0015.0	177-159	16.51
		312/403.0-0000-0001.0	159 to 149	13.96
		312/401.0-0000-0024.0	128 to 122	4.91
		312/401.0-0000-0019.0	119 to 114	4.96

These areas offer opportunities of recreational activities to local residents and visitors. Several multi-use trails intersect the existing ROW. DCR trails vary in type from Forest Roads and Trails with natural surfaces to processed gravel, varying in width and condition. The Project has been designed to utilize existing access within NEP easements wherever feasible; however, coordination with DCR will be required for improving existing access and constructing new access roads within State Forest lands. As is discussed in more detail in *Section 3.3.3.1.1* below, due to the complex, steep, and rocky terrain, proposed access routes were selected based on historic use, constructability, feasibility, and safety.

18 Structure numbers refer to existing number.
19 Rounded to the nearest 100th.

3.3.2 Vegetation Removal/Maintenance

To obtain the minimum horizontal clearance of 30-ft to the edge of ROW under all weather conditions, the existing maintained portion of the ROW will need to be expanded, as necessary. The existing maintained ROW on the mainline, Crystal Lake Tap Line and Athol Tap Line is roughly 85-ft, 75-ft and 100-ft, respectively. To provide the necessary clearances for the replacement and new structures, the mainline and Crystal Lake Tap ROWs will be cleared to 100-ft and the Athol Tap ROW will be cleared to 125-ft. It is anticipated that approximately 105 acres on ROW and 18 acres off ROW will be removed to meet the required horizontal clearances. Following the completion of construction, maintenance activities will be consistent with the Five-Year Vegetation Management Plan (2019-2023), and subsequent approved plans, presented in *Appendix D*.

Routine vegetation management will continue within the ROW in accordance with NEP's approved VMP, see *Appendix D*. This plan was completed in compliance with 333 CMR 11.00, as well as all applicable state and federal regulations that mandate the management of utility ROWs, including, but not limited to: all applicable clauses of Chapter 85 of the Acts of 2000; the Massachusetts Endangered Species Act (MESA) and its regulations 321 CMR 10.00; 310 CMR 10.00, and 310 CMR 22.00; applicable Federal Regulatory Commission standards including NERC Standard FAC-003-5, Commissioner Order 693, and all applicable Federal Occupational Safety and Health Act, Department of Transportation and Department of Environmental Protection regulations.

As part of an Integrated Vegetation Management ("IVM") program, NEP's professional arborists oversee the uses of mechanical, natural, and chemical (herbicide application) methodologies when considering controls to maintain a ROW. Trained and licensed herbicide applicators use hand-held equipment under the direct supervision of certified supervisors/foremen. Vegetation management is necessary to ensure safe, reliable delivery of electric service through the transmission and distribution lines located on NEP ROWs. Tall growing tree species must be prevented from growing into or falling onto the lines. Dense woody vegetation, vines, invasive, and poisonous vegetation is removed from around structures, access roads, and anywhere in which they prevent access to the ROW for inspections, maintenance, repairs and emergency access to the lines. Mitigation measures are incorporated into the VMP procedures, and no significant adverse impacts are anticipated because of VMP implementation. Tree removal is also necessary to facilitate the construction of off-ROW access roads.

Table 9 summarizes the extent of tree/vegetation removal for the proposed Project.

Table 9: Summary of Estimated Tree Removal in MA[20]

Tree Removal Location	Approximate Acres on ROW	Approximate Acres Off ROW
Project Wide in MA	109	55
Wetlands	14	2
Riverfront Area[21]	14	3
Open Space	50	9
State Article 97 Land (DCR Property)	18	1
Municipal Article 97 Lands	10	2
Private Article 97 Lands	2	< 0.25
Federal Property	2	3
Land Trust Property	3	< 2
DFW/WMA	14	1

3.3.3 Access Routes, Work Pads/Envelopes and Pull Pads

3.3.3.1 Access Road Routes

As detailed in *Sections 1.6.1,* historic access roads/paths will require significant improvement to meet the access requirements for the Project and are categorized as either Standard Road Type 1-2 or Designed Road Type 3-5 as shown on the MEPA General Purpose Plans in *Appendix A*.

A summary of proposed access route types along with its impacts on ROW and off ROW is provided in *Table 10*. In addition, on ROW, the anticipated limit of cut/fill area is approximately 266 acres and off ROW is approximately 12 acres. Below are the summarized quantities of proposed access route types within the Commonwealth of Massachusetts.

Table 10: Summary of Proposed Access Routes

Type	Quantity on ROW	Quantity on off ROW
Standard Road Type 1 & 2 (lf)	875	6,309
Designed Road Type 3-5 (lf)	161,023	18,821
Existing (lf)	7,121	42,721
Temporary Construction Matting[22] (sf)	3,419,471	300,156

3.3.3.1.1 Access Within DCR Properties

As discussed in *Section 3.3.1*, the existing ROW traverses the Leominster, Otter River, Royalston and Warwick State Forests. These properties are owned, maintained, and managed by DCR. The proposed Project will involve the construction of approximately 8 lf of Standard Road Type 1 & 2 on ROW, and

20 Tree clearing amount was calculated by totally tree clearing for clearance with the conductor and tree clearing associated with the limit of disturbance.

21 Tree clearing approximations determined by GIS analysis of TLE Lidar imagery, ROW Survey and Riverfront Area Polygons.

22 Include matting for work envelopes, pull pads, access road and limit of disturbance matting in BVW and Isolated Wetlands, residential lawns and agricultural fields.

approximately 533 lf off ROW within the Warwick State Forest. No Standard Road Type 1 & 2 are proposed with the Leominster, Otter River, or Royalston State Forests.

The proposed Project will involve the construction of approximately 24,603 lf of Designed Road Type 3 – 5 within the ROW on DCR Property, and approximately 4,094 lf off ROW within the aforementioned DCR properties. As noted in *Section 3.3.3* above, wetland areas will be crossed using temporary construction matting. The following table, *Table 11,* summarizes impacts by access road type within the boundaries of DCR-owned properties.

Table 11: Summary of Project Impacts Within DCR Properties (as noted below)

Activity	Quantity[23]			
	On ROW		Off-ROW	
	Linear Feet	Square Feet	Linear Feet	Square Feet
Leominster State Forest				
Standard Road Type 1 & 2	N/A	N/A	N/A	N/A
Designed Road Type 3 - 5	3,096	37,152	2	24
Existing	N/A	N/A	N/A	N/A
Matting (Temporary)[24]	1,508	24,123	N/A	N/A
Royalston State Forest				
Standard Road Type 1 & 2	N/A	N/A	N/A	N/A
Designed Road Type 3 - 5	1,055	12,660	524	8,384
Existing	N/A	N/A	N/A	N/A
Matting (Temporary)	794	12,705	16	262
Otter River State Forest				
Standard Road Type 1 & 2	N/A	N/A	N/A	N/A
Designed Road Type 3 - 5	5,036	60,432	14	168
Existing	N/A	N/A	N/A	N/A
Matting (Temporary)	3,034	48,544	N/A	N/A
Warwick State Forest				
Standard Road Type 1 & 2	8	96	533	6,396
Designed Road Type 3 - 5	15,416	184,992	3,553	42,636
Existing	23	276	3,625	43,500
Matting (Temporary)	8,550	136,797	1,442	23,067

23 SF of standard road, designed road and existing calculated with a travel width of 12-ft. Existing road or access are those that does not require improvements or modifications.
24 Includes matting for work envelopes, pull pads, access roads and limit of disturbance matting.

3.3.3.1.2 Off-ROW Access Routes

The majority of the access routes leading onto the ROW are already established (i.e. from existing public ways, parking lots, or gravel pits). However, in nine (9) municipalities off-ROW land will be utilized for access. Most of these areas are off-ROW access routes where construction vehicles will use existing (unpaved) access roadways with improvements, as needed, or use re-established access routes that have more recently gone unused. There are several areas where off-ROW access roads will be established.

Where access roads exist, they generally have an 8-ft-wide travel lane. All off-ROW access roads are in uplands and upland portions of these access routes will be maintained after the Project is completed to allow for maintenance equipment to access the site, although actual post-construction conditions will be determined by NEP's agreements with individual property owners.

3.3.3.2 Work Pads/Envelopes and Pull Pads

Work envelopes will be placed at all structures where work is proposed. Work envelopes are necessary to accommodate the removal of existing structures, installation of new or replacement structures and their appurtenant features. Similarly, pull pads are being used to install new conductor, overhead transmission wire and OPGW. Pull pads are necessary to stage equipment being used to install new conductor and OPGW (see *Appendix A:* MEPA General Purpose Plans).

Temporary construction matting will be placed in locations where access is required to cross wetland resource areas. As the majority of the terrain throughout the ROW is rocky, uneven, and steep, the relocation of boulders[25] may be warranted to ensure safe mat placement. Relocated boulders will remain on-site (i.e., within the A1/B2 Lines existing easement). Within wetlands and agricultural fields, construction matting will be utilized to provide a safe work area. In the remaining upland work areas, stone work pads will be constructed. In general, the work envelopes have been designed to be up to approximately 157-ft by 80 to 100-ft depending on the width of the ROW and extent of grading required to create the level work area and provide adequate space for the typical live line construction associated with the Project's scope of work. The use of construction mats minimizes the need to remove vegetation beneath the access way and reduces the degree of soil disturbance and rutting in soft soils. Typical construction mats used by NEP are comprised of wooden timbers bolted together into 4-ft by 16-ft sections, wooden lattice mats, or composite mats. Similarly, pull pads may require grading or temporary construction mats in specific locations to support pulling of conductors and/or OPGW. Refer to EG-303NE in *Appendix C* for additional details. Approximately 2,200,651 sf of temporary construction matting within wetlands is anticipated for this Project.

3.3.3.3 Limit of Disturbance

It is anticipated that construction activities and materials will be confined to the LOD as shown on the MEPA General Purpose Plans in *Appendix A,* as described in *Section 1.6.2*. Within the LOD, equipment access, the placement of temporary BMPs, soil stockpiling and equipment maneuvering is anticipated. In addition, where applicable, tree removals are preliminarily assumed within the LOD zone due to the anticipated secondary impacts from grading activities. The proposed LOD overlaps with approximately 5 acres of DCR property. There is no disturbance or grading anticipated outside of the NEP's easement on DCR property for the construction of work envelopes, and pull pads; however, there are existing trails that are being improved outside of the ROW.

25 Boulders vary in size from small to large stones.

The proposed LOD occupies 141 acres within the ROW and approximately 55 acres off ROW, excluding temporary construction matting which will be utilized with wetlands, residential lawns, and agricultural areas. NEP will coordinate with landowners to obtain temporary construction access, as necessary. Due to the land use constraints within Article 97 lands, construction access will be limited to the easement. As the Project design advances modifications, such as adding additional retaining walls, may be necessary to stay within the confines of the easement.

3.4 MITIGATION MEASURES FOR LAND

The Project design reflects NEP's significant efforts first to avoid and then to minimize adverse impacts to the land surrounding the Project site to the extent practicable. For example, NEP located the Project entirely within an existing ROW. Where feasible, the new foundations will be located to avoid adverse impacts. Also, the proposed design locates proposed structures in proximity to existing structures, whenever feasible; places proposed structures so that the transmission wires span several resource areas; clears vegetation only where necessary for safe operation; and utilizes existing/upland roadways for construction purposes. Overall, the Project is not expected to change or significantly impact land uses within the ROW or areas within 300-ft of the ROW during construction or operation as it is an existing transmission line.

NEP will submit a Stormwater Pollution Prevention Plan ("SWPPP") for the Project in compliance with the EPA's National Pollutant Discharge Elimination System ("NPDES") program under the Stormwater Construction General Permit. The SWPPP establishes a construction period contact list, presents a description of the proposed work, and identifies stormwater controls, spill prevention, and inspection practices to be implemented for the management of construction-related stormwater discharges from the Project. The SWPPP clearly identifies parties responsible for monitoring and reporting any activities out of compliance with the SWPPP or other environmental permits or approvals, and for handling extraordinary situations. The SWPPP also defines monitoring to occur until all disturbed areas on the site have been stabilized using standard BMPs. In this manner, the potential impacts associated with land disturbance (e.g., erosion and sedimentation) will be proactively managed so that impacts can be avoided. See *Section 12: Mitigation and Section 61 Findings*.

4.0 WETLANDS AND WILDLIFE

4.1 INTRODUCTION

Vanessa Hangen Brustlin, Inc ("VHB") and BSC Group, Inc. ("BSC"), as consultants to NEP, delineated wetland resources along the Project route between Spring 2020 and Summer 2021, and Spring 2022. During the field investigations, 462 wetland areas and 128 streams were identified and delineated within MA. Since this Project consists of existing transmission assets, wetland resource areas cannot be completely avoided. In these instances, appropriate mitigation measures will be provided.

This section presents an overview of the identified and delineated wetlands and waterways along the Project route. Additional information and photographs are presented in *Appendix E: Supplemental Wetlands Information*. This information has been used by the design team to avoid, minimize, and/or mitigate work within sensitive resource areas as well as evaluate Project-related impacts.

4.2 PRELIMINARY DATA REVIEW

Before the start of the wetland field investigations/delineation, existing information was reviewed regarding the presence or absence of wetlands within the ROW. These source materials included:

- USGS Topographic Maps
- USGS Color Ortho Imagery (various years)
- U.S. Fish & Wildlife Service National Wetlands Inventory ("NWI") MassGIS Datalayer
- MassGIS MassDEP Wetlands 1:12,000 Datalayer
- MassGIS 2021 Natural Heritage and Endangered Species Program ("NHESP") Priority Habitats of Rare Species Datalayer
- MassGIS 2021 NHESP Estimated Habitats of Rare Wildlife Datalayer
- MassGIS NHESP Certified Vernal Pools Datalayer
- MassGIS NHESP Potential Vernal Pools MassGIS Datalayer
- MassGIS FEMA ("Federal Emergency Management Agency") Q3 Flood Datalayer and FEMA Flood Insurance Rate Maps
- MassGIS Soils Datalayer

This information was synthesized and used in the field to assist wetland scientists in the location and identification of wetland systems along the Project route.

4.3 WETLAND DELINEATION METHODOLOGY/PROCEDURE

Surveys for wetland resource areas were conducted within the existing transmission line ROW and off ROW access route proposed locations in the municipalities of Warwick, Royalston, Athol, Winchendon, Gardner, Westminster, Fitchburg, Leominster, and Sterling. Field teams used established delineation procedures as outlined in the Massachusetts Department of Environmental Protections Handbook on Delineating Bordering Vegetated Wetlands (March 1995) ("DEP Handbook") and U.S. Army Corps of Engineers ("USACE") Wetland Delineation Manual ("Environmental Laboratory, January 1987") ("1987 Manual") and the USACE Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region ("USACE Supplement") (2012). An excerpt of VHB's Wetland Delineation Report specific to wetlands identified in Massachusetts along with photographs is presented in *Appendix E: Supplemental Wetlands Information*.

4.4 WETLAND RESOURCE AREAS

The Project is located within three (3) major watersheds including the Connecticut, Millers, and Nashua Watersheds. Of the three (3) watersheds intersected by the transmission line and tap lines, the largest is the Connecticut Watershed (11,260 square miles) and the smallest is the Millers River Watershed (392 square miles). The majority of the Project area is located within the Millers River Watershed.

The Connecticut Watershed is comprised of 11,260 square miles of wetlands, connecting 148 tributaries, including 38 major rivers and several lakes and ponds. The Miller River Watershed is comprised of 390 square miles of wetlands, about 313 square miles of which are in Massachusetts, connecting 107 lakes and ponds. The Nashua River Watershed is comprised of 538 square miles of wetlands, about 454 square miles of which are in Massachusetts, connecting six (6) major tributaries.

4.4.1 Waterways

On ROW, 37 intermittent streams and 55 perennial streams were identified during the delineation of the A1/B2 Lines. Off-ROW, 23 intermittent streams and 13 perennial streams were identified. There are 15 streams that have been designated by the Massachusetts Division of Fisheries and Wildlife ("DFW") as significant cold-water resources. These include: Pauchaug Brook, Kidder Brook, Collar Brook, Fish Brook, Tully Brook, East Branch Tully River, Lawrence Brook, Boyce Brook, West Gulf Brook, Mellen Brook, Bailey Brook, Fall Brook, Slack Brook, Burnt Mill Pond Brook, and Lemerise Brook. Other named perennial watercourses include Fish Brook, Beaver Brook, Miller's River, Beaman Brook, Wilder Brook, Parlay Brook, Foster Brook, and Reservoir Brook.

Stream substrates vary from stream to stream, and are comprised of boulder, cobble, gravel, sand, silt, and organic bottoms. Bank widths are also variable ranging from 0 to 60-ft in width.

According to the Massachusetts Surface Water Quality Standards and Classifications (Regulations 314 C.M.R. 4.00) there were multiple Class A and Class B waters within the delineation scope. Class A waters identified included: Richard Reservoir, Fish Brook, Perley Brook, Burn Millpond Brook, Notown Reservoir, Goodfellow Brook, Black Brook, and Fall Brook Reservoir. Class B waters identified included Tully Brook, Collar Brook, East Branch Tully River, Boyce Brook, Beaver Brook, Otter River, Millers River, and Wilder Brook.

Work is proposed within Outstanding Resource Waters ("ORWs"). Structure replacements, both steel direct embed structures and caisson foundations, temporary construction mat access and work envelopes are proposed within wetlands mapped as ORW associated with Goodfellow Pond, Simonds Pond, Notown Reservoir, Distributing Reservoir, Morse Reservoir, Fall Brook Reservoir, and Perley Brook Reservoir. Fall Brook Reservoir and Notown Reservoir are Class A Public Water Supplies (Class A Surface Water Source).

4.4.2 Wetland Characterization

The existing overhead transmission line ROW contains a variety of wetlands, most of which have been historically affected by the routine vegetation management for the safe operation of the transmission facilities. These wetlands typically consist of scrub-shrub, emergent marsh, or wet meadow communities. In accordance with the federal classification system found in Cowardian (1979), the following wetland community types were identified on the existing ROW:

Table 12: Wetland Community Types by Municipality

Cowardian Classification	Municipality								
	Warwick	Royalston	Athol	Winchendon	Gardner	Westminster	Fitchburg	Leominster	Sterling
Palustrine Emergent Persistent/Non-Persistent Seasonally Saturated (“PEM1B/PEM2B”)								X	
Palustrine Emergent Non-Persistent Seasonally Saturated/Seasonally Flooded (“PEM2B”)				X	X				X
Palustrine Emergent Non-Persistent Seasonally Saturated/Seasonally Flooded (“PEM2B/2C”)	X								
Palustrine Emergent Non-Persistent Seasonally Flooded/Permanently Flooded (“PEM2B/2Hb”)						X			
Palustrine Emergent Non-Persistent Seasonally Saturated/Seasonally Flooded/Semi-Permanently Flooded (“PEM2B/2C/2E”)		X							
Palustrine Emergent Non-Persistent Seasonally Saturated/Seasonally Flooded (“PEM2B/2C/2Fb”)			X						
Palustrine Emergent Persistent Seasonally Flooded (“PEM1C”)									
Palustrine Emergent Non-Persistent Seasonally Flooded (“PEM2C”)							X		
Palustrine Scrub Shrub Broad-leaved Deciduous Seasonally Saturated (“PSS1B”)			X			X			X
Palustrine Scrub Shrub Broad-leaved Deciduous Seasonally Saturated/Seasonally Flooded (“PSS1B/1C”).	X						X	X	
Palustrine Scrub Shrub Broad-leaved Deciduous Seasonally Saturated/Seasonally Flooded/Semi-Permanently Flooded (“PSS1B/1C/1E/1F”)		X			X				
Palustrine Scrub Shrub Broad-leaved Deciduous Seasonally Saturated (“PSS1B/1C/1E/1F/1G”)				X					
Palustrine Forested Broad-leaved Deciduous Seasonally Saturated (“PFO1B”)	X	X	X	X	X			X	
Palustrine Unconsolidated Bottom Semi-Permanently Flooded Beaver (“PUB1Fb”)					X				

Palustrine Forested Wetlands (“PFO”) are dominated by woody tree species that lose their leaves in the fall and become dormant until the spring. The hydrology of PFO wetlands vary significantly and may be inundated or saturated for different lengths of the year. Because hydrology is variable, soil and vegetation types may vary as well.

Wetland vegetation common in PFO wetlands delineated within the ROW included: eastern white pine (*Pinus strobus),* red maple (*Acer rubrum*), red oak (*Quercus rubra*), eastern hemlock (*Tsuga canadensis*), Speckled Alder (*Alnus incana*), Common winterberry holly (*Ilex verticillata*), highbush blueberry (*Vaccinium corymbosum*), partridgeberry (*Mitchella repens*), and cinnamon fern (*Osmundastrum cinnamomeum*). Signs of hydrology included water-stained leaves, high water table, saturation, inundation visible on aerial imagery, geomorphic position, and microtopographic relief. Soils were generally classified as having a Depleted Matrix F3, Redox Dark Surface F6, or Thick Dark Surface A12.

Palustrine Emergent Wetlands ("PEM") are dominated by herbaceous vegetation, though there can be some trees and shrubs present. The hydrology of PEM wetlands can vary considerably from being seasonally inundated in certain situations to permanently flooded in others. Substrates in PEM wetlands vary with hydrology. Soils associated with permanently flooded areas may consist entirely of organic soils, or mineral soils enriched with organic materials. PEM wetlands that are saturated for only portions of the year are generally mineral soils.

Wetland vegetation common in PEM wetlands delineated within the ROW included: cinnamon fern, marsh fern (*Thelypteris palustris*), sensitive fern (*Onoclea sensibilis*), royal fern (*Osmunda spectabilis*), three-way sedge (*Dulichium arundinaceum*), sallow sedge (*Carex lurida*), common woolsedge (*Scirpus cyperinus*), eastern star sedge (*Carex radiata*), tall white-aster (*Doellingeria umbellata*), New England American-aster (*Symphyotrichum novaeangliae*), common soft rush (*Juncus effusus*), sharp-fruited rush (*Juncus acuminatus*), American bur-reed (*Sparganium americanum*), rattlesnake manna grass (*Glyceria canadensis*), bluejoint Canada reed grass (*Calamagrostis canadensis),* rice cut grass (*Leersia oryzoides*), white meadowsweet (*Spiraea alba*), bristly blackberry (*Rubus hispidus*), common wrinkle-leaved goldenrod (*Solidago rugosa*), American witch-hazel (*Hamamelis virginiana*), jewelweed (*Impatiens capensis*), arrow-leaved tearthumb (*Persicaria sagittata*), Devil's beggar-ticks (*Bidens frondosa*), boneset thoroughwort (*Eupatorium perfoliatum*), and partridgeberry. Dominant woody species included smooth arrowwood (*Viburnum dentatum*), glossy false buckthorn (*Frangula alnus*), highbush blueberry, winterberry (*Ilex verticillata*), speckled alder, gray birch (*Betula populifolia*), and red maple scattered throughout or along the periphery. Signs of hydrology include water-stained leaves, high water table, saturation, hydrogen sulfide odor, inundation visible on aerial imagery, geomorphic position, drainage patterns, FAC-neutral test, and microtopographic relief. Soils were generally classified as having a Depleted Matrix F3, Redox Dark Surface F6, Thick Dark Surface A12, Histisol A1, and Histic epipedon A2.

Palustrine Scrub Shrub Wetlands ("PSS") are dominated by woody deciduous plants that are less than 20-ft tall. The hydrology of a PSS wetland can vary between wetlands but is generally categorized as having shallow inundation or soil saturation in the early spring followed by extended periods of dry conditions during the late spring, summer and fall. Soils within PSS wetlands generally consist of mineral soils with minor amounts of organics.

Dominant vegetation included glossy buckthorn (*Frangula alnus*), highbush blueberry, cinnamon fern, various sedges (*Carex sp.),* maleberry (*Lyonia ligustrina*), bristly blackberry, royal fern, white meadowsweet, sensitive fern, speckled alder, and gray birch.

Common signs of hydrology included saturation, drainage patterns, FAC-neutral test, oxidized rhizospheres on living roots, geomorphic position, microtopographic relief, surface water, high water table, and water-stained leaves. Soils varied and included Sandy Redox S5, Depleted Matrix F3, Redox Dark Surface F6, Histosol A1, Depleted Below Dark Surface A11, Depleted Dark surface F7, Histic Epipedon A2, Histisol A1, and Very Shallow Dark Surface TF12.

4.4.3 State Wetland Resource Area Classification and Evaluation

State regulated wetland resource areas found within and immediately adjacent to the ROW along the Project route consist of BVW, BLSF, Isolated Land Subject to Flooding ("ILSF"), Bank, LUW, and RA, as described below. Vernal Pool habitat is also discussed in terms of NHESP Designated potential vernal pools ("PVPs") and certified vernal pools ("CVPs"). Each type of wetland has an associated set of regulatory performance standards. The Project's approach to meeting these standards is addressed in *Section 11: Regulatory Compliance*.

Bordering Vegetated Wetlands: BVW is defined at 310 CMR 10.55(2) as freshwater wetlands (wet meadows, marshes, swamps, and bogs) which border on creeks, rivers, streams, ponds and lakes. BVWs are areas where the soils are saturated and/or inundated such that they support a predominance of wetland indicator plants. The ground and surface water regime and the vegetation community which occur in each type of freshwater wetland are specified in the Massachusetts Wetlands Protection Act (WPA) G.L. c. 131, § 40.

Due to ROW vegetation maintenance activities, the majority of BVW delineated along the existing ROW have dominant elements of both PEM and PSS vegetation. All dominant PEM wetlands delineated have a significant element of PSS vegetation, but not vice versa.

Bordering Land Subject to Flooding: BLSF is defined at 310 CMR 10.57(2)(a) as an area with low, flat topography adjacent to and inundated by flood waters rising from creeks, rivers, streams, ponds or lakes. BLSF extends from the banks of these waterways and water bodies; where a BVW occurs, it extends from said wetland. The boundary of BLSF is the estimated maximum lateral extent of flood water which will theoretically result from the statistical 100-year frequency storm.

Isolated Vegetated Wetlands ("IVW") and Isolated Land Subject to Flooding: ILSF is defined at 310 CMR 10.57(2)(b) as an isolated depression or a closed basin that serves as a ponding area for run-off or high ground water which has risen above the ground surface. Isolated wetlands are not jurisdictional resource areas under the WPA unless they hold enough water to meet the definition of ILSF (310 CMR 10.57(2)(b)). Protection of IVW varies by municipality and are often afforded local protection regardless of size. During field investigations, wetlands were not delineated beyond the utility ROW. Off-ROW hydrologic connections were assumed for wetlands located on the border of the ROW.

Inland Bank: Bank is defined at 310 CMR 10.54(2) as the portion of the land surface, which normally abuts and confines a water body. It occurs between a water body and a vegetated bordering wetland and adjacent floodplain, or, in the absence of these, it occurs between a water body and upland. A Bank may be partially or totally vegetated, or it may be comprised of exposed soil, gravel or stone. The physical characteristics of a Bank, as well as its location, are critical to the protection of wildlife. The upper boundary of a Bank is the first observable break in the slope or the mean annual flood level, whichever is lower. The lower boundary of a Bank is the mean annual low flow level.

Land Under Waterbodies and Waterways: LUW is defined at 310 CMR 10.56(2) as the land beneath any creek, river, stream, pond or lake. The boundary of LUW is the mean annual low water level. Land under all ponds, lakes, perennial and intermittent streams, located within the Project route, is afforded protection under the WPA (G.L. c. 131, § 40) and regulations at 310 CMR 10.56.

Riverfront Area: RA is defined at 310 CMR 10.58(2) as the area of land between a river's mean annual high-water line and a parallel line measured horizontally. RA may include or overlap other resource areas or their buffer zones. The RA does not have a buffer zone.

Under the 310 CMR 10.58(2)(1), 200-ft RA is given to the following:

A. A river or stream shown as perennial on the current United States Geological Survey ("USGS") or more recent map provided by the Department is perennial.

B. A river or stream shown as intermittent or not shown on the current USGS map or more recent map provided by the Department, that has a watershed size greater than or equal to one (1) square mile, is perennial.

C. A stream shown as intermittent or not shown on the current USGS map or more recent map provided by the Department, that has a watershed size less than one (1) square mile, is intermittent unless:

i. The stream has a watershed size of at least ½ (0.50) square mile and has a predicted flow rate greater than or equal to 0.01 cubic feet per second at the 99% flow duration using the USGS Stream Stats method. The issuing authority shall find such streams to be perennial; or

ii. When the USGS StreamStats method cannot be used because the stream does not have a mapped and digitized centerline (including but not limited to streams located in the following basins: North Coastal Basin, Taunton Basin, Buzzards Bay Basin, Cape Cod and Islands Basin, and that portion of the South Coastal Basin that is south of the Jones River sub-basin), and the stream has a watershed size of at least ½ (0.50) square mile, and the surficial geology of the contributing drainage area to the stream at the project site contains 75% or more stratified drift, the issuing authority shall find such streams to be perennial. Stratified drift shall mean sand and gravel deposits that have been layered and sorted by glacial meltwater streams. Areal percentages of stratified drift may be determined using USGS surficial geologic maps, USGS Hydrological Atlases, Massachusetts Geographical Information System (MassGIS) surficial geology data layer, or other published or electronic surficial geological information from a credible source."

Vernal Pool Habitat: Vernal Pool habitat is defined at 310 CMR 10.04 as confined depressions that hold water for two (2) continuous months during spring and/or summer most years, and which are free of adult fish, including a 100-ft buffer if that area is within a jurisdictional wetland pursuant to the WPA and regulations.

4.5 LOCAL RESOURCE AREA CLASSIFICATION AND EVALUATION

Local wetland resource areas are those wetlands that are provided additional protection beyond that provided by the WPA and/or are not provided protection under the WPA and the state wetlands regulations. For example, local bylaws may provide additional interests or performance standards to a wetland resource area. Additionally, isolated wetlands may be provided protection by a local wetland bylaw or ordinance that claims jurisdiction over these areas. In addition, several municipalities also consider the 100-ft buffer zone a wetland resource area as opposed to an upland buffer. Municipalities that have implemented a wetland bylaw or ordinance are described below (*Table 13 Additional Bylaw Protections by Municipality*):

Table 13: Additional Bylaw Protections by Municipality

MUNICIPALITY	ADDITIONAL BYLAW PROTECTION BY MUNICIPALITY
ATHOL	No Wetlands Bylaw.
FITCHBURG	Additional jurisdictional resource areas include all isolated wetlands, vernal pools, kettle holes, and 100-ft Buffer Zone to Resource Areas (not including FEMA 100-Year Floodplain/BLSF). 50-ft No Disturb Zone and 75-ft No Build Zone.
GARDNER	Additional jurisdictional resource areas include all vernal pools, intermittent streams, and 100-ft Buffer Zone to Resource Areas (not including FEMA 100-Year Floodplain/BLSF). 30-ft No Disturb Zone and 60-ft No Build Zone.
LEOMINSTER	No Wetlands Bylaw.
ROYALSTON	No Wetlands Bylaw.
STERLING	No Wetlands Bylaw.
WARWICK	No Wetlands Bylaw.
WESTMINSTER	Additional jurisdictional resource areas include all vernal pools. 25-ft No Disturbance Zone.
WINCHENDON	Additional jurisdictional resource areas include all vernal pools, ponds of any size, springs, intermittent streams, and 100-ft Buffer Zone to Resource Areas (not including FEMA 100-Year Floodplain/BLSF).

4.5.1 Wildlife

This section discusses wildlife and associated habitat characteristics commonly found in the types of wetlands that are present along the Project route.

PSS Wetlands: A variety of birds, mammals, reptiles, amphibians and invertebrates are known to use the habitat provided by PSS wetlands. The diverse vegetation and structural features associated with forested (and scrub-shrub) wetlands provide feeding, breeding, nesting, and cover for a variety of wildlife species. Important wildlife habitat characteristics found within Project impact areas include:

- Wetland/ Aquatic food plants
- Upland/wetland food plants (hard mast and fruit)
- Shrub thickets/stream beds with abundant earth worms
- Thick shrub/herbaceous cover (suitable for Veery nesting)
- Standing dead tree (snag)
- Dense herbaceous cover
- Small mammal burrows
- Tree roots under water's surface
- Large woody debris on ground
- Rock piles and crevices
- Depressions that may serve as seasonal vernal pools
- Areas of ice-free open water in winter
- Emergent wetland pockets
- Intermittent streams

Wildlife commonly found in PSS wetland communities include birds such as: common yellowthroat (*Geothlypis trichas*), song sparrow (*Melospiza melodia*), common grackle (*Quiscalus quiscula*), and American goldfinch (*Carduelis tristis*). Small mammals include the water shrew (*Sorex palustris*), short-tailed shrew (*Blarina bevicauda*), white-footed mouse (*Peromyscus leucopus*), star nosed mole (*Condylura cristata*), eastern chipmunks (*Tamias striatus*) and eastern cottontail (*Sylvilagus floridanus*). Larger species, such as ruffed grouse (*Bonasa umbellus*), wild turkeys (*Meleagris gallopavo),* skunks (*Mephitis mephitis*), raccoons (*Procyon lotor)*, Virginia opossums (*Didelphis virginiana),* and woodchucks (*Marmota monax)* may also be present.

PEM Wetlands: Wildlife commonly found in PEM wetland communities include: American toad (*Bufo a. americanus*), northern spring peeper (*Pseudoacris c. cinerus*), wood frog (*Rana clamitans melanota*), red winged black bird (*Agelaius phoenicecu*), swamp sparrow (*Melospiza georgiana*), and common yellowthroat (*Geothlypis trichas*).

4.6 IMPACTS TO WETLANDS AND WILDLIFE

The Project's anticipated wetland impacts include areas within the ROW as well as any off-ROW resource areas that are impacted. This section provides an overview of the temporary and permanent impacts of access roads and construction areas in BVWs, 100-ft Buffer Zone to BVW, other wetland areas and Wildlife within the work areas.

Overall, impacts to wetland resource areas are anticipated to have both temporary and permanent impacts on the resource areas and its associated buffer zones due to comprehensive nature of the refurbishment (including new structures) and access improvements and establishment of new access. Additionally, incremental changes to the existing footprint of power line structures and access roads might have temporary and long-term impacts on the wildlife, but they will be localized to the immediate areas within the ROW. Wildlife habitats will remain intact. NEP proposes to address all the impacts and provide appropriate wetland mitigation to offset any permanent wetland impact.

- Temporary impacts include construction matting, soil stockpiling and maneuvering equipment within the Limit of Disturbance.
    - Temporary impacts are anticipated within Bank, BVW, Isolated Wetlands, RA, BLSF and LUW.
- Permanent impacts include tree removal for horizontal clearance with the overhead line and within the Limit of Disturbance; fill within BVW, Isolated Wetlands, LUW, and BLSF associated with new concrete caisson foundations; cut/fill associated with road building, work envelopes and pull pads; and access road re-establishment and establishment of new access roads.
    - Permanent impacts are anticipated within BVW, Isolated Wetlands, RA, BLSF, LUW and Buffer Zone.

Table 2 above presents a summary of wetland resource area impacts. Wetland Resource Areas are shown on the *MEPA General Purpose Plans in Appendix A: Figures.* The discussion of wildlife impacts is incorporated into the wetlands impact analysis, below.

4.6.1 TEMPORARY IMPACTS

4.6.1.1 Bordering Vegetated Wetlands

Temporary impacts to BVW are anticipated due to construction mats used for access roads and construction areas (e.g., construction work envelopes, and pull pads). A typical construction mat detail is presented in *Appendix C*. Construction mats are placed over existing vegetation (i.e., there is little or no ground disturbance). After all work is completed, construction mats will be removed, and the site restored to preconstruction condition after approximately one growing season.

Access Roads: Since this Project involves comprehensive refurbishment activities and system improvements to the existing assets, upland access options were infeasible in some areas due to extensive wetlands within the ROW and a number of constraints (e.g., steep slopes, avoiding cultural resources). In these areas, existing access roads will be improved or re-established to provide safe access for vehicles during construction and for the future operation and maintenance of the transmission lines and tap lines. The construction of new access roads will require either cut or fill, and placement and compaction of imported gravel. NEP has established standards for establishing access roads as described in *EG-303NE, Appendix C.* Access roads are being designed for a 12-ft wide travel lane.

Where present, BVW will be stabilized by placement of temporary construction mats. The area of disturbance is approximately 16-ft wide. Although new, re-established, or improved upland access routes may be maintained as such, construction mats used along access roads during construction will be removed from the BVWs.

BVWs that will be temporarily impacted for refurbishment activities are identified in Table 14.

Table 14: BVW with Temporary Impacts due to Construction Matting for Access

MUNICIPALITY	WETLAND ID
WARWICK	WA-W1, WA-W2, WA-W4, WA-W6, WA-W7, WA-W10, WA-W11, WA-W12, WA-W13, WA-W14, WA-W16, WA-W17, WA-W21, WA-W22, WA-W24, WA-W25, WA-W29, WA-W31, WA-W34, WA-W35, WA-W37, WA-W38, WA-W39, WA-W40, WA-W41, WA-W42.
ROYALSTON	RO-W1, RO-W3, RO-W4, RO-W4A, RO-W5, RO-W6, RO-W7, RO-W10, RO-W11, RO-W12, RO-W13, RO-W14, RO-W15, RO-W16, RO-W16A, RO-W17, RO-W21, RO-W22, RO-W24, RO-W25, RO-W26, RO-W27, RO-W28, RO-W29, RO-W30, RO-W31, RO-W34, RO-W35, RO-W36, RO-W38, RO-W39, RO-W40, RO-W42, RO-W43, RO-W44, RO-W45, RO-W47, RO-W48, RO-W49, RO-W50, RO-W51, RO-W52, RO-W53, RO-W54, RO-W64, RO-W63, RO-W62, RO-W61, RO-W59, RO-W58, RO-W57, RO-W56, RO-W38.
WINCHENDON	WIN-W1, WIN-W1A, WIN-W3, WIN-W4, WIN-W5, WIN-W7, WIN-W12, WIN-W14, WIN-W15, WIN-W22, WIN-W27, WIN-W28, WIN-W30, WIN-W31, WIN-W32, WIN-W33, WIN-W34.
GARDNER	GA-W1, GA-W2, GA-W3, GA-W4, GA-W5, GA-W5A, GA-W6, GA-W7, GA-W8, GA-W11, GA-W13, GA-W14, GA-W15, GA-W17, GA-W18, GA-W19, GA-W20, GA-W22, GA-W23, GA-W25, GA-W26, GA-W29, GA-W30, GA-W32, GA-W33, GA-W35.
WESTMINSTER	WE-W1, WE-W2, WE-W3, WE-W4, WE-W5, WE-W6, WE-W10, WE-W11, WE-W12, WE-W15.
FITCHBURG	F1-W1, F1-W3, F1-W4, F1-W5, LE-W1, LE-W2, F1-W9
LEOMINSTER	LE-W4, LE-W8, LE-W10, LE-11A, LE-W12, LE-W13, LE-W15, LE-W16, LE-W17, LE-W21, LE-W22, LE-W23, LE-W24, LE-W27, LE-W32.
STERLING	ST-W2.
ATHOL	AT-W24, AT-W23, AT-W22, AT-W20A, AT-W20, AT-W19, AT-W18, AT-W17, AT-W15B, AT-W15A, AT-W15, AT-W12, AT-W11, AT-W8, AT-W7, AT-W5, AT-W2, AT-W1

Construction Areas: The installation of new structures/or replacement of structure foundation, and placement of work envelopes in or near BVW, and activities within the LOD will result in short-term impacts associated with the use of construction mats within BVW.

Construction work envelopes will vary in size based on various factors, for example specific activities and equipment required at each location and topographical constraints. In general, the work envelopes have been designed to be up to approximately 157-ft by 80 to 100-ft depending on the width of the ROW and extent of grading required to create the level work area and provide adequate space for the typical construction associated with the project scope of work. Similarly, pull pads may require grading or temporary construction mats in specific locations to support pulling of conductors and/or OPGW. In addition, BVW impact area was conservatively calculated to include all areas where construction mats are used, but because the mats are installed in 4-ft by 16-ft sections they cannot conform to the exact wetland boundary and often extend beyond the boundaries of the BVW.

BVWs that will be temporarily impacted for refurbishment activities are identified in Table 15.

Resulting impacts from matting associated with access road, work envelopes, pull pads and LOD are anticipated to be approximately 51 acres of BVW. However, these impacts will be limited to the construction phase only.

Table 15: Temporary Impacts due to Construction Matting for Foundation Installation

MUNICIPALITY	WETLAND ID
WARWICK	WA-W1, WA-W2, WA-W4, WA-W6, WA-W7, WA-W9, WA-W10, WA-W11, WA-W12, WA-W13, WA-W14, WA-W15, WA-W16, WA-W17, WA-W20, WA-W21, WA-W22, WA-W22C, WA-W23, WA-W24, WA-W25, WA-W27, WA-W28, WA-W29, WA-W31, WA-W34, WA-W35, WA-W37, WA-W38, WA-W39, WA-W40, WA-W41, WA-W42,
ROYALSTON	RO-W1, RO-W2, RO-W3, RO-W4, RO-W4A, RO-W5, RO-W6, RO-W6A, RO-W7, RO-W8, RO-W9, RO-W10A, RO-W10, RO-W11, RO-W12, RO-W13, RO-W14, RO-W15, RO-W16, RO-W16A, RO-W17, RO-W21, RO-W22, RO-W23, RO-W24, RO-W25, RO-W26, RO-W27, RO-W28, RO-W29, RO-W30, RO-W31, RO-W32, RO-W33, RO-W34, RO-W35, RO-W36, RO-W38, RO-W39, RO-W40, RO-W41, RO-W42, RO-W43, RO-W44, RO-W45, RO-W47, RO-W48, RO-W49, RO-W50, RO-W51, RO-W52, RO-W53, RO-W54, RO-W67, RO-W64, RO-W63, RO-W62, RO-W61, RO-W60, RO-W59, RO-W58, RO-W57, RO-W56, RO-W55, RO-W38.
WINCHENDON	WIN-W1, WIN-W2, WIN-W3, WIN-W4, WIN-W5, WIN-W7, WIN-W11, WIN-W12, WIN-W13, WIN-W14, WIN-W15, WIN-W22, WIN-W25, WIN-W27, WIN-W28, WIN-W30, WIN-W31, WIN-W32, WIN-W33, WIN-W34.
GARDNER	GA-W1, GA-W2, GA-W3, GA-W4, GA-W5, GA-W5A, GA-W6, GA-W7, GA-W8, GA-W9, GA-W10, GA-W12, GA-W13, GA-W14, GA-W15, GA-W16, GA-W17, GA-W18, GA-W19, GA-W20, GA-W22, GA-W23, GA-W25, GA-W26, GA-W27, GA-W28, GA-W9, GA-W11, GA-W13, GA-W14, GA-W15, GA-W17, GA-W18, GA-W19, GA-W20, GA-W22, GA-W23, GA-W25, GA-W26, GA-W27, GA-W29, GA-W30, GA-W31, GA-W32, GA-W33, GA-W35, GA-W41, GA-W40, GA-W39, GA-W38, GA-W37, GA-W7, GA-W36.
WESTMINSTER	WE-W1, WE-W2, WE-W3, WE-W4, WE-W5, WE-W6, WE-W8, WE-W10, WE-W11, WE-W12, WE-W13, WE-W14, WE-W15, WE-W16, WE-W17.
FITCHBURG	F1-W1, F1-W2, F1-W3, F1-W4, F1-W5, F1-W6.
LEOMINSTER	LE-W1, LE-W2, LE-W3, LE-W6, LE-W7, LE-W8, LE-W10, LE-W11, LE-W11A, LE-W12, LE-W13, LE-W14, LE-W14A, LE-W15, LE-W16, LE-W17, LE-W18,LE-W19, LE-W21, LE-W22, LE-W23, LE-W24, LE-W27, LE-W30, LE-W31, LE-W32,
STERLING	ST-W2
ATHOL	AT-W24, AT-W23, AT-W22, AT-W20A, AT-W20, AT-W19, AT-W18, AT-W17, AT-W16, AT-W15B, AT-W15A, AT-W15, AT-W13, AT-W12, AT-W11, AT-W9, AT-W8, AT-W7, AT-W6, AT-W5, AT-W4, AT-W2, AT-W1.

4.6.1.2 Other Wetland Resource Areas

Access Roads: Temporary construction matting may be used for access where existing access roads do not exist. Stone will be added to some access roads within the BLSF to stabilize the surface and support equipment. Where this is necessary, the existing road surface will be over-excavated and filled with clean gravel or stone so there will be no change in elevation or flood storage capacity. Thus, no compensatory flood storage is required, and no significant temporary or permanent impact is anticipated.

Where stream crossings are required, construction mats will be installed in a manner that will span the Bank, thus avoiding direct temporary impacts to Bank. In most cases, construction mat crossings will span the Bank of rivers and streams. However, the potential for alteration has been accounted for in the review of MEPA thresholds and approximately 67,954 sf of temporary construction matting has been proposed. Crossings are proposed for site access within the medium-sized to larger streams and rivers e.g., the Black Brook, Mirey Brook, Fish Brook, Perley Brook, Boyce Brook, and Fall Brook, located along the Project route. Where crossings are required on open water, and medium-sized to larger streams with spans are greater than 30-ft, temporary impacts to LUW are anticipated. Approximately 32,206 sf of matting is anticipated to temporarily impact LUW.

Construction Areas: There will be temporary impacts to RA, BLSF, and Isolated Wetlands, due to the placement of construction mat work envelopes during the installation of new/or replacement structures and overhead line work and activities within the LOD (*see MEPA General Purpose Plans in Appendix A*). In these instances, the construction mat work envelopes are placed on top of existing vegetation and over intermittent stream channels. As such, roots are not disturbed, earth disturbance is largely avoided, and streams are allowed to flow beneath the mat platform. The construction mats will be removed, and the area restored, as necessary, upon completion of construction. No change in elevation or flood storage capacity will occur related to temporary impacts due to construction matting.

Temporary matting impacts associated with access roads, work envelopes, pull pads and the LOD within RA, BLSF, and Isolated Wetlands is approximately 11 acres, 0.27 acres and 1.64 acres, respectively.

BLSF, IVW, and RA will be temporarily impacted due to mowing for equipment access. See *Table 16* for identification of isolated wetlands within each town with temporary impacts due to matting.

Table 16: Isolated Wetlands with Temporary Impacts due to Matting

MUNICIPALITY	WETLAND ID
WARWICK	WA-W23
ROYALSTON	RO-W55, RO-W2, RO-W32
GARDNER	GA-W9, GA-W31, GA-27
WESTMINSTER	WE-W13, WE-W14
FITCHBURG	FI-W8, FI - W10
LEOMINSTER	LE-W9, LE-W11, LE-W14, LE-W14A, LE-W18, LE-W20
ATHOL	AT-W13, AT-W9

4.6.1.3 Wildlife

During construction, temporary impacts to wildlife may be caused by the presence of construction equipment, construction activities, and habitat alteration/vegetation impacts resulting from construction. The duration of temporary impacts may vary from the period of active construction only, to the following growing season, when vegetation recovers from disturbance. Wildlife using the forested edge of the cleared ROW as well as the ROW itself may be affected. Mobile species such as birds and large mammals will temporarily leave the area to avoid construction activities and disturbance but may then be impacted by the displacement. Smaller and less mobile animals, such as small mammals and herpetofauna, may be directly impacted by activities within the ROW. The number of individual animals impacted during the construction phase are expected to be relatively few, compared to the total population of any given species in and around the ROW. Temporary impacts will be localized to the immediate areas of construction, which includes only a portion of the ROW, and are not anticipated to be significant to any species at the population level.

4.6.2 PERMANENT IMPACTS

4.6.2.1 Bordering Vegetated Wetlands

Access Roads: NEP evaluated existing and historically used access routes that traverse BVWs to determine whether road improvements in select locations are feasible due to their location, the length of resource area crossed and whether there is an existing historic road base in these areas. No access roads will be established within BVW.

Construction Areas: No permanent impacts to BVW are anticipated for construction areas due to work envelopes or pull pads.

Structures: Concrete caisson foundations will be required for installation of new structures/or replacement structures within BVW, resulting in the permanent fill of approximately 1,896 sf of BVW. In general, approximately 79 sf of fill is necessary for each concrete caisson steel monopole structure. The Project was designed to remove structures from wetlands were possible, resulting in the removal of approximately 36 structures from BVW. 24 structures are proposed with concrete caissons within BVW are highlighted in *Table 17: Fill within BVW for Concrete Caisson Installation* below and on the MEPA General Purpose Plans.

Table 17: Fill within BVW for Concrete Caisson Installation

MUNICIPALITY	WETLAND ID	MAINLINE OR TAP NAME	STRUCTURE #
ATHOL	AT-W23	MAINLINE	413
	AT-W17	MAINLINE	404
	AT-W8	MAINLINE	140
	AT-W15B	MAINLINE	151
GARDNER	GA-W14	MAINLINE	229
	GA-W13	MAINLINE	380
ROYALSTON	RO-W49	ATHOL TAP 2	CHW 8
	RO-W59	ATHOL TAP 1	CHE 10
	RO-W59	ATHOL TAP 2	CHW 24
	RO-W10	ATHOL TAP 1	CHE 32
	RO-W11	ATHOL TAP 2	CHW 28
	RO-W26	ATHOL TAP 1	CHE 38
	RO-W4A	ATHOL TAP 1	CHE 39
	RO-W28	ATHOL TAP 2	CHW 30
WARWICK	WA-W22	MAINLINE	201
	WA-W29	MAINLINE	228
	WA-W29	ATHOL TAP 1	CHE 87
WESTMINSTER	WE-W1	MAINLINE	40
	WE-W3	ATHOL TAP 1	CHE 73
	WE-W3	ATHOL TAP 2	CHW 32
	WE-W10	ATHOL TAP 1	CHE 46
WINCHENDON	WIN-W14	ATHOL TAP 1	CHE 66
	WIN-W33	ATHOL TAP 2	CHW 42
	WIN-W33	ATHOL TAP 1	CHE 61
	WIN-W34	MAINLINE	194

Vegetation Management: To provide a safe area for construction, reliability, maintenance, and operation of the proposed line, vegetation on the existing ROW will continue to be maintained to prevent the growth of tall woody species. In addition, to obtain the minimum horizontal clearance of 30-ft to the edge of ROW under all weather conditions, the existing maintained portion of the ROW will need to be expanded. The existing maintained ROW on the mainline, Crystal Lake Tap and Athol Tap is 85-ft, 75-ft, and 100-ft, respectively. To provide the necessary clearances for the replacement and new structures, the mainline and Crystal Lake Tap ROWs will be cleared to 100-ft and the Athol Tap ROW will be cleared to 125-ft.

Tree removal within BVW and the LOD is anticipated to result in converting approximately 17 acres of PFO to PSS. Following the completion of construction, vegetation maintenance activities will be consistent with the Five-Year Vegetation Management Plan ("VMP") (2019-2023), and subsequent approved plans, presented in *Appendix D*.

4.6.2.2 100-ft Buffer Zone to BVW and Inland Bank

Access Roads: Impacts to the 100-ft Buffer Zone to BVW and Inland Bank are anticipated due to the improvement/reestablishment of existing access roads and the establishment of new access roads. Approximately 18 acres of permanent impacts are anticipated within 100-ft Buffer Zone to BVW and Inland Bank. Where access roads exist, they are typically 8-ft wide and are comprised of historic fill material. Over time, access roads become degraded through weathering. The width and quality of the existing access roads do not meet the current NEP standard to safely support sconstruction equipment. To meet the safety and equipment requirements of the Project, NEP will upgrade the existing access roads from their existing width to a 12-ft wide travel lane. In areas where access road improvements are needed, the existing road will be regraded to provide a flat surface for utility equipment. Imported gravel will be added to the access roads where necessary as will be done for new access. Disturbed road shoulders will be stabilized immediately after road construction. Access roads to be improved that approach a wetland will terminate before the delineated limits of the wetland. See *Table 18,* for the anticipated Buffer Zones that will be permanently impacted by access roads.

Construction Areas: Work envelopes, pull pads and the LOD associated with construction access are anticipated to impact the 100-ft Buffer Zone to BVW and Inland Bank. In some locations, work envelope/pull pad improvements are needed to create a stable work platform for the safe operation of utility equipment. Permanent stone work envelope improvements are limited to regrading in the 100-ft buffer zone and upland areas. See *Table 19* for the anticipated Buffer Zones that will be permanently impacted by construction areas.

Approximately 90 acres of disturbance in Buffer Zone is anticipated. Where applicable, exposed soils will be stabilized with stone to prevent erosion and sedimentation to nearby resource areas.

Table 18: Buffer Zone with Permanent Impacts due to Access Road Improvements

MUNICIPALITY	WETLAND ID
WARWICK	WA-W1, WA-W2, WA-W4, WA-W5, WA-W6, WA-W7, WA-W8, WA-W9, WA-W10, WA-W11, WA-W12, WA-W13, WA-W14, WA-W15, WA-W16, WA-W17, WA-W18, WA-W19, WA-W21, WA-W22, WA-W22B, WA-W22C, WA-W23, WA-W24, WA-W25, WA-W26, WA-W27, WA-W28, WA-W29, WA-W30, WA-W31, WA-W32, WA-W33, WA-W34, WA-W35, WA-W36, WA-W37, WA-W38, WA-W39, WA-W40, WA-W41, WA-W42.
ROYALSTON	RO-W1, RO-W2, RO-W3, RO-W4, RO-W4A, RO-W5, RO-W6, RO-W6A, RO-W7, RO-W8, RO-W9, RO-W10A, RO-W10, RO-W11, RO-W12, RO-W13, RO-W14, RO-W15, RO-W16, RO-W16A, RO-W17, RO-W20, RO-W21, RO-W22, RO-W23, RO-W24, RO-W25, RO-W26, RO-W27, RO-W28, RO-W29, RO-W30, RO-W31, RO-W32, RO-W34, RO-W35, RO-W36, RO-W37, RO-W38, RO-W39, RO-W40, RO-W41, RO-W42, RO-W43, RO-W44, RO-W45, RO-W47, RO-W48, RO-W49, RO-W50, RO-W51, RO-W52, RO-W53, RO-W54, RO-W67, RO-W66, RO-W65, RO-W64, RO-W63, RO-W62, RO-W61, RO-W60, RO-W59, RO-W58, RO-W57, RO-W56, RO-W38.
WINCHENDON	WIN-W1, WIN-W1A, WIN-W3, WIN-W4, WIN-W5, WIN-W7, WIN-W10, WIN-W11, WIN-W12, WIN-W13, WIN-W14, WIN-W15, WIN-W22, WIN-W23, WIN-W24, WIN-W25, WIN-W26, WIN-W27, WIN-W28, WIN-W30, WIN-W31, WIN-W32, WIN-W33, WIN-W34.
GARDNER	GA-W1, GA-W2, GA-W3, GA-W4, GA-W5, GA-W5A, GA-W6, GA-W7, GA-W8, GA-W9, GA-W10, GA-W11, GA-W12, GA-W13, GA-W14, GA-W15, GA-W16, GA-W17, GA-W18, GA-W19, GA-W20, GA-W22, GA-W23, GA-W25, GA-W26, GA-W27, GA-W28, GA-W29, GA-W30, GA-W31, GA-W32, GA-W33, GA-W34, GA-W35.
WESTMINSTER	WE-W1, WE-W2, WE-W2B, WE-W3, WE-W4, WE-W5, WE-W6, WE-W7, WE-W8, WE-W9, WE-W10, WE-W11, WE-W12, WE-W13, WE-W14, WE-W15, WE-W16.
FITCHBURG	F1-W1, F1-W3, F1-W4, F1-W5, LE-W1, LE-W2, F1-W7, F1-W8, F1-W9, F1-W10,
LEOMINSTER	LE-W3, LE-W4, LE-W5, LE-W6, LE-W7, LE-W8, LE-W9, LE-W10, LE-W11, LE-W11A, LE-W12, LE-W13, LE-W14, LE-W14A, LE-W15, LE-W16, LE-W17, LE-W18, LE-W19, LE-W20, LE-W21, LE-W22, LE-W23, LE-W24, LE-W25, LE-W26, LE-W27, LE-W28, LE-W29, LE-W30, LE-W32, LE-W33.
STERLING	ST-W2

ATHOL	AT-W24, AT-W23, AT-W22, AT-W20A, AT-W20, AT-W19, AT-W15B, AT-W15A, AT-W15, AT-W14, AT-W13, AT-W12, AT-W11, AT-W9, AT-W8, AT-W7, AT-W6, AT-W5, AT-W2, AT-W1.

Table 19: 100-ft Buffer Zone with Permanent Impacts due to Work Envelopes

MUNICIPALITY	WETLAND ID
WARWICK	WA-W7, WA-W18, WA-W19, WA-W19A, WA-W20, WA-W21, WA-W22, WA-W22C, WA-W23, WA-W24, WA-W27, WA-W28, WA-W29, WA-W30, WA-W31, WA-W32, WA-W33, WA-W37, WA-W39, WA-W40, WA-W41, WA-W42,
ROYALSTON	RO-W1, RO-W2, RO-W3, RO-W4, RO-W4A, RO-W5, RO-W6, RO-W6A, RO-W7, RO-W9, RO-W10A, RO-W10, RO-W11, RO-W12, RO-W13, RO-W14, RO-W15, RO-W16, RO-W17, RO-W22, RO-W23, RO-W24, RO-W25, RO-W26, RO-W27, RO-W28, RO-W29, RO-W30, RO-W31, RO-W33, RO-W34, RO-W35, RO-W36, RO-W37, RO-W38, RO-W39, RO-W40, RO-W41, RO-W44, RO-W47, RO-W48, RO-W49, RO-W51, RO-W52, RO-W53, RO-W54, RO-W67, RO-W66, RO-W65, RO-W64, RO-W63, RO-W62, RO-W61, RO-W60, RO-W59, RO-W58, RO-W57, RO-W56, RO-W55.
WINCHENDON	WIN-W1, WIN-W1A, WIN-W3, WIN-W4, WIN-W5, WIN-W10, WIN-W11, WIN-W12, WIN-W13, WIN-W14, WIN-W15, WIN-W22, WIN-W23, WIN-W24, WIN-W25, WIN-W26, WIN-W27, WIN-W28, WIN-W30, WIN-W31, WIN-W33,
GARDNER	GA-W1, GA-W4, GA-W6, GA-W7, GA-W8, GA-W9, GA-W10, GA-W11, GA-W12, GA-W13, GA-W14, GA-W15, GA-W16, GA-W17, GA-W18, GA-W19, GA-W22, GA-W25, GA-W27, GA-W29, GA-W30, GA-W31, GA-W32, GA-W33, GA-W34, GA-W35, GA-W40, GA-W38, GA-W36, GA-W7.
WESTMINSTER	WE-W1, WE-W2B, WE-W3, WE-W4, WE-W5, WE-W6, WE-W7, WE-W8, WE-W9, WE-W10, WE-W11, WE-W12, WE-W13, WE-W14, WE-W15, WE-W16,
FITCHBURG	F1-W1, F1-W3, F1-W4, F1-W5, LE-W1, LE-W2, F1-W7, F1-W8, F1-W9, F1-W10, LE-W3,
LEOMINSTER	LE-W4, LE-W5, LE-W6, LE-W7, LE-W8, LE-W12, LE-W13, LE-W14, LE-W14A, LE-W15, LE-W16, LE-W17, LE-W18, LE-W19, LE-W20, LE-W21, LE-W22, LE-W27, LE-W28, LE-W30, LE-W32, LE-W34,.
STERLING	ST-W2
ATHOL	AT-W23, AT-W21, AT-W20, AT-W19, AT-W18, AT-W17, AT-W16, AT-W15B, AT-W15A, AT-W15, AT-W14, AT-W13, AT-W12, AT-W11, AT-W9, AT-W8, AT-W4, AT-W2,

4.6.2.3 Other Wetland Resource Areas

Access Roads: Stone will be added, if necessary, to maintain and expand some roads within the RA and BLSF to stabilize the surface and support equipment. Where this is necessary in BLSF, the existing road surface will be over excavated and filled with clean gravel or stone so there will be no change in elevation or flood storage capacity. While this is a permanent impact, no compensatory flood storage is required, and no significant impact is anticipated. In areas where improved access roads intersect with rare species habitat, impacts and construction methodology will be site specific.

Riverfront areas that will be permanently impacted by refurbishment activities are associated with nine (9) unnamed streams and the following watercourses:

Pauchaug Brook, Black Brook, Mirey Brook, Kidder Brook, Collar Brook, Fish Brook, Boyce Brook, Lawrence Brook, Mill Glen Pond, Bailey Brook, Saw Mill Pond, Notown Reservoir, and Monoosnoc Brook. Other named perennial watercourses include Fish Brook, Beaver Brook, Miller's River, and Wilder Brook.

Permanent impacts within RA associated with the access road, work envelopes and pull pads will be approximately 31 acres. Where feasible work envelopes and pull pads will be loamed and seeded and allowed to revegetate.

Permanent impacts are not anticipated to occur within BLSF due to access roads, work envelopes or pull pads as these areas will be over-excavated resulting in no loss of flood storage. However, these construction activities will occur within approximately 7 acres.

Structures: New concrete caisson foundation installation will result in permanent fill of approximately 76.6 cy within BLSF and 79 sf within an Isolated Wetland, and alteration of approximately 3,476 sf of RA. BLSF impacts from structures (as noted in *Table 2*) will be offset by compensatory flood storage (see mitigation discussion, below). Two (2) concrete caissons are proposed within LUW in the Crystal Lake Tap in Gardner. Impacts from structures within other wetland resource areas will be negligible after mitigation.

Vegetation Management: To provide a safe area for construction, reliability, maintenance, and operation of the proposed line, vegetation on the existing ROW will continue to be maintained post construction to prevent the growth of tall woody species. In addition, to obtain the minimum horizontal clearance of 30-ft to the edge of ROW under all weather conditions, the existing maintained portion of the ROW will need to be expanded. The existing maintained ROW on the mainline, Crystal Lake Tap and Athol Tap is 85-ft, 75-ft, and 100-ft, respectively. To provide the necessary clearances for the replacement and new structures, the mainline and Crystal Lake Tap ROWs will be cleared to 100-ft and the Athol Tap ROW will be cleared to 125-ft.

Tree removal within BLSF, RA, Isolated Wetland and Bank associated with vegetation cutting and the LOD is anticipated to result in 2 acres, 18 acres, 0.28 acres, and 0.61 acres, respectively. Following the completion of construction, vegetation maintenance activities will be consistent with the Five-Year Vegetation Management Plan (VMP") (2019-2023), and subsequent approved plans, presented in *Appendix D*.

Approximately six (6) isolated wetlands will be permanently impacted by refurbishment activities, five (5) of the six (6) IVW's are proposed for tree removals resulting in alteration of a PFO to a PSS. One (1) IVW (RO-W10A) will be permanently impacted by the installation of a concrete caisson foundation, (see *Table 20).*

Table 20: Isolated Wetlands with Permanent Impacts

MUNICIPALITY	WETLAND ID
WARWICK	WA-W22B, WA-W30
ROYALSTON	RO-W10A
WINCHENDON	WIN-W31A
GARDNER	GA-W27
ATHOL	AT-W9

4.6.2.4 Wildlife

Permanent impacts due to the Project will consist primarily of incremental changes to the existing footprint of power line structures and access roads, the addition of new access roads, and the conversion of forested areas to scrub shrub and emergent habitat types. The change in footprint of these infrastructure components will cause an incremental loss of vegetation and associated habitat. However, these impacts will not affect the long-term ability of the ROW and surrounding area to provide wildlife habitat. After one or two growing seasons, much of the temporary disturbance will be recovered, and only a small portion of the overall habitat provided by the ROW will be permanently impacted by construction. The basic structure of the ROW and type of habitat present (various open and shrubby habitats) will not be changed by the Project. Because the habitat will largely remain intact, when construction-related disturbance ends, most displaced individuals are expected to return and continue using the habitat provided by the ROW. A wealth of research indicates that the early successional habitat provided by ROWs is beneficial to a wide variety of wildlife species (Yahner 2003, King 2002), including birds, reptiles, and amphibians, especially in landscapes that are primarily forested or developed.

4.7 MITIGATION MEASURES FOR WETLANDS AND WILDLIFE

NEP proposes to provide appropriate wetland mitigation that meets local, state, and federal requirements to offset any permanent wetland impacts. While Project information presented herein is thorough with regard to impacts, and many proposed mitigation measures are identified and described, NEP is still evaluating specific details related to wetland mitigation. Permit applications to be submitted to state and federal regulatory agencies will provide the specific mitigation information required for the Project. At the local level, NEP will work with Conservation Commissions to discuss impacts and proposed mitigation as part of the Notice of Intent process. In addition, post construction, NEP will prepare applications for Certificates of Compliance from each of the Conservation Commissions. These Certificates ensure that wetland resources have been restored. NEP is committed to developing a mitigation package appropriate to address impacts of the Project. It is anticipated that mitigation will demonstrate no net loss of existing wetland functions values, and statutory interests within the watershed.

4.7.1. Design and Construction Best Management Practices (“BMPs”)

Construction activities will minimize disturbed areas; use upland/existing access roads and work envelopes where possible; utilize erosion and sedimentation controls; and involve supervision and inspection of construction activities within resource areas by an Environmental Monitor.

General mitigation measures discussed below will reduce wetland resource area impacts associated with each phase of construction. Many of these measures are standard proven procedures that NEP incorporates in all transmission line construction projects. Others are site specific measures designed to meet the needs of the Project.

Structures: During new/or replacement structure installation, erosion and sedimentation controls will be installed along the perimeter of the excavation to avoid sedimentation of the adjacent wetlands. Following excavation, spoil piles will be contained by controls in appropriate upland locations.

Access Roads: As part of the wetland delineation and constructability review, existing and previously used access roads (roads that were established during the construction and/or maintenance of the existing lines that are now overgrown) were documented to determine feasible routes that would avoid and minimize impact to wetland resource areas. Where feasible, access road locations have been chosen to avoid BVW completely (usually by way of off-ROW upland access where available); to minimize impacts by crossing BVW using existing paths (previously impacted areas); or to traverse the BVW at its narrowest location.

Impacts on small streams are minimal and limited to the construction phase only. These impacts consist of temporarily spanning streams with construction mats to allow construction equipment to cross. A detailed erosion and sediment control plan will be designed and implemented (see below). Following construction, temporary construction mat access roads will be removed from BVW and associated intermittent streams. Impacted resource areas will then be restored to pre-construction configurations and contours to the extent practicable. Work occurring in BLSF will either not result in the loss of flood storage capacity, or compensatory flood storage will be provided.

Work Envelopes/Pull Pads: Structure improvements in or near BVW will result in short-term effects associated with the creation of temporary construction work envelopes. Proposed BVW work envelopes will include temporary construction mats placed on top of existing vegetation. Following construction, all mats will be removed from BVW and Bank and the impacted resource areas will then be restored to their pre-construction configurations and contours to the extent practicable.

There is no work proposed in the vicinity of CVPs or NHESP PVPs. However, one field delineated PVP was identified in Warwick. Temporary mats are proposed within this area.

Erosion and Sedimentation Control: In addition to those described above, erosion and sediment control devices will be installed along the perimeter of identified wetland resource areas prior to the onset of soil disturbance activities to ensure that spoil piles and other disturbed soil areas are confined and do not result in downslope sedimentation of wetland resources. Low growing tree species, shrubs, and grasses will be mowed only along access roads and at work envelopes. To avoid disturbing the root mat, tree stumps will be left in place except at work envelopes, structure locations and within access roads.

Dewatering may be necessary during excavations for new/or replacement structures within or adjacent to wetland areas. If there is adequate vegetation in upland areas to function as a filter medium, the water generally will be discharged to the vegetated land surface. Where vegetation is absent or where slope prohibits, water will be pumped into a dewatering basin consisting of a filter bag with haybale or silt fence perimeter controls which will be located in approved areas outside wetland resource areas. The pump intake hose will not be allowed to set on the bottom of the excavation throughout dewatering. The basin and all accumulated sediment will be removed following dewatering operations and the area will be seeded and mulched.

Concrete Wash Outs: Concrete wash outs will be used to manage concrete waste associated with the installation of caisson foundations. Concrete and concrete washout water will not be discharged directly on the ground, in wetlands or waterbodies, or in catch basins or other drainage structures. Where possible, concrete washouts will be located away from wetlands or other sensitive areas. Concrete washout areas will be regularly inspected by an Environmental Monitor.

Environmental Field Issue Document: Per NEP policy, Environmental Field Issue ("EFI") guidelines are developed for all construction and maintenance projects. At a minimum, the EFI will include the location of sensitive areas to be avoided, a summary of all permit requirements, detailed erosion and sediment control plans, and training requirements/documentation. All contractors and Environmental Monitors will be required to participate in EFI training before beginning work on site. In accordance with a schedule specified in the EFI, regular construction progress meetings will provide the opportunity to reinforce the contractor's awareness of these matters.

Supervision and Monitoring: Throughout the entire construction process, NEP will retain the services of an Environmental Monitor ("Monitor"). The primary responsibility of the Monitor will be to oversee construction activities, including the installation and maintenance of erosion and sedimentation controls, on a routine basis to ensure compliance with all applicable permitting requirements. The Monitor will be a qualified environmental scientist responsible for supervising construction activities relative to environmental issues. The Monitor will be experienced in erosion and sediment control techniques described in this narrative and will have an understanding of wetland resources to be protected.

During periods of prolonged precipitation, the Monitor will inspect all locations to confirm that the environmental controls are functioning properly. In addition to retaining the services of a Monitor, NEP will require the contractor to designate an individual to be responsible for the daily inspection and upkeep of environmental controls. This person will also be responsible for providing direction to the other members of the construction crew regarding matters of wetland access and appropriate work methods.

4.7.2 Wetland Resource Area Restoration

NEP uses standard mitigation measures on all transmission line construction projects to minimize impacts on wetland resource areas. These measures include revegetation and stabilization of disturbed wetland and adjacent upland soils and ROW vegetation management practices. Following construction, construction mats will be removed from BVW, and stone used for construction work envelopes, pull pads or guard structure work envelopes (locations to be determined) will be removed from BLSF and RA. Impacted areas will be returned to pre-construction configurations and contours to the greatest practicable extent. Restoration will include loam and seeding disturbed areas, final grading and installation of permanent erosion control devices, where necessary, in the adjacent uplands.

4.7.3 Wetland Replication and Compensatory Flood Storage

Unavoidable alteration due to new concreate caisson foundation installation will result in approximately 1,896 sf of permanent fill in BVW and 76.6 cubic yards ("cy") of flood storage displacement. Potential replication and compensatory flood storage mitigation measures are outlined below; as noted previously, final details will be developed after consultation with federal, state and local agencies.

Wetland Replication: Potential wetland replication areas to compensate for the approximately 1,896 sf of permanent fill in BVW have been identified and are currently under review by NEP and their consultants. Wetland replication areas will be chosen based on their proximity to impact areas and potential to enhance the functions and values of existing wetland systems. These replications areas will offset nearby impacts related to new structure installations. Wetland seed mix will be applied, and woody vegetation plantings will be installed immediately following grading activities. Replication areas will be monitored as required in local, state and federal permits.

NEP will work with the local Conservation Commissions to finalize mitigation for permanent loss in BVW.

Compensatory Flood Storage: Massachusetts Department of Environmental Protection ("MassDEP") requires compensation for any loss of 100-year flood storage capacity in accordance with the applicable performance standards of the WPA, as outlined at 310 CMR 10.57(4)(1). In accordance with these requirements, compensatory flood storage mitigation for the Project may include on-site replication at the same incremental elevations as the lost flood storage.

As noted previously, the Project will result in 76.6 cy of flood storage displacement due to the installation of eight (8) concreate caisson foundations. Compensatory flood storage mitigation is proposed for the Project and includes on-site replication at the same incremental elevations as the lost flood storage. Sediment controls will be installed along the perimeter of the excavation area to avoid sedimentation of the adjacent wetlands. Following excavation, the disturbed area will be restored, seeded and/or mulched.

NEP will work with the local Conservation Commissions, to finalize mitigation for permanent loss in flood storage area.

5.0 RARE SPECIES

5.1 INTRODUCTION

To assess the potential for state or federally listed, endangered, threatened, and/or special concern plant and/or animal species along the Project route, NEP reviewed MassGIS 2021 Priority and Estimated Habitat data layers, solicited database information from the Massachusetts NHESP, and followed the U.S. Fish and Wildlife Service ("USFWS") Endangered Species Consultation Procedure available on their website.

5.2 USFWS

As a result of the USFWS Endangered Species Consultation Procedure, it was determined that four (4) federally listed species may be present within the Project area. One (1) species is a threatened mammal, one (1) species is a candidate insect, one (1) species is an endangered plant, and one (1) species is a threatened plant. Review is ongoing to determine permitting and/or avoidance measures.

5.3 NHESP

Based on NHESP data layers and consultation, the Project route contains 9 state-listed species (two (2) reptiles, one (1) amphibian, two (2) invertebrates, three (3) birds and one (1) plant), along portions of the Project route in Warwick, Royalston, Winchendon, Athol, Fitchburg and Leominster. Specific species are not identified herein at the agency's request. These areas are within ROW that is maintained per NEP's VMP and the yearly Operations and Maintenance Plan, as approved annually by NHESP.

This section outlines the pre-consultation process with NHESP, including field surveys and wildlife habitat assessments conducted to date, potential impacts to rare species habitat, and proposed mitigation measures.

5.3.1 NHESP Pre-Consultation Process

NEP is currently consulting with NHESP for the Project. Information regarding the species present within the Project footprint was generated using the Restricted Data regarding rare species presence within National Grid owned properties and easement areas that NHESP provides to NEP annually.

Preliminary Habitat Assessments and Field Surveys: BSC conducted several field visits to assess habitat quality for general wildlife and habitat suitability specifically for listed species in 2021. These field assessments focused on the areas of known occurrence mapped by NHESP, and wetland areas where habitat assessment is required for wetland permitting compliance. Suitable habitat for each of the 9 listed species is present in various locations in the Project area.

To date, BSC has prepared a preliminary memo, summarizing observations and the potential for impacts based on the observed habitat, known biology of the species, standard construction methods, and NHESP-approved, species-specific BMPs. This memo will be submitted to NHESP as part of the consultation process.

5.4 PROPOSED MITIGATION MEASURES

In addition to generally avoiding and minimizing species and habitat impacts to the maximum extent feasible, the Project will use NHESP-approved, species-specific measures to reduce impacts. At this time, NEP is working closely with NHESP and consultation is ongoing. The Project will implement the necessary actions to avoid, minimize, and mitigate Project-related impacts to comply with the MESA permit issued for the Project.

If, after consultation with NHESP, it is determined that a take will occur, a Conservation Management Plan ("CMP") will be prepared to comply with MESA.

5.5 ANTICIPATED CONCLUSION

Consultation with NHESP is required to determine if the Project can be permitted using the Checklist option under MESA, or if CMP would be required.

6.0 HISTORICAL/ARCHEOLOGICAL RESOURCES

6.1 INTRODUCTION

This section reviews the Project's potential impacts on cultural resources.

NEP contracted SWCA Environmental Consultants ("SWCA") to conduct cultural resource due diligence on the Project. SWCA staff conducted background research and a physical inspection of the Project area. Background research involved a review of existing cultural resource reports on file at SWCA and the MHC, correspondence, and previously recorded historic and archaeological site files on file at MHC.

6.2 HISTORIC AND ARCHEOLOGICAL RESOURCES

In September 2020, SWCA conducted a due diligence review and documented known archaeological sites within and in proximity to the Project ROW. The analysis included a review of the State Historic Preservation Offices ("SHPO") site files for archaeological sites and aboveground resources. For archaeological and cultural resources, the study area was established at 1 km from the A1/B2 centerline within Massachusetts, as well as 1 km from the centerline of the tap lines. The area of potential effect ("APE") for aboveground historic resources includes areas adjacent to the ROW where visual impacts may occur. The APE for archaeological resources is defined as any areas of ground disturbance that may occur as a result of implementing the Project.

As part of the due diligence review, SWCA conducted a review of the MHC's Inventory of Historic and Archaeological Assets of the Commonwealth using the Massachusetts Cultural Resource Information System ("MACRIS") for the Massachusetts portion of the Project in June and July 2020. Records were searched for cultural resources within 1 km of the A1/B2 centerline within Massachusetts, as well as 1 km from the centerline of the tap lines. National Register of Historic Places ("NRHP") files were also checked for the Project municipalities to identify any listed properties located in or near the A1/B2 Lines. Locational information from the files was cross-checked against SHPO maps, and those locations were confirmed using Google Earth (2020) imagery. The file review included both historic aboveground resources and archaeological resources that are listed or evaluated as eligible for listing in the State and National Registers of Historic Places, as well as surveyed properties that have not been evaluated or listed. Cultural resource management reports and town histories and historic maps salient to the Project study area were also consulted.

Based on the results of the cultural resources due diligence, SWCA recommended conducting an archaeological sensitivity assessment along the A1/B2 Lines to define areas of high archaeological sensitivity that might be impacted by the proposed work. The sensitivity assessment was completed on January 6, 2021 and formed the basis for developing a field testing plan related to the structure replacement locations. SWCA developed a research proposal based on the background research and sensitivity assessment, which was submitted to the MHC in April 2021.

Archaeological survey fieldwork for the Project structure replacement portion was conducted between June 28 and September 1, 2021, in Massachusetts. Additional fieldwork was conducted on December 6, 2021. Testing consisted of excavating 1,501 50-x-50- cm test pits 1,094 of which were in Massachusetts. In total, 150 pieces of cultural material were recovered (11 Native American and 139 Historic period), of which 142 came from Massachusetts. Five (5) archaeological resources were identified. Four (4) sites were identified in Massachusetts: three (3) pre-contact and one (1) post-contact. None of the sites in Massachusetts are considered significant and no further survey was recommended.

Additional testing was completed in 2022 for proposed new and/or re-established access roads. This additional field testing was sent in a research proposal to MHC on March 28, 2022. MHC modified permit #4001 to include the access road testing on April 8, 2022.

SWCA will submit the archaeological locational survey technical report to the MHC in October 2022. Should any archaeological site examinations be recommended, an additional research proposal will be submitted to the MHC at that time.

7.0 CLIMATE CHANGE ADAPTATION AND RESILIENCY

NEP has taken steps to promote climate change adaptation and resiliency in the design of the Project and continues to consider climate change and long-term infrastructure resiliency an important goal in its long-term infrastructure planning. The Project will result in a more climate-ready and resilient transmission system that can withstand more extreme weather events; address existing system capacity shortages and increased demand; and support future interconnections from renewable energy projects. In addition, the Project uses substantial portions of an existing ROW, thereby minimizing alteration of new land resources to construct the Project. The purpose of the Project is to address existing asset conditions along the A1/B2 Lines that pose a threat to electrical reliability.

The system upgrades, as proposed, are intended to help ensure the long-term longevity and reliability of the region's electrical infrastructure in the face of growing demand and the changing climate. The proposed upgrades to the A1/B2 Lines, the Athol, Crystal Lake and East Westminster Taps and access road improvements will weatherize this energy infrastructure and provide high speed communications between substations which will improve outage response times and help protect communities from blackouts during severe weather events.

The proposed Project has been designed in alignment with NEP's reliability goals and strategies in the following ways:

- Incorporates new design standards and the latest in design;
- Provides needed upgrades to existing electric transmission infrastructure;
- Provides the shortest project delivery time to meet the identified needs;
- Minimizes impacts to natural and social environments; and
- Provides a stronger electrical transmission system, vital to the public's safety, security and economic prosperity.

7.1. MEASURES TO ADAPT THE PROJECT TO CLIMATE CHANGE PER RMAT DESIGN STANDARDS

The Project has incorporated measures that seek to reduce potential vulnerability to anticipated climate risks and improve resiliency for future climate conditions. Governor Baker's Executive Order 569 (Order) set forth specific objectives to build resilience and adapt to the impacts of climate change in the Commonwealth. As part of the Order, the Executive Office of Energy and Environmental Affairs ("EOEEA") was instructed to produce the Massachusetts State Hazard Mitigation & Climate Adaptation Plan ("SHMCAP") (Plan). In addition to the Plan, the Order provides support to local and regional entities to develop action plans and implement priority projects via the Municipal Vulnerability Preparedness ("MVP") grant program. The predictive success of a project's improved resilience to climate change impacts is measured by the EEA Resilient MA Action Team's ("RMAT") Climate Resilience Design Standards Tool. The Plan states in its risk assessment, that, "in addition to increasing demand for heating and cooling, periods of both hot and cold weather can stress energy infrastructure…Electricity consumption during summer may reach three times the average consumption rate of the period between 1960 and 2000; more than 25 percent of this consumption may be attributable to climate change." [26]

The Plan identifies that without reliable energy service, the basic needs of residents, visitors, businesses, and governments cannot be met. The Project, which is designed to improve reliable energy service within

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26 EOEEA, 2011 as cited in Massachusetts State Hazard Mitigation and Climate Action Plan, 2018, p. 265. Retrieved 6/14/2022,https://resilientma.org/shmcap-portal/static/media/SHMCAP-September2018-Full-Plan-web.286acceb.pdf#page=90

the region, serves this overall purpose. The Plan identified precipitation changes, sea level rise, rising temperatures, and extreme weather as the primary climate change interactions specific to regional power grid planning and incorporation of climate change data.

In accordance with the MEPA Interim Protocol on Climate Change Adaptation and Resiliency, NEP consulted the RMAT Climate Resilience Design Standards Tool for the Project. A copy of the output report generated by the RMAT tool ("RMAT Report") is provided in *Appendix G*. A review of high-risk parameters related to Environmental Justice ("EJ") Populations can be found in *Section 8.2.3.*

NEP considered each of these factors in designing the Project. NEP reviewed the RMAT Climate Resilience Design Standards Tool for climate projections, including coastal vulnerability, sea level rise and coastal flooding from the National Oceanic and Atmospheric Administration ("NOAA") and temperature rise. However, the Project area is located outside of areas identified as vulnerable to sea level rise and coastal flooding. The Project is also designed to account for more frequent extreme weather events and extreme heat. The Project's engineering design used structure loading criteria required by the National Electric Safety Code ("NESC") and National Grid Design Loads for Overhead Transmission Structures. The NESC load criteria require consideration of combined ice and wind district loading, extreme wind conditions, and extreme ice with concurrent wind conditions. NEP's standards also include consideration and contingency for heavy load imbalances and heavy ice conditions. All of these considerations result in a design that is better equipped to withstand extreme weather. The design incorporates materials (including steel structures and state of the art conductors) that have long useful lives and respond well to corrosive environments. The Project is also equipped to respond to increases in temperature. The new transmission line conductors are designed to operate at higher maximum operating temperatures at a higher carrying capacity and under fluctuations in air temperature.

The Project also contributes to regional climate resilient adaptation strategies for all the municipalities that the Project passes through. The RMAT Report documents the vulnerability of existing aging infrastructure and identifies key strategies to alleviate these vulnerabilities, including repair, upgrades and reuse and timely maintenance. Additionally, Project activities such as construction of access roads, work envelopes and installation of concrete caisson foundations will be required in floodplains. Design standards subject to floodplain will be followed during construction and the Project will meet the performance standards set forth by the state to ensure there are no impacts to climate change. The Project will result in a stronger electrical transmission system that is vital to the area's safety, security, and economic prosperity.

7.2. CONSIDERATION OF ALTERNATIVE LOCATIONS AND DESIGN STRATEGIES IN LIGHT OF CLIMATE CHANGE

For the reasons described in *Section 2.0*, the Project team concluded that the proposed Project location is the only location that meets the identified Project need and reliability, addresses the various regulatory objectives, minimizes environmental impacts, and provides a cost-effective solution to customers.

8.0 ENVIRONMENTAL JUSTICE

8.1. INTRODUCTION

This section reviews the Project's potential impacts on the EJ Populations pursuant to Section 58 of Chapter 8 of the Acts of 2021. The assessment has been prepared following the latest MEPA Protocol for Analysis of Impacts on Environmental Justice Populations (hereinafter, "MEPA Protocol for Analysis of EJ Impacts") that addresses and enhances public involvement.

NEP conducted analysis on EJ communities within a distance of 1-mile (i.e. the Designated Geographic Area ("DGA") of the Project.Within a 1-mile radius of the Project route, NEP identified 18 EJ Populations distributed in five (5) municipalities, including Gardner, Athol, Fitchburg, Leominster, and Lancaster. In total, Gardner, Athol, Fitchburg, Leominster, and Lancaster have 79.80%, 42.90, 72.90%, 67.10% and, 39% of the population living in an EJ Population, respectively. Additionally, as per the DPH EJ Tool, the total percentage of the communities of color in these five (5) municipalities are 9.90%, 18.0%, 37.70%, 30.70%, and 18.6%, respectively. Based on the MA DPH EJ Tool analysis, NEP identified populations that met the EJ criteria of income, minority, and minority and income within the designated geographical area. No English Isolation EJ Populations were identified within the designated geographical area; however, one EJ Population in Leominster (Block Group 2, Census Tract 7092.02) was identified to have 5% or more of the population who do not speak English very well.[27] This population was identified as having 7.7% of the population speaking Spanish or Spanish Creole. Additionally, NEP found that the median household income of the EJ Populations is $44,659 in Leominster and $44,659 in Gardner (MADPH, April 26).[28]. *Table 21* summarizes all of the EJ populations, their EJ criteria, population and median income within the 1-mile designated geographic area and Census Tract. Additionally, NEP identified 65 EJ communities present within the 5-mile radius of the designated geographical area.

8.1.1 Public Involvement

Per 301 CMR 11.05(4)(b), Advance Notification of the Project was sent via electronic mail on June 14, 2022, by BSC to all contacts on the EJ Reference List, provided by the MEPA Office on February 23, 2022.

The Advance Notification consisted of the EJ Screening Form, as provided by the MEPA Office in the Public Involvement Protocol; a copy is provided in *Appendix H*. Efforts were made to ensure that language in the EJ Screening Form was understandable to the reader; that is, "technical" language was replaced with plain language, and legal jargon was omitted to the extent feasible.

NEP has undertaken measures to incorporate community involvement into the MEPA process. These community engagement strategies were determined based upon existing NEP stakeholder outreach methods and community engagement strategies provided in the Public Involvement Protocol. These involvement methods were discussed and supported by the MEPA Office during a Pre-Filing Consultation held on April 7, 2022.

A public website, available in Spanish and English, is available which provides details of the Project, an interactive mapper, and contact information for review. This website address[29] was also provided on the EJ Screening Form. Additionally, NEP hosted a virtual public meeting on July 11, 2022; information pertaining to this meeting was advertised in the Athol Daily News, Sentinel & Enterprise (Fitchburg and Leominster), Gardner Magazine and The Gardner News, Lancaster Online, Winchendon Courier, W

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27 Data for languages spoken was obtained from the American Community Survey 2011-2015 5-year estimates, Table B16001.
28 MADPH (2022, April 26). *MA DPH Environmental Justice Tool*.
29 Website address: www.newenglandA1B2.com

orcester Telegram & Gazette, and the Greenfield Recorder, and was also provided to the EJ Reference list via electronic mail and to the abutters of the A1/B2 Lines within EJ Populations via mail, see *Appendix H.* Repositories for hard copies of Project materials have been established at public libraries within each of the nine (9) municipalities within the Project Site in the Commonwealth of Massachusetts, which will be updated regularly as additional Project documents become available. NEP has established a Project-specific email address (info@newenglandA1B2.com) for community members to ask any remaining questions they may have,

As noted above, no English Isolation EJ Populations were identified within the designated geographical area; however, one (1) EJ Population in Leominster was identified to have 5% or more of the population who do not speak English very well. Additionally, NEP contacted the municipalities within 5-miles of the Project to confirm that the languages spoken other than English were limited to Spanish. Given this information, the EJ Screening Form, meeting invitation and meeting invitation advertisement were translated into Spanish. Interpretation services were provided at the public meeting.

NEP will maintain the distribution list of contacts from the EJ Reference List and any additional contacts that are identified during the virtual meetings and public engagement process. Contacts will receive notifications of the MEPA site visit, summaries of supplemental information submitted to the MEPA office and any other relevant notices or materials issued during the course of the MEPA review.

Table 21: Massachusetts Department of Public Health (DPH) EJ Communities (1- Mile)[30]

Municipality	Census Tract	Category	Minority Population	Median Income
GARDNER	Block Group 1, 7075	Income	13.9 %	$56,023
	Block Group 3, 7075	Minority	34.3 %	$80,221
	Block Group 1, 7072	Income	18.4 %	$32,746
	Block Group 3, 7073	Minority and Income	40.4 %	$40,486
	Block Group 1, 7073	Income	21.4 %	$42,608
	Block Group 2, 7073	Income	14.30%	$44,659
	Block Group 2, 7074	Income	17.50%	$51,635
	Block Group 2, 7075	Minority	32.9 %	$63,401
	Block Group 1, 7071	Income	0.6 %	$41,397
	Block Group 3, 7075	Minority	34.3 %	$80,221
ATHOL	Block Group 1, 7033	Income	3.50%	$42,292
	Block Group 2, 7031	Income	5.50%	$43,938
	Block Group 1, 7031	Income	8.4 %	$35,556
	Block Group 3, 7032	Minority	33.40%	$0
FITCHBURG	Block Group 2, 7103	Minority	27.50%	$62,353
LEOMINSTER	Block Group 2, 7092.02	Minority and Income	40.4 %	$44,659
	Block Group 1, 7092.02	Minority	32.6 %	$59,896
	Block Group 3, 7092.01	Minority and income	30.3%	$55,938
LANCASTER	Block Group 4, 7131	Minority	29.6 %	$95,278

8.2 ASSESSMENT OF EXISTING UNFAIR OR INEQUITABLE ENVIRONMENTAL BURDEN

8.2.1 Vulnerable Health Criteria

This section outlines the assessment of existing unfair or inequitable environmental burden, pre-consultation process, including surveys and interaction amongst community-based organizations ("CBOs"), tribes, or other residents, Massachusetts Department of Public Health ("DPH") EJ Tool survey, assessments on vulnerable health EJ criteria, and assessments conducted to date, including potential impacts to the EJ population, and proposed mitigation measures. The DPH's Bureau of Environmental Health worked with the Massachusetts Executive office of Energy and Environmental Affairs (EOEEA) to identify four (4) environmentally related health indicators to identify populations and communities with higher-than-average rates of environmentally related health outcomes. The four (4) vulnerable health criteria

30 Data was obtained from https://www.mass.gov/info-details/massgis-data-2020-us-census-environmental-justice-populations

include: Low Birth Weight Rate, Pediatric Asthma Ed Visits Rate per 10,000, Heart Attack Rate, and Lead Poisoning Rate for each census track and municipality.[31] Vulnerable health criterion is defined as environmentally related health indicators that are measured to be 110% above state-wide averages.

The first part of the assessment analyzes the area around the Project for the potential for state listed environmental justice communities along the proposed route. NEP reviewed MA DPH Environmental Justice Tool data layers and solicited database information available on their website. Using the DPH EJ Tool, EJ Populations within 1-mile of the Project ("Designated Geographic Area") that exhibit one (1) or more of the four (4) specific "vulnerable health criteria" were identified. As a result of the MEPA Protocol for Analysis of EJ Impacts Requirements/Procedure and MA DPH Environmental Justice Tool[32], it was determined that all municipalities present in the designated geographic area meet at least one (1) Vulnerable Health EJ Criteria. The assessment concluded that the designated geographical areas exhibit "vulnerable health EJ criteria," and therefore, potentially bear an unfair or inequitable environmental burden and related public health consequences. See *Table 22* below.

Table 22: Vulnerable Health EJ Criteria (1 - Mile) (rounded to tenth)

Municipality	EJ and Vulnerable Health EJ Criteria Status	Vulnerable Health Topic EJ Criteria Met	Statewide Rate per 1000[33]
GARDNER	Meets at least one Vulnerable Health EJ Criteria	Low Birth Weight Rate per 1000	216.8
		Pediatric Asthma Ed Visits Rate per 10,000	83.1
		Heart Attack Rate per 10,000	26.4
		Lead Poisoning Rate per 1,000	17.6
ATHOL	Meets at least one Vulnerable Health EJ Criteria	Pediatric Asthma Ed Visits Rate per 10,000	83.1
		Lead Poisoning Rate per 1,000	17.6
		Low Birth Weight Rate per 1,000	216.8
		Heart Attack Rate per 10,000	26.4
FITCHBURG	Meets at least one Vulnerable Health EJ Criteria	Low Birth Weight Rate per 1,000	216.8
		Lead Poisoning Rate per 1,000	17.6
		Heart Attack Rate per 10,000	26.4
		Pediatric Asthma Ed Visits Rate per 10,000	83.1

31 Four vulnerable health EJ criteria are tracked in the DPH EJ Viewer, of which two (heart attack hospitalization and childhood asthma) are tracked on a municipal level, and two (childhood blood lead, and low birth weight) are tracked on a census tract level.
32 https://matracking.ehs.state.ma.us/Environmental-Data/ej-vulnerable-health/environmental-justice.html
33 Five-year average that is equal to or greater than 110% of the state rate.

LEOMINSTER	Meets at least one Vulnerable Health EJ Criteria	Pediatric Asthma Ed Visits Rate per 10,000	83.1
		Heart Attack Rate per 10,000	26.4
		Lead Poisoning Rate per 1,000	17.6
		Low Birth Weight Rate per 1,000	216.8
LANCASTER	Meets at least one Vulnerable Health EJ Criteria	Pediatric Asthma Ed Visits Rate per 10,000	83.1
		Lead Poisoning Rate per 1,000	17.6
		Heart Attack Rate per 10,000	26.4

8.2.2 Additional DPH Tool

NEP identified additional potential sources of pollution within the municipalities in the designated geographic area that could be contributing to the existing unfair or inequitable environmental burden and related public health consequences. Of the 18 EJ Populations in the designated geographic area, 10 EJ Populations, within five (5) municipalities were found to have potential sources of pollution. Pollution sources reviewed consist of air operating permits, large quantity generators, M.G.L. C. 21E Sites, Tier II Toxics use reporting facilities, MassDEP sites with AULs, MassDEP groundwater discharge permits, wastewater treatment plants, MassDEP public water suppliers, underground storage tanks, EPA Facilities, and Energy generation and supply.

Lancaster

In Lancaster, Block Group 4, Census Tract 7131, seven (7) potential pollution sources were identified. In total, there are three (3) underground storage tanks, and one (1) M.G.L. C. 21E Site, wastewater treatment plant, MassDEP public water supplier, and EPA Facility (See *Table 2*3).

According to NEP's survey on enforcement histories, there were two (2) facilities that received documented enforcement including the Lancaster Water Department and MCI Shirley Department of Corrections. The Lancaster Water Department (MassDEP public water supplier) has a history of 18 enforcements issued from 1996 to 2016 (See *Appendixt H*). MCI Shirley Department of Correction (underground storage tank) has a history of seven (7) enforcements from 2011 to 2018, within one (1) penalty, a fine of $500 (See *Appendix H).*

Leominster

In Leominster, Block Group 2, Census Tract 7092.02, one (1) underground storage tank was identified as a potential source of pollution (See *Table 23*).

According to NEP's survey on enforcement histories, Speedway 2431 was found to have a record of two (2) enforcements issued in 2011 and 2019 with no penalty assessed (See *Appendix H).*

Fitchburg

In Fitchburg, Block Group 2, Census Tract 7103, 32 potential pollution sources were identified including two (2) air operating permits, two (2) large quantity generators, four (4) large quantity toxic user, four (4) M.G.L. C. 21E Sites, seven (7) Tier II Toxics use reporting facilities, three (3) MassDEP sites with AULs, one (1) wastewater treatment plant, six (6) underground storage tanks, two (2) EPA Facilities, and one (1) Energy generation and supply (See *Table 23*).

According to NEP's survey on enforcement histories there are 10 Individuals/Facilities that comprise the potential pollution sources. These facilities are:

- 431 Westminster St LLC (Air permit, Large quantity toxic user)
- Newark America (Air permit, Large quantity toxic user, "Tier II" toxic use reporting facility, EPA Facility)
- Omnova Solutions Inc. (Large quantity toxic user, "Tier II" toxics use reporting facilities, underground storage tank, EPA facility)
- Modu Form Inc. (Large quantity toxic user, "Tier II" toxics use reporting facility)
- Avery Dennison ("Tier II" toxics use reporting facility)
- Chemdesign Corp (AUL, Underground storage tank)
- Montachusett Regional Vocational School (Underground storage tank)
- Fitchburg Wastewater West Plant (Underground storage tank)
- Cristy Corporation (Underground storage tank)
- Booster Pump Station (Underground storage tank).

431 Westminster St LLC has a history of three (3) enforcements with no penalty assessed from 2000 to 2009. Newark America has a history of three (3) enforcements from 2001 to 2008, with a penalty assessed in 2005 with a fine of $19,900. Omnova Solutions Inc. has a history of five (5) enforcements from 2002 to 2021, with a penalty assessed in 2002 with a fine of $21,500. Modu Form Inc. has a history of four (4) enforcements from 1996 to 2014, with two (2) penalties assessed. One (1) in 1996 for $500, and one (1) in 2000 for $9,250. Avery Dennison has a history of three (3) enforcements from 2001 to 2015 with no penalties assessed. Chemdesign Corp has a history of four (4) enforcements with no penalties assessed from 2002 to 2013. Montachusett Regional Vocations School has a history of five (5) enforcements from 2009 to 2017, with one (1) penalty assessed in 2010 for $500. The Fitchburg Wastewater West Plant has a history of three (3) enforcements from 2011 to 2014, with one (1) penalty assessed in 2014 for $500. The Cristy Corporation has a history of one (1) enforcement in 2011 with no penalty assessed. Lastly, the Booster Pump Station has a history of three (3) enforcements with no penalties assessed from 2011 to 2016. (*See Appendix H).*

Gardner

In Gardner, Block Groups 1, Census Tract 7075, contains eight (8) potential pollution sources, Block Group 2 contains five (5) potential pollution sources, and Block group 3 contains four (4) potential pollution sources. In Block Group 1, four (4) Tier II Toxics use reporting facilities, one (1) wastewater treatment plant, one (1) MassDEP public water supplier, one (1) underground storage tank, and one (1) energy generation and supply (See *Table 23*). In Block 2, one (1) large quantity generator, one (1) Tier II Toxics use reporting facility, one (1) underground storage tank, one (1) EPA facility, and one (1) energy generation and supply were identified (See *Table 23*). In Block 3, one (1) large quantity generator, and two (2) underground storage tanks were identified (See *Table 23*).

According to NEP's survey on enforcement histories there are five (5) Individuals/Facilities that comprise the potential pollution sources. These facilities are:

- Heywood Hospital ("Tier II" toxics use reporting facility, Underground storage tank)
- Gardner Water Department (Wastewater treatment plant, "Tier II" toxics use reporting facility, MassDEP public water supplier)

- Vivitide, LLC (Large quantity generator, EPA facility)
- North Central Correctional Institution (Underground storage tank)
- Gardner Stop & Buy (Underground storage tank).

Heywood Hospital has a history of 10 enforcements from 1997 to 2021, with four (4) penalties assessed for a total of $2,500. The Gardner Water Department has 17 enforcements from 1996 to 2022, with no penalties assessed. Vivitide LLC, has three (3) enforcements from 2006 to 2021, with one (1) penalty assessed for $9,000. North Central Correctional Institution has a history of five (5) enforcements from 1996 to 2021, with no penalties assessed. Lastly, the Gardner Stop & Buy has a history of 12 enforcements from 2006 to 2018, with six (6) penalties assessed for a total of $4,000 (*See Appendix H).*

Athol

In Athol, Census Tract 7031, Block Groups 1 and 2, each have 12 potential pollution sources, and Block Group 1, Census Tract 7073 and Block Group 3, Census Tract 7032 have nine (9) and two (2) potential pollution sources, respectively. In Census Tract 7031, Block Groups 1 and 2, there are two (2) Tier II Toxics use reporting facilities, four (4) MassDEP sites with AULs, one (1) wastewater treatment plant, three (3) underground storage tanks, and two (2) EPA facilities. (See *Table 23*).

According to NEP's survey on enforcement histories there are seven (7) Individuals/Facilities that comprise the potential pollution sources. These facilities are:

- Getty Petroleum Marketing Inc. (Underground storage tank)
- Girardi Distributors Corp (Underground storage tank)
- Pexco LLC (EPA Facility)
- Speedee Oil Change & Tune-Up (Large quantity generator, Underground storage tank)
- Cumberland Farms 2468 (Underground storage tank)
- Athol Memorial Hospital ("Tier II" toxics use reporting facility, Underground storage tank)
- Peterborough Oil Company ("Tier II" toxics use reporting facility, Underground storage tank).

Getty Petroleum Marketing Inc. has a history of three (3) enforcements from 2016 to 2019, with one (1) penalty assessed in 2019 for $500. Cumberland Farms 2143 has a history of one (1) enforcement in 1997 with no penalty assessed. The Girardi Distributors Corp has a history of three (3) enforcements from 2016 to 2020 with no penalties assessed. Pexco LLC has a history of three (3) enforcements from 1997 to 2004; in 1997 a penalty of $4,000 was assessed. Speedee Oil Change and Tune-Up has a history of two (2) enforcements from 20006 and 2008 with no penalties assessed. Cumberland Farms 2468, Athol Memorial Hospital and Peterborough Oil Company have all received one (1) enforcement with no penalty assessed in 2005, 2015 and 2006, respectively (See *Appendix H).*

Table 23: Other Potential Sources of Pollution within EJ Boundaries (1 - Mile)

Municipality	EJ Census Tracts	Air Operating Permits	Large quantity generators	Large quantity toxic user	M.G.L. c. 21E Sites	"Tier II" toxics use reporting facilities	MassDEP sites with AULs	MassDEP groundwater discharge permits	Wastewater treatment plants	MassDEP public water suppliers	Underground storage tanks	EPA facilities	Energy generation and supply	Total
ATHOL	7031, Block Group 1 and 2	0	0	0	0	2	4	0	1	0	3	2	0	12
	7032, Block Group 3	0	0	0	1	0	0	0	0	0	1	0	0	2
	7033, Block Group 1	0	0	0	1	3	1	0	0	0	4	0	0	9
GARDNER	7075, Block Group 1	0	0	0	0	4	0	0	1	1	1	0	1	8
	7075, Block Group 2	0	1	0	0	1	0	0	0	0	1	1	1	5
	7075, Block Group 3	0	1	0	0	0	1	0	0	0	2	0	0	4
FITCHBURG	7103, Block Group 2	2	2	4	4	7	3	0	1	0	6	2	1	32
LEOMINSTER	7092.02, Block Group 2	0	0	0	0	0	0	0	0	0	1	0	0	1
LANCASTER	7131, Block Group 4	0	0	0	1	0	0	0	1	1	3	1	0	7

8.2.3 RMAT Tool High-Risk Rating Parameters

This section reviews the Project's potential temporary and permanent climate change impacts on the EJ Populations. The assessment has been prepared by running preliminary climate change exposure and risk rating Project inputs on the RMAT tool. The RMAT is tasked with monitoring and tracking the State Hazard Mitigation and Climate Adaptation Plan ("SHMCAP") implementation process, making recommendations to and supporting agencies on plan updates, and facilitating coordination across State government and with stakeholders, including municipalities, and businesses. The guidelines provided by the tool are structured around three categories - site suitability ("SS"), regional coordination ("RC"), and flexible adaptation pathways ("AP"). These categories assess the adverse climate change impacts of the Project assets on the local and regional level, while also projecting future capacity and design for uncertainty and vulnerabilities to the climate from the Project.

The RMAT tool runs the Project asset impacts and generates an overarching climate risks analysis based on three variables: sea level rise and storm surge, extreme precipitation including urban flooding and riverine flooding, and extreme heat. According to the preliminary analysis, the Project is not exposed to sea level rise/storm surge.

The Project asset risk related to extreme heat is high (Tier 3) within all EJ Populations. The Project risk is at high exposure to extreme heat because the Project is not located within 100-ft of an existing water body and activities include tree removal. In addition, the Project's high exposure to extreme heat is because the existing ROW's canopy cover is approximately 10% to 40% of the ROW area. and the Project requires 164 acres of the existing canopy cover to be removed to comply with Transmission Lines Design Standard requirements. The ROW will be maintained as a vegetated corridor with no new impervious development capacity beyond the Project scope, thereby mitigating any additional risk of extreme heat and heat islanding. Notwithstanding the Project location and canopy reduction requirements; the improvements to the conductor capacity proposed among the Project objectives establishes a more resilient and qualified energy delivery service during times of high usage, such as extreme heat events, which are anticipated to increase in frequency due to climate change.

Similarly, the Project asset risk related to extreme precipitation - riverine flooding is high in all EJ Populations except in one (1) EJ Population in Leominster. The high exposure to extreme precipitation - riverine flooding is due to the Project location's history of riverine flooding. The Project is within 500-ft of a waterbody and less than 20-ft above the waterbody. The moderate exposure in one (1) of the sites in Leominster is due to the location of the EJ Population. The section of the ROW that goes through this specific EJ Populations is not within a mapped FEMA floodplain [outside of the Massachusetts Coast Flood Risk Model (MC-FRM)] and the Project is more than 500-ft from a waterbody.

Lastly, the Project asset risk related to extreme precipitation - urban flooding is high in all EJ Populations except in two (2) of the EJ Populations, one (1) in Leominster and one (1) in Gardner where the exposure is moderate. The Project has high exposure to extreme precipitation - urban flooding because the maximum annual daily rainfall exceeds 10 inches within the overall Project's useful life, and the existing impervious area of the ROW is between 10% and 50% of the total area. Similarly, the Project has moderate exposure to extreme precipitation - urban flooding in two EJ Populations, one (1) in Leominster and one (1) in Gardner, because the existing impervious area of the Project site is less than 10%.

State, federal, and local regulations will be followed to address all impacts caused during construction, and compensatory flood storage will be provided in accordance with the WPA Regulations for any proposed fill in BLSF.

8.2.4 Feedback from Public Meeting Pursuant to MEPA EJ Public Involvement Protocol

No issues or concerns were raised during the virtual public meeting on July 11, 2022.

8.3. ANALYSIS OF PROJECT IMPACTS TO DETERMINE DISPROPORTIONATE ADVERSE EFFECT

8.3.1. Nature and Severity of Project Impact

The Project will occur within the existing ROW, thereby minimizing adverse environmental impacts. Due to the nature of the Project, outage constraints in the region, and NEP's efforts to reduce impacts to the natural and human environment, Project activities will be sequenced in both the mainline and tap lines. No long-term impacts on soil, bedrock, vegetation, surface water, groundwater, wetland resources or air quality will occur. Any potential sedimentation impacts, and other short-term construction impacts to wetlands and surface waters, will be mitigated through the use of soil erosion and sediment control BMPs and temporary construction mats to protect wetland soils, vegetation root stock, and streams. As part of the Project, an environmental monitor will be part of the Project team to ensure compliance with all regulatory programs and permit conditions, and to oversee the proper installation and maintenance of the soil erosion and sediment control BMPs. Because the nature and severity of project impacts are minimal on all populations, including EJ populations, the Project will not materially exacerbate any existing unfair or inequitable environmental or public health burden impacting the EJ population.

8.3.1.1. Potential Environmental and Public Health Impacts and Proposed Mitigation

Potential environmental and public health impacts of the Project and anticipated mitigation include the following:

Air Quality

Construction-period activities, such as grading, road building, vehicle travel, and other earth-disturbing work may result in a temporary increase in airborne dust. Impacts to air quality will be minimized by managing the control of dust movement with practices such as spreading wood mulch or straw and using water trucks to spray dried soil to keep it moist. The potential for dust generation is only anticipated during the construction period. Post construction, soil will be stabilized and re-vegetated.

In addition, diesel-powered equipment is required to use ultra-low sulfur diesel fuel. Any diesel-powered non-road construction equipment rated 50-horsepower or more that will be used on the Project for 30 days or more will be required to install emission control devices. The impacts from these emissions will be minimal and are not anticipated to cause impacts to public health. Additionally, idling times are limited to five (5) minutes except when engine power is necessary for the delivery of materials or to operate accessories to the vehicle such as power lifts. Vehicle idling is to be minimized during construction activities and be in compliance with the Massachusetts Anti-idling Law, G.L. c. 90 § 16A, c. 111 §§ 142A – 142M, and 310 CMR 7.11.

Water Quality

The Project will incorporate protective and preventative measures to minimize and avoid impacts to water quality. The ROWs cross many wetland areas, streams and rivers. To protect water quality and these sensitive areas, temporary roads will be constructed using construction mats which will be removed following the completion of construction and the wetlands will be restored. In addition, BMPs, such as the use of straw wattles, silt fencing, stormwater management features, and other control measures will be used to prevent soil and other material from being transported into wetlands and streams. Using these BMPs, any impacts to water quality will be negligible and temporary and are not anticipated to cause impacts to public health.

Land Protection and Open Space

There is one (1) EJ Population with Municipal Open Space (Gardner Municipal Golf Course) within the Project ROW specifically, Block Group 1, Census Tract 7075 in Gardner. Access to the golf course will not be impacted by the Project since the activities will be limited to within the existing ROW.

The A1 and B2 Lines pass through several State Forests owned and maintained by DCR. There is one (1) EJ Population within the Project ROW, Block Group 2, Census Tract 7103, located within a DCR Property (Leominster State Forest). This property does not have access roads, trails, or parking for public access. Additionally, Project activities will be limited to the existing ROW. Access to Protected Land and Open Space within EJ Populations will not be impacted.

Noise

The EJ Populations that are most likely to have temporary noise impacts are the communities that are directly within or are located near the ROW. The EJ Populations that have relatively dense development are Block Group 1, Census Tract 7075 in Gardner and Block Group 1, Census Tract 7031 in Athol. The EJ Population in Athol is approximately 100-ft from the Athol Tap Line, whereas the ROW goes through the EJ Population in Gardner. Noise impacts associated with construction-period activities are temporary in nature and expected to be minimal. Where construction will occur adjacent to residences, NEP will notify landowners prior to the commencement of work. Noise-generating activities will be conducted in accordance with any local and state requirements and are not anticipated to cause impacts to public health.

Traffic

Impacts to traffic during the construction of the Project will be minor and intermittent. The work areas will be accessed primarily from NEP-owned access routes or minor town roadways. Within Block Group 2, Census Tract 7103 in Fitchburg, temporary access off Route 2 will be required. NEP will obtain the necessary permits from MassDOT for access. Once on-site, vehicle traffic will be limited to within or in proximity to the ROW. Since the ROW is an un-manned facility, there will be no permanent impacts to traffic patterns or use of existing roadways and no impacts to public health are anticipated from traffic post-construction.

NEP anticipates no long-term construction impacts as the Project will occur within the existing ROW. Any short-term construction impacts will be mitigated through the use of BMPs and completed in accordance with any local, state, and federal regulations.

8.3.2 Comparable Impacts on EJ and Non-EJ Populations

The MEPA Protocol for Analysis of EJ Impacts states that "the Proponent should also analyze whether the impacts on the EJ population are greater or less than those on non-EJ populations. The purpose of this analysis is to assess whether the project is adding impacts to an already burdened area in a "targeted" way that is disproportionate when compared to non-EJ populations." Due to the nature of this project, there is no disproportionate impact on EJ populations within the DGA.

The Project generally minimizes impacts on all populations by refurbishing an existing line within an existing transmission line corridor. Because of this, the Project does not result in any significant long-term environmental or public health impacts for any population, including EJ populations. Impacts from construction are temporary and insignificant. They will not result in any public health impacts to any population. Other impacts, such as temporary impacts to wetlands, do not directly affect any population or affect any populations disproportionately.

8.3.3. Project Benefits

The Project will benefit from an increased reliability of the overall transmission line by refurbishing the existing structures and wire. on more robust structures and higher strength conductor will be installed which are better suited to withstand storm events and are less prone to experiencing line outages. The new overhead lines will be larger which will allow more electricity to flow during times of high usage, such as extreme heat events, which are anticipated to increase in frequency due to climate change. The installation of OPGW will allow better communication between substations, resulting in improved response time during storm-related emergencies and outages, which will increase public safety.

Other benefits of this Project that are not expressly stated includes the reduction of an overall disturbance to adjacent landowners, wetland resource areas, and rare species habitat over time by planning for the future and reducing the likelihood of multiple repeat projects, thereby reducing environmental impacts, and reducing costs to NEP's customers. Addressing the climate change crisis requires a major expansion of renewable energy and the infrastructure necessary to support and deliver that energy. NEP is actively taking steps to ensure that its system is ready to meet this critical challenge. Replacing infrastructure like the A1/B2 Lines helps to accomplish this goal. The replacement lines will have higher kV ratings that will support higher volumes of currently active and forecasted renewable energy resources in this region. This longer-term view is supported by the recently shared initial results of the ISO-NE 2050 study, where an upgrade to 115 kV would be necessary based on the current study assumptions and long-term forecasts for the Commonwealth. Furthermore, the replacement of the Lines will have the added benefit of allowing significantly more renewable energy resources to connect into the system if and when the lines are operated at 115kV. 115kV operation will require work at substations along these lines before it can be implemented. Overall, the Project will improve transmission system infrastructure and comply with comprehensive regional plans for improving electric transmission reliability in New England, for EJ and Non-EJ Populations alike. No long-term impacts on soil, bedrock, vegetation, surface water, groundwater, wetland resources or air quality will occur as a result of this Project. Throughout construction, mitigation measures will be implemented effectively to minimize Project impacts on the environment.

Following the completion of construction, NEP uses standard mitigation measures on all transmission line construction projects to minimize the impacts of projects on the natural environment. These measures include revegetation and stabilization of disturbed soils, ROW vegetation management practices, and vegetation screening maintenance at road crossings and in sensitive areas. Other measures are used on a site-specific basis. NEP will implement standard and site-specific mitigation measures for the Project.

As discussed above, short-term construction related impacts are not anticipated to adversely affect EJ Populations as BMPs will be implemented and construction will follow federal, state and local construction requirements. The Project is not anticipated to result in increased health burdens considered in the vulnerable health criteria. The Project will not result in a new potential pollution source, or negatively impact the environment to further burden the EJ Populations that are affected by current pollution sources. Lastly, there is not a significant disproportionate effect identified with 10% of Project impacts located within the EJ Populations, which represents 10% of the Project ROW, whereas 90% of Project impacts are within non-EJ Populations, which represents 90% of the Project ROW. Therefore, it is the opinion of NEP that the Project will not have unfair or inequitable impacts on the EJ Populations within the designated geographic area.

8.3.4. ANALYSIS OF PROJECT IMPACTS TO DETERMINE CLIMATE CHANGE EFFECTS

The Project team has evaluated the project impacts in regard to Climate Adaptation and specifically the effect on EJ populations as directed by the MEPA protocol. The cities of Leominster, Gardner, and Athol include EJ populations within the DGA of the Project. The MEPA protocol requires evaluation with respect to sea level rise/storm surge and extreme precipitation (urban or riverine flooding), tree clearing and/or land use change (e.g., adding impervious area) and its effect on heat conditions in the area, or other climate related changes that could be affected by the Project.

Structures with concrete caisson foundations that are located within the 100-year flood zone could slightly impact flooding conditions have been evaluated along the ROW. There are several structures proposed with concrete caisson foundations located within the 100-year (i.e., 1% risk) flood zone based on review of available Flood Insurance Rate Maps (FIRMs); however, there are none located within the identified EJ population communities of Leominster, Gardner, and Athol. Compensatory flood storage will be provided as required by the WPA. Additionally, any work areas that will be constructed within the 100-year flood zone will be constructed using temporary timber matting and will not permanently impact the flood zone.

Additionally, access roads and work pads that will be created along the ROW to support construction will use pervious gravel and will include stormwater BMPs to manage and control stormwater runoff. The change from shrub vegetated landscape to gravel roads and work pads is not anticipated to significantly change drainage conditions along the ROW.

As described in section 8.2.3, the project asset risk to extreme heat was high within all EJ neighborhoods, per the RMAT tool. A driver of this risk score is removal of 164 acres of the existing canopy cover to comply with Transmission Lines Design Standard requirements. 24 acres (15% of project total) of tree removal will occur in EJ Census Blocks. An examination of the proposed conditions in all EJ neighborhoods reveals that one section of the ROW, approximately .31 miles long parallel to Park St. in Gardner, proposed tree removal intermittently extends to the existing tree line on the east side of some properties. Where this occurs, shade to these properties in the morning will be reduced, though not fully eliminated, and portions of the property near the ROW may experience a minor short-term increase in temperature. In contrast to these minor potential impacts, the Project provides substantial benefits through improvements to the conductor capacity which establishes a more resilient and qualified energy delivery service during times of high usage, such as extreme heat events, which are anticipated to increase in frequency due to climate change.

9.0 GREENHOUSE GAS PROTOCOL

9.1 INTRODUCTION

As part of the MEPA Greenhouse Gas ("GHG") Protocol, the Executive Office of Energy and Environmental Affairs ("EOEEA") requires a review of a Project's potential for emission of greenhouse gases. The Greenhouse Gas Emissions Policy was included in the MEPA review process to fulfill the statutory obligation to take all feasible measures to avoid, minimize, or mitigate damage to the environment by the Project. The Policy requires Projects to undergo review by the MEPA office to quantify the Project's GHG emissions, along with the impacts of proposed mitigation in terms of emissions and energy savings and identify measures to avoid, minimize, or mitigate such emissions. MEPA GHG Protocol provides guidance to projects that are subject to MEPA review without creating specific new regulatory requirements.

The Project does not have any emissions sources that require analysis under the GHG emission Quantification Protocol. However, the protocol provides the Secretary with discretion, on a case-by-case basis, to require GHG analysis of certain types of other project impacts, including projects that will result in alteration of land greater than 50 acres. If such an analysis is required, the protocol states that the Secretary will advise the proponent of this requirement in the Certificate on the ENF or EENF. In the Project pre-filing meeting, the MEPA Office indicated it would be requiring a GHG analysis of the tree removal aspects of the Project. The MEPA Office did not identify a methodology and NEP agreed to evaluate possible approaches and discuss them in the EENF. NEP is evaluating potential analysis approaches to meet MEPA's requirement including field analysis, available datasets and research, and emissions mitigation evaluation. One potential analysis would include the following two steps:

1. Estimate the existing carbon stocks using height adjusted land cover values with LiDAR.

Estimation of above ground (trees) and below ground (roots) biomass applies average biomass carbon values for each land cover, as classified in the 2016 1-m High Resolution Land Cover layer. The biomass carbon values are derived from the best available datasets for New England land covers. To account for stand age and density, available LiDAR data would be used to calculate forest height and adjust against the average height of forest trees in the data sets used to assign biomass carbon values. Deviation from the average will be used as a factor to increase or decrease the value assigned to that portion of the land cover. To verify the GHG values, five (5) sample sites will be chosen to be evaluated in the field to confirm assumptions.

2. Carbon Flux Analysis.

Comparison between the existing and proposed land cover would be conducted by calculating the differential between existing carbon values and estimated carbon values taking into account soil type and proposed land cover. The flux would include sequestration rates and growth between the time of construction and the MEPA proposed time horizon of 2050.

10.0 GENERAL TRANSMISSION LINE CONSTRUCTION PROCEDURES

10.1 CONSTRUCTION PROCEDURES

The Project will adhere to conventional transmission line maintenance and construction procedures along with any agency requirements. These procedures are documented in EG-303NE (please refer to *Appendix C*), which outlines NEP policies for ROW access, maintenance and construction BMPs. By consistently implementing these procedures, NEP ensures that transmission lines are constructed by trained personnel in a manner that minimizes potential impacts to the environment, adheres to permit conditions, and meets industry standards. This section summarizes NEP policies and addresses Project-specific construction methods. The discussion presumes that all required permits and authorizations will have been issued, and that throughout construction appropriate consideration will be given to Project implementation in a manner consistent with conditions of permits/authorizations and approved mitigation measures.

10.2 ENVIRONMENTAL COMPLIANCE AND MONITORING

Project activities will be overseen by an "Environmental Monitor," a qualified environmental professional designated by NEP who can capably monitor on-site construction conditions in relation to permit and regulatory requirements (see *Section 11: Regulatory Compliance*). In addition, NEP's contractor will designate a Construction Supervisor who will be responsible for daily inspections of work areas during the construction period and will address potential issues related to the environment (i.e., erosion and sedimentation). The Construction Supervisor will be on-site daily to perform required inspections and has "stop work" authority if required due to an observed or reported infraction of the standards and procedures.

Documentation identifying deficiencies of sediment and erosion control measures will be forwarded to the construction supervisor for implementation of corrective measures. As a proactive approach to ensure compliance with environmental permit requirements, all construction personnel will be briefed on the Project's environmental issues and permit obligations prior to construction. Field staff will also be trained to recognize and respond to changing field conditions as they relate to protecting sensitive areas, wetland resource areas and preventing sedimentation and stormwater runoff. Regular progress meetings will be held to reinforce contractor's awareness of these issues.

Environmental Monitors will be responsible for monitoring work when activities occur within rare species habitat. Specific functions to be performed by the scientist will be defined during consultation with NHESP.

10.3 CONSTRUCTION STAGES

Once initiated, work will generally follow the sequence listed below. However, certain activities may occur simultaneously within one or more areas of the Project.

- Refreshment of flagging of wetland and other sensitive resources adjacent to work areas and access roads;
- Vegetation management
- Install BMPs;
- Construct, improve or re-establish access roads; maintain as necessary;
- Establish work envelopes;
- Install new/or replacement utility structures;
- Install OPGW/Replace shield wires;
- Remove existing and temporary structures;
- Restore the ROW, as necessary, including revegetation of disturbed areas resulting from the construction process to the greatest practicable extent; and dispose of existing line components;
- Conduct follow-up inspections, as required.

The following sections provide details for the transmission line construction activities.

10.3.1 Refreshment of Resource Area Flagging

Wetlands in the Project area have been delineated and are shown on the *MEPA General Purpose Plans presented in Appendix A*: Figures. Sensitive resources, e.g., rare species habitat and vernal pool habitat, have also been field-identified. Prior to the start of construction, these resources will be rechecked for accuracy and reflagged, as appropriate.

10.3.2 Establish Limit of Disturbance

It is anticipated construction activities and materials will be confined to the LOD as shown on the MEPA General Purpose Plans in *Appendix A.* Prior to the start of construction, these areas will be flagged, as appropriate. The LOD zone represents the additional work area beyond the limits of grading which is also shown on the MEPA General Purpose Plans in *Appendix A.* Within the LOD, equipment access, the placement of temporary BMPs, soil stockpiling and equipment maneuvering is anticipated. In addition, where applicable, tree removals are preliminarily assumed within the LOD zone due to the anticipated secondary impacts from grading activities. Temporary construction matting is assumed to be utilized where-access is necessary in wetlands. NEP is working toward solutions to reduce the extent of the LOD throughout the Project ROW. NEP will coordinate with landowners as necessary for temporary construction access as the plans are refined.

Due to the land use constraints within Article 97 lands, construction access will be limited to the easement. These areas will be reviewed as the design advances and modifications to the design, such as adding additional retaining walls, may be necessary to stay within the confines of the easement.

10.3.3 ROW Clearing and Installation of BMPs

Following the ROW vegetation management activities, proper sediment and erosion control devices, such as straw wattles, silt soxx, straw bales, and siltation fencing, will be installed in accordance with approved plans and permit requirements (e.g., OOC), and overseen by NEP's Construction Supervisor. Weekly inspections to evaluate potential erosion and/or sedimentation issues will be conducted, and inspection reports will be submitted until "final stabilization" has been achieved (i.e., 70 percent vegetative cover or at least to pre-construction conditions within the disturbed areas). Photographic documentation will also be performed. The control devices will provide the dual function of mitigating construction-related erosion and sedimentation, as well as serving as a physical boundary to delineate resource areas and to contain construction activities within approved areas.

10.3.4 ROW Vegetation Management

To facilitate construction equipment access along the majority of the ROW and at structure sites, vegetative removal, will be undertaken in select areas, as necessary. This will be done to provide access to proposed structure locations to facilitate safe equipment passage, to provide safe work sites for personnel within the ROW, and to maintain safe and reliable clearances between vegetation and transmission line conductors. Additionally, disturbed areas would be allowed to revegetate with low growing scrub-shrub species, similar to existing vegetation within the maintained portions of the ROW.

As part of an IVM program, NEP's professional arborists oversee the use of mechanical, natural, and chemical (herbicide application) methodologies to effectively manage vegetation along the ROW. Vegetation maintenance of the ROW will be consistent with the approved VMP. Herbicides will be applied by licensed applicators to select target species. Herbicides are never applied in areas of standing water or within designated protective buffer areas associated with wells, surface waters, and agricultural areas. NEP currently utilizes a four- to five-year vegetation maintenance cycle on its transmission ROWs. NEP's ROW vegetation maintenance practices encourage the growth of low-growing shrubs and other vegetation that provide a degree of natural vegetation control. Vegetation maintenance under and adjacent to the transmission lines and tap lines will be consistent with current ROW procedures. Vegetation management within sensitive areas, including NHESP-designated priority habitat, is outlined in the VMP.

10.3.5 Access Road Reestablishment and Improvements

Access roads along the ROW allow NEP and contractor personnel to construct, inspect, and maintain the existing and proposed transmission line facilities. After careful planning and field investigations, NEP has determined that the majority of the line requires establishing new or improving existing access roads. In locations where maintenance or upgrades are required to support construction activities, gravel may be added to provide a stable and level surface for construction vehicles. It may also be necessary to reestablish roads that were used for the installation and maintenance of the existing lines but have become overgrown. To be conservative, it is assumed that access roads will be maintained after they are improved or reestablished for the Project. NEP's actions and future maintenance of off-ROW access routes will be guided by agreements with individual property owners.

In planning for site access, consideration was given to avoiding the use of access roads within or adjacent to environmentally sensitive areas to minimize the potential impacts associated with construction activities. Due to the extensive wetlands located in portions of the ROW, access across wetland areas and streams could not be avoided. Where upland access is not available, vehicles and equipment will be accommodated by the temporary placement of construction mats. Temporary construction mat access roads will be removed following completion of construction.

Although construction mats displace the weight load of equipment, depressional grooves or furrows (i.e., rutting) in the wetland soil may still result. It is important to note that rutting is not the normal circumstance that results from the use of construction mats. The extent of this temporary impact is a direct function of many factors, including but not limited to soil texture; moisture content; type of construction mat; and time of year. If the rutting is greater than approximately six (6) inches deep, these areas will be re-graded (or backbladed) to reestablish the preexisting topography and maintain existing wetland hydrology. NEP will work with each community's Conservation Commission or authorized representative (i.e., Agent), as well as the USACE, to ensure that the area is in compliance with all performance standards in all applicable wetlands regulations as well as each OOC.

Access road construction will be carried out in compliance with the conditions and approvals of the appropriate federal, state and local regulatory agencies, including the NHESP and MHC. Exposed soils on access roads will be wetted and stabilized, as necessary, to suppress dust generation. Crushed stone aprons will be used at all access road entrances to public roadways to clean the tires of construction vehicles and minimize the migration of soils off-site.

Equipment typically used during the installation and maintenance of access roads will include dump trucks used to transport fill materials to work sites, and bulldozers, excavators, vibratory rollers, backhoes and graders which will be used to place fill materials or make cuts to achieve the proper access road profile. Throughout the Project, pick-up trucks will be used to transport crews and hand-held equipment to work sites. Low-bed trailers will be used to transport tracked and other off-road equipment, which cannot be operated on public roadways to the work site.

10.3.6 Establish Work Envelopes and Staging Areas for Construction

Construction work envelopes, pull pads, and guard structure work envelopes (locations to be determined) will support the equipment needed to complete the structure installation, replacement and improvements. Work envelopes and staging areas (*shown on MEPA General Purpose Plans)* are primarily within existing ROW, but work envelopes for structures 466, 467, 468, 469, 493, 502A, 503A, 504, 537-1, 539, (Westminster); 598, 550, 599, 606, 555, 607, 608, 556, (Leominster); 597, 598, 599, 600, 601 (Sterling); CHE 97, CHE 98, CHE 99 (Chestnut Hill SS, Athol), are partially or completely off the ROW.

Construction work envelopes will vary in size based on various factors, for example specific activities and equipment required at each location and topographical constraints. In general, the work envelopes have been designed to be up to approximately 157-ft by 80 to 100-ft depending on the width of the ROW and extent of grading required to create the level work area and provide adequate space for the typical construction associated with the project scope of work as shown on the MEPA General Purpose Plans.

The actual area needed to support equipment will depend on the equipment needs at that particular location, as well as site specific conditions. Grading and/or stabilization may be required within work envelopes to provide a level work surface for construction equipment and crews in upland areas. Anticipated limits of disturbance associated with grading activities are identified on the MEPA General Purpose Plans. NEP designed the Project to avoid permanent impacts to wetland resource areas to the maximum practicable extent, but since this Project consists of maintenance and improvements to an existing alignment, permanent and temporary impacts could not be avoided. Where impacts to BVW are required for work envelopes, construction mats will be temporarily placed over wetland areas to distribute equipment loads and minimize disturbance to the wetland and soil substrates. Proposed construction mat locations are shown in the MEPA General Purpose Plans. Temporary construction mats will be removed following completion of construction.

Any area identified by NEP's archaeological consultant as a potentially significant archaeological resource will be avoided if safe/practicable alternatives are available. NEP will conduct investigations for archaeological resources in accordance with a Massachusetts State Archaeologist's permitted plan prior to any site preparation or excavation.

10.3.7 Installation of Foundations and Replacement and Installation of Structures

Equipment typically used during the installation of foundations and the replacement of structures includes excavating equipment such as backhoes and excavators, rock drills/augers and concrete trucks. Suspension structures will be installed using the "Direct Embed" construction method, and Deadend structures will be installed using the "Self-Supporting" construction method, also referred to as caisson foundations, described as follows.

Table 24: Installation of Foundations and Replacement and Installation of Structures

Direct Embed:	The installation of a direct embed structure (e.g., tangent or in-line structures) involves the excavation of a hole, the installation of a vertically placed steel culvert (corrugated pipe), placement of the new pole within the culvert, and backfill of the culvert with stone around the pole. The fill needed for these structures is the backfill required within the culvert above existing surrounding grade. Assuming the average direct embed foundation (i.e., culvert) will be installed flushed with the surrounding grade per NEP Standards, no fill above ground will result. The area affected by each foundation, assuming a 72-inch diameter culvert, is approximately 28 square feet. Guy wires and anchors will be installed as required by code.
Self-Supporting (Caisson Foundations):	The installation of a self-supporting structure (e.g., angle and dead-end structures) involves drilling a vertical subsurface temporary casing shaft (oversized to fit the permanent casing), followed by the installation of the permanent casing within the temporary casing, the installation of the steel reinforcing cage (tied rebar), the placement of anchor bolt clusters (to attach the structure to the foundation), pouring of concrete to form the foundation within the permanent casing (also called a caisson foundation), backfilling the void between the permanent and temporary casing as the temporary casing is removed, bolting the new structure to the foundation, and final grading around the base of the structure. Assuming the average caisson foundation protrudes approximately 4-ft above surrounding grade, each 10-ft diameter caisson would result in approximately 316 cubic feet of fill per pole.

In general, any excavated material will be placed next to the excavation. Steel culvert casings are used to support the sides of excavations. Once the structure has been properly positioned and plumbed within the hole, the excavation will be backfilled with clean three-quarter inch minus gravel and tamped to provide structural integrity. Following the backfilling operation, any remaining excavation spoils will be spread over upland areas or removed from the site.

Handheld equipment, including shovels and vibratory tampers, are used during the backfilling of foundations and structures. Dump trucks are used to remove excavation spoils from the work site if necessary. Cranes are used to erect structures, and bucket trucks or a crane with a basket are used to lift the linemen to the aerial work zone. Tracked equipment that cannot be operated on public roadways will be transported to the work site by means of a low-bed trailer. Poles will be comprised of two (2) to three (3) sections and will be transported to the site via tractor trailers.

Dewatering may be necessary during excavations for foundations near wetland areas. At all times dewatering will be performed in compliance with the EG-303NE guidelines and BMPs. If there is adequate vegetation in upland areas to function as a filter medium, the water generally will be discharged to the vegetated land surface. Where vegetation is absent or where slope prohibits, the water will be pumped into a hay bale or silt fence settling basin located in an upland area. The pump intake will not be allowed to rest on the bottom of the excavation throughout dewatering. The basin and all accumulated sediment will be removed following dewatering operations and the area will be seeded and mulched.

10.3.8 Conductor and OPGW Installation

Following structure upgrades, the OPGW will be replaced by utilizing “Tension Stringing Methods” in accordance with Institute of Electrical and Electronics Engineers (“IEEE”) 524 and National Grid

Transmission Specifications Document # SP.06.01.301. The wire will be installed in sections varying in length from a single span to two (2) miles or more. The equipment that typically will be used during the conductor and shield wire installation operation includes stringing blocks; a multi-reel rope puller; a single reel hardline puller; a bundle tensioner; conductor reel stands; bulldozers; and cranes.

The wire stringing equipment is used to pull the conductor and shield wire through the stringing blocks one wire at a time. First the insulators and stringing blocks will be installed on the structures. Next the ropes (one per phase and shield wire) will then be pulled from structure to structure by either equipment on the ground or with a helicopter. The rope will then be used to pull in the hard line (wire rope) from the puller to the wire reels and the puller will then pull in each shield wire or phase conductor bundle. At no time during installation will the wire be permitted to come into contact with the ground. Once the wire is in place, it will be pulled up to final sag and permanently affixed to the new structures. This process will be repeated for each section of line. During the stringing operation, temporary guard structures or boom trucks with guard attachments will be placed at road and highway crossings, and at crossings of existing utility lines, to ensure public safety and the continued operation of other utility equipment. The location of the temporary guards is currently under review.

To minimize disturbance to soils and vegetation, existing access roads will be used to the fullest extent possible in the placement of wire stringing equipment and materials. The wire reels and other large material items will be transported to and along the ROW using large trucks and tractor trailers. Pickup trucks will be used to transport work crews and small materials to work sites.

10.3.9 Restoration of the ROW

Restoration efforts will be completed following the construction operations. Construction debris will be removed from the Project site and disposed of properly. Disturbed areas around structures and other graded locations will be seeded with an appropriate seed mixture and/or mulched to stabilize the soils in accordance with applicable regulations. Construction work envelopes will be loamed and seeded where necessary (i.e., where grading is proposed). Temporary sedimentation control devices will be removed following the stabilization of disturbed areas; straw bales, straw wattles, or similar may be removed or left in place after the stakes are pulled and the strings cut.

Wetland restoration areas will be monitored until 75 percent vegetative cover is achieved or in accordance with applicable agency requirements.

10.3.10 Replication Area Construction

Where wetland replication is undertaken, construction will have oversight conducted by qualified environmental consultants. Replication areas will be monitored, and corrective actions undertaken as necessary to ensure that within two (2) growing seasons there will be a 75 percent vegetative cover of indigenous wetland plant species. All work will be completed in compliance with applicable permit conditions. Wetland replications will be conducted as required under the WPA Regulations. The locations of wetland replication areas are currently under review.

10.4 CONSTRUCTION TRAFFIC AND EQUIPMENT

10.4.1 Construction Traffic

Access to the ROW for construction equipment will typically be gained from public roadways crossing the ROW in various locations along the route and adjacent existing off-ROW access roads. Because each of the construction tasks will occur at different times and locations over the course of the construction, traffic will be intermittent at these entry roadways. Traffic will consist of various vehicle types ranging from pick-up trucks to heavy construction equipment.

NEP's contractor will coordinate closely with MassDOT to develop acceptable traffic management plans for work within state highways. NEP will coordinate with local authorities for work on local streets and roads. At locations where construction equipment will be staged in a public way, the contractor will follow a pre-approved work zone traffic control plan. Prior to use of off-ROW access roads, permission will be obtained from private landowners.

10.4.2 Construction Equipment

Table 27 lists the equipment that is likely to be required to install the new overhead transmission lines and to remove the existing structures. Any diesel-powered non-road construction equipment with engine horsepower ratings of 50 and above to be used for 30 or more days over the course of construction will either be USEPA Tier 4-compliant or will be retrofitted with USEPA-verified (or equivalent) emission control devices such as oxidation catalysts or other comparable technologies (to the extent that they are commercially available) and installed on the exhaust system side of the diesel combustion engine. NEP requires the use of ultra-low sulfur diesel fuel in its diesel-powered construction equipment and limits idling time to five (5) minutes except when engine power is necessary for the delivery of materials or to operate accessories to the vehicle such as power lifts. Vehicle idling is to be minimized during construction activities, in compliance with Massachusetts Anti-idling Law, G.L. c. 90 § 16A, c. 111 §§ 142A – 142M, and 310 CMR 7.11.

Table 25: Typical Overhead Transmission Line Construction Equipment

Construction Phase	Typical Equipment/Materials Required
Site Preparation	Pickup and other small trucks Flatbed trucks, brush hogs, bulldozers, bucket trucks for tree canopy trimming, woodchippers Erosion and sediment control devices Equipment for tree trimming and/or cutting
General Activities	Vehicles to transport personnel Side booms, forklifts and cranes to handle materials Trucks to haul sanitary/solid wastes from construction sites Pickup trucks for supplies Portable toilets / office trailers
Access Roads	Bulldozer or front-end loader Excavators / grader Dump trucks for hauling crushed stone or gravel Vibratory rollers Pickup or stake body trucks for culverts, tooling and personnel
Structure Upgrades	Trucks to haul out old hardware (roll off dumpsters) Cranes Trucks with welding equipment to cut steel supports or components Dump trucks to haul smaller components, gravel or spoils Digging equipment such as back hoes or excavators

Installation of Replacement and New Structures	Bulldozer or front-end loader All-terrain vehicles (ATVs) Tracked carrier (marooka) or a Skidder Flatbed trucks and tractor trailers for hauling structure components Augers Excavators and backhoes Cranes Bucket trucks Conductor pulling and tensioning rigs Helicopters Large-bore foundation drill rigs for caisson foundations Concrete trucks Pickups and other small trucks
Restoration	Pickup and other small trucks Excavators and backhoes Skidsteer/bull dozer Dump Trucks

10.5 SAFETY AND PUBLIC HEALTH CONSIDERATIONS

NEP will construct and maintain the facilities for the proposed Project so that the health and safety of the public are protected. This will be accomplished through adherence to all federal, state, and local regulations, and industry standards and guidelines established for protection of the public. Specifically, the proposed Project improvements will be designed, constructed, and maintained in accordance with the National Electric Standards Committee standards. The facilities will be designed in accordance with sound engineering practices using established design codes and guides published by, among others, the IEEE, the American Society of Civil Engineers ("ASCE"), the American Concrete Institute ("ACI"), and the American National Standards Institute ("ANSI"). Practices which will be used to protect the public during construction will include, but not be limited to, establishing traffic control plans for construction traffic on busy streets to maintain safe driving conditions, restricting public access to potentially hazardous work areas, and use of temporary guard structures at road and electric line crossings to prevent accidental contact with the conductor during installation.

Following construction, all transmission structures will be clearly marked with warning signs to alert the public of potential hazards if climbed or entered. Throughout the Project design and implementation sequence, NEP will evaluate locations that may require the installation of signs, and/or other types of barriers (e.g., large stones) at access points from public roads.

11.0 REGULATORY COMPLIANCE

11.1 INTRODUCTION

NEP has incorporated extensive measures into the design to avoid and minimize Project impacts to the greatest practicable extent, and where impacts cannot be avoided, NEP will implement appropriate mitigation. This section provides a general overview of the Project's approach to complying with the jurisdictional regulations of state and federal regulatory review agencies. Specific impact areas were presented previously in *Sections 3 through 8*, and mitigation measures are addressed in *Section 12: Mitigation Overview and Section 61 Findings.*

11.2 STATE REGULATIONS

11.2.1 Section 401 Water Quality Certification

The wetlands along the ROW are subject to the jurisdiction of Sections 401 and 404 of the federal Clean Water Act (CWA), 33 U.S.C. § 1251 et seq. The CWA establishes the basic federal structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters.

A Section 401 Water Quality Certification is required under the CWA for certain activities in wetlands and waters, but the law gives states the authority to review projects that must obtain federal licenses or permits and that result in a discharge to state waters. The purpose of the Massachusetts Section 401 review is to ensure that a project will comply with state water quality standards and other appropriate requirements of state law. Statutory authority for this certification is stated in the federal Clean Water Act, 33 U.S.C. § 1341, and the Massachusetts Clean Water Act, G.L. c. 21, §26-53. Regulatory authority for this certification is located at 314 CMR 9.00. Water quality standards referenced in the certification are found in 314 CMR 4.00.

This Project requires an Individual Section 401 Water Quality Certification, primarily due to the anticipated "Take" determination from NHESP under MESA. The Project also requires a Water Quality Variance due to the placement of temporary construction matting within wetlands that are located within 400-ft of the OHWM of a Class A Surface Water. Applications will be filed with MassDEP for review under 314 CMR 9.00. MassDEP evaluation criteria for applications are the incorporation of all appropriate and practicable measures for avoiding and minimizing impacts to wetland resource areas. The Project's design avoids, minimizes, and mitigates adverse impacts, as described in this section and *Section 12.*

11.2.2 Massachusetts Wetlands Protection Act

The Project will require approvals under the WPA and the implementing regulations at 310 CMR 10.00 . These regulations govern state-wetland resource areas that include BVW, RA, Bank and BLSF. Project-related impacts to these resource areas require an official finding of approval by the appropriate jurisdictional authority in the form of an OOC.

The WPA and its regulations are administered by municipal Conservation Commissions and MassDEP. Conservation Commissions are empowered under state law to issue OOCs. MassDEP has the authority to intervene in a project and to act on appeals of the OOCs. Permit applications (Notices of Intent ("NOIs")) will be filed with Conservation Commissions in Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, Athol, and Sterling detailing the proposed asset improvements, the short-term and long-term impacts, and the proposed mitigation for those impacts. The wetlands review process is focused on how the Project and the proposed mitigation conform to the performance standards for each affected WPA Resource Area.

In the communities with local wetlands bylaws, the application and hearing process will also address how the Project elements and proposed mitigation measures conform to the requirements of those town bylaws. NEP will coordinate with the Conservation Commissions of these communities such that the final mitigation package appropriately addresses local requirements.

The sections below summarize the Project's compliance with the WPA's general performance standards. The mitigation described herein and in the following subsection, Federal Regulations, will be used as the basis for compliance with state and federal wetland law.

11.2.2.1 Consistency of the Project with WPA - Limited Project (310 CMR 10.53(3)(d))

As outlined in 310 CMR 10.53(3)(d), the construction, reconstruction, operation and maintenance of underground and overhead public utilities is considered a "limited project" that may, under certain circumstances, be permitted without meeting the performance standards. These include the ability of the Project to avoid impacts, minimize unavoidable impacts, and mitigate for those impacts. It is within the issuing authority's discretion to consider the magnitude of the alteration and the significance of the project site to the interests identified in the WPA; the availability of reasonable alternatives to the proposed activities; the extent to which the adverse impacts are minimized; and the extent to which mitigation measures, including replication or restoration are provided to contribute to the protection of the interests identified in the WPA. In addition, no limited project may be permitted if there will be an adverse impact to specified habitat sites of rare vertebrate or invertebrate species.

The proposed work associated with this Project occurs within an existing approved ROW. In accordance with the limited project provisions of the WPA, the Project may be permitted in accordance with the following conditions as well as any additional conditions deemed necessary by the issuing authority:

- the issuing authority may require a reasonable alternative route with fewer adverse effects for a local distribution or connecting line not reviewed by the Energy Facilities Siting Board;
- best available measures shall be used to minimize adverse effects during construction; and
- the surface vegetation and contours of the area shall be substantially restored.

An alternatives analysis has been conducted by the Proponent, as described in Section 2 of this Project Narrative. NEP is confident that the proposed Project offers the most reasonable and balanced alternative to addressing the system's needs. In terms of minimizing adverse effects during construction, *Sections 4 and 10* discusses the construction practices utilized to minimize impacts to wetland resource areas as well as to ensure that areas temporarily impacted by construction are substantially restored. In addition, NEP is committed to working with federal, state, and local regulatory agencies and providing an appropriate range of mitigation measures, including, as appropriate, replication of permanent fill impacts; wetland restoration; wetland habitat enhancement and/or permanent land preservation (see *Section 12*).

11.2.2.2 Inland Bank (310 CMR 10.54)

Bank is defined by 310 CMR 10.54(2)(a) as "the portion of the land surface, which normally abuts and confines a water body." Where Inland Bank is encountered within the Project area, the following applicable WPA general performance standards apply:

Where the presumption set forth in 310 CMR 10.54(3) is not overcome, any proposed work on a Bank shall not impair the following:

- the physical stability of the bank;
- the water carrying capacity of the existing channel within the Bank;
- ground water and surface water quality;

- the capacity of the Bank to provide breeding habitat, escape cover and food for fisheries; and
- the capacity of the Bank to provide important wildlife habitat functions.

Temporary alteration of a small amount of Inland Bank may result from the placement of construction mats across stream banks in construction work areas and along access points. Using construction mats for this purpose is intended to minimize stream bank impacts by avoiding compaction, bank erosion, and loss of vegetation which would result in permanent impact to the physical stability of the banks or the water carrying capacity of the existing channels. These areas are anticipated to be restored when construction is completed. Permanent impacts will occur to a small segment of Bank where tree removal will result in a conversion of PFO to PSS.

The proposed Project is not anticipated to impact groundwater or surface water or the capacity of the Banks to provide breeding habitat, escape cover, food for fisheries, or reduce the capacity of the Banks to provide important wildlife habitat functions following completion of the Project.

11.2.2.3 Bordering Vegetated Wetland (310 CMR 10.55)

BVW, as defined by 310 CMR 10.55(2) (a) and (c), are "freshwater wetlands that border on creeks, rivers, streams, ponds, and lakes." BVW is prevalent throughout the Project area. Where BVW occurs, the following WPA general performance standards apply:

- Where the presumption set forth in 310 CMR 10.55(3) is not overcome, any proposed work in a BVW shall not destroy or otherwise impair any portion of said area.
- Notwithstanding the provisions of 310 CMR 10.55(4) (a), the issuing authority may issue an OOC permitting work which results in the loss of up to 5,000 sf of BVW when said area is replaced in accordance with the following general conditions and any additional, specific conditions the issuing authority deems necessary to ensure that the replacement area will function in a manner similar to the area that will be lost:
    - the surface of the replacement area to be created ("the replacement area") shall be equal to that of the area that will be lost ("the lost area");
    - the ground water and surface elevation of the replacement area shall be approximately equal to that of the lost area;
    - the overall horizontal configuration and location of the replacement area with respect to the bank shall be similar to that of the lost area;
    - the replacement area shall have an unrestricted hydraulic connection to the same water body or waterway associated with the lost area;
    - the replacement area shall be located within the same general area of the water body or reach of the waterway as the lost area;
    - at least 75% of the surface of the replacement area shall be reestablished with indigenous wetland plant species within two (2) growing seasons, and prior to said vegetative reestablishment any exposed soil in the replacement area shall be temporarily stabilized to prevent erosion in accordance with standard U.S. Soil Conservation Service methods; and
    - the replacement area shall be provided in a manner which is consistent with all other General Performance Standards for each resource area in Part III of 310 CMR 10.00.

The Project was designed to avoid or minimize adverse impacts to the extent practicable. However, since these are existing facilities in an existing alignment, temporary and permanent alternation to BVW will occur, including a small amount of permanent fill. Unavoidable temporary impacts to BVW will occur in work areas and along access routes during construction. These impacts are primarily associated with the use of stabilization techniques (e.g., construction mats, stabilizing material) which minimize impacts while allowing necessary work within resource areas to occur. Disturbed areas will be restored to their original condition.

11.2.2.4 Land Under Water Bodies and Waterways (310 CMR 10.56)

LUW is defined by 310 CMR 10.56(2)(a), as "the land beneath any creek, river, stream, pond or lake." The Project crosses jurisdictional LUW at numerous locations during its length. LUW is associated with several perennial and intermittent streams and water bodies within the Project area. Where LUW is encountered, the following applicable WPA general performance standards apply:

- Where the presumption set forth in 310 CMR 10.56(3) is not overcome, any proposed work within LUW shall not impair the following
  - The water carrying capacity within the defined channel, which is provided by said land in conjunction with the banks;
  - Ground and surface water quality;
  - The capacity of said land to provide breeding habitat, escape cover and food for fisheries; and
  - The capacity of said land to provide important wildlife habitat functions.

Two (2) concrete caisson foundations are proposed within LUW in the Crystal Lake Tap in Gardner. The majority of streams and open water can be spanned or avoided by conducting work from either side of the waterbody. In several locations, temporary impacts to LUW due to the placement of construction mats was unavoidable. It is anticipated that approximately 32,206 sf of temporary impacts to LUW will occur due to the use of construction matting for access and/or work areas.

11.2.2.5 Land Subject to Flooding (310 CMR 10.57)

BLSF as defined by 310 CMR 10.57(2)(a), is "an area with low, flat topography adjacent to, and inundated by, flood waters rising from creeks, rivers, streams, ponds or lakes". ILSF as defined by 310 CMR 10.57(2)(b), is "an isolated depression or closed basin without an inlet or an outlet. It is an area which at least once a year confines standing water to a volume of at least ¼ acre-feet and to an average depth of at least six inches". BLSF and ILSF are present throughout the Project area. Where BLSF is encountered, the following WPA general performance standards apply:

- Compensatory storage shall be provided for all flood storage volume that will be lost as the result of a proposed project within BLSF, when in the judgment of the issuing authority said loss will cause an increase or will contribute incrementally to an increase in the horizontal extent and level of flood waters during peak flows.
- Work within BLSF, including that work required to provide the above-specified compensatory storage, shall not restrict flows so as to cause an increase in flood stage or velocity.
- Work in those portions of BLSF found to be significant to the protection of wildlife habitat shall not impair its capacity to provide important wildlife habitat functions. Except for work which would adversely affect vernal pool habitat, a project or projects on a single lot, for which a Notice(s) of Intent is filed or after November 1, 1987, that (cumulatively) alter(s) up to 10% or 5,000 sf (whichever is less) or land in this resource area found to be significant to the protection of wildlife habitat, shall not be deemed to impair its capacity to provide important wildlife habitat function. Additional alternations beyond the above threshold, or altering vernal pool habitat, may be permitted if they will have no adverse effects on wildlife habitat, as determined by procedures contained in 310 CMR 10.60.

New and/or re-established access roads within BLSF will be over-excavated and stabilized with stone rather than placing stone on top of the existing substrate so they are the same grade and there will be no loss of flood storage capacity. Placement of foundation caissons will result in a loss of a small amount of flood storage capacity. Where necessary, lost flood storage volume will be replaced in locations not previously used for flood storage and will be incrementally equal to the theoretical volume of flood water at each elevation, up to and including the 100-year flood elevation. Compensatory flood storage areas will be located within the same reach as the lost storage volume and will have an unrestricted hydraulic connection to the waterway, to the extent possible. Compensatory flood storage will be designed to allow for the re-establishment of wet meadow and scrub shrub wetland or transitional wetland/upland environments that will contribute to wildlife habitat values.

11.2.2.6 Riverfront Area (310 CMR 10.58)

As noted in *Section 4: Wetlands and Wildlife*, 68 perennial streams are located within the Project area. Each of these perennial streams has a jurisdictional 200-ft RA. Pursuant to 310 CMR 10.58(4), where this 200-ft RA occurs within the Project area, the following WPA general performance standards apply:

Protection of Other Resource Areas. *The work shall meet the performance standards for all other resource areas within the riverfront area as identified in 310 CMR 10.30 (coastal bank), 10.32 (salt marsh), 10.55 (BVW), and 10.57 (Land Subject to Flooding). When work in riverfront area is also within the buffer zone to another resource area, the performance standards for the riverfront area shall contribute to the protection of the interests of G.L. c. 131, s. 40 in lieu of any additional requirements that might otherwise be imposed on work in the buffer zone within riverfront area (310 CMR 10.58(4)(a)).*

Protection of Rare Species. *No project may be permitted within the riverfront area which will have any adverse effect on specified habitat sites of rare wetland or upland, vertebrate or invertebrate species, as identified by the procedures established under 310 CMR 10.59 or 10.37, or which will have any adverse effect on vernal pool habitat certified prior to the filing of the Notice of Intent (310 CMR 10.58(4)(b)).*

Practicable and Substantially Equivalent Economic Alternatives. *There must be no practicable and substantially equivalent economic alternative to the proposed project with less adverse effects on the interests identified in G.L. c. 131, s. 40. 310 CMR 10.58(4)(c)).*

The existing ROW within the RA is currently maintained as a working ROW and has been cleared and is maintained in accordance with an approved VMP and local, state, and federal law and regulation. Maintenance of existing structures occurs on a routine basis as necessary, also in compliance with local, state, and federal law and regulation.

The Project will result in temporary disturbance and permanent impacts to portions of the RA along the Project route. Temporary disturbance in RA will result from the placement of construction mats to establish stable work and access areas. Permanent impacts will result from structure installations, access road construction and conversion of forested habitat to scrub-shrub and emergent habitat. A portion of the construction work envelopes will be loamed and seeded to allow vegetative cover to become reestablished. NEP recognizes that maintaining/reestablishing the natural vegetation within the RA is critical to protecting water supplies, providing flood control, preventing pollution and protecting wildlife and fisheries habitat. NEP will coordinate with the Conservation Commissions of the communities such that the final mitigation package appropriately addresses state and local requirements.

The Project has considered the RA performance standards in the following ways.

Protection of Other Resource Areas Within RA: To the extent practicable, the Project meets the performance standards for Bank (no impact), BLSF (no net loss of flood storage capacity), and BVW (restoration and mitigation proposed for temporary and permanent impact).

Protection of Rare Species: Project activities within the RA will occur within habitat for a protected species (one (1) amphibian, two (2) reptiles, two (2) birds and two (2) invertebrates). The consultation process has been initiated with NHESP, as described in *Section 5*. Although impacts will be avoided and minimized to the maximum extent practicable, without compromising the safety of Project construction and future maintenance personnel, there is some potential for a "take" to occur due to road improvements. A MESA Checklist will be required and a CMP may also be necessary. The final determination will be based on the feedback and direction received from NHESP. If a CMP is required, several potential mitigation options are available, as described in *Section 5*. Coordination with NHESP will ensure that the proper approach is used, and a protection plan for all Project related state-listed species is provided if needed.

Practicable and Substantially Equivalent Economic Alternatives: The WPA general performance standards for RA require that the applicant prove by a preponderance of the evidence that there are no practicable and substantially equivalent economic alternatives to the proposed Project with less adverse effects on the interests identified in the WPA. *Section 2* discusses the alternatives evaluated to minimize impacts to wetland resource areas. This information will be provided as part of the NOIs prepared for the Project.

No Significant Adverse Impact: Impacts are fully described in *Section 4* and proposed mitigation measures are addressed in *Section 12*. Temporary impacts where necessary for installation of linear site-related utilities are allowed within the RA, provided the area is restored to its natural conditions (310 CMR 10.58 (4) (d) 1.a.). Although RA impacts resulting from the proposed Project are primarily temporary land disturbance, all disturbance will be temporary in nature. Proposed tree removal will result in conversion of forested habitat to scrub-shrub and emergent habitat. The majority will be restored to existing ROW conditions, most of which has been historically affected by the safe operation of the transmission facilities. Unavoidable permanent impacts include the improvement of existing access routes (expansion and grading) to ensure safe access to existing and proposed structures, and direct installation of replacement structures.

To offset temporary construction impacts, protective measures and BMPs will be in placed to avoid and minimize impacts. The approach for accessing the site, establishing work areas and performing construction activities is discussed in detail in *Section 10: General Transmission Line Construction Procedures*. The proposed Project will not result in a significant adverse impact or impairment or reduce the capacity of the RA to provide important wildlife habitat functions.

11.2.2.7 Isolated Vegetated Wetlands (IVW) and Isolated Land Subject to Flooding (310 CMR 10.57)

ILSF is defined at 310 CMR 10.57(2)(b) as an isolated depression or a closed basin that serves as a ponding area for run-off or high ground water which has risen above the ground surface. Isolated wetlands are not jurisdictional resource areas under the WPA unless they hold enough water to meet the definition of ILSF (310 CMR 10.57(2)(b)). During field investigations, wetlands were not delineated beyond the utility ROW. Off-ROW hydrologic connections were assumed for wetlands located on the border of the ROW.

11.2.2.8 Wildlife Habitat Evaluations (310 CMR 10.60)

A wildlife habitat evaluation was completed pursuant to 310 CMR 10.60 and the procedures and methods detailed in MassDEP's Massachusetts Wildlife Habitat Protection Guidance for Inland Wetlands.

Requirements for completing wildlife habitat evaluations depend on the type of wetland resource area impacted and the magnitude of impact. As part of the MassDEP Guidance document, two forms are typically used for Wildlife Habitat Evaluations – Appendix A and Appendix B. Appendix A is a "simplified" evaluation generally used for projects with limited resource area impacts. Appendix B is a more detailed evaluation generally used for evaluating projects with larger impacts, project locations within VP habitat, mapped "Habitat of Potential or Statewide Importance" and/or other activities specified on the Appendix A form.

Appendix B evaluations were conducted for the Project because of the nature of the Project and the cumulative impacts to jurisdictional resource areas. The wildlife habitat evaluation is summarized in *Section 4: Wetlands and Wildlife*, and applicable portions are presented in *Appendix F*. Some habitat functions associated with forested wetland will be permanently altered as a result of the proposed Project, but they will be replaced by the increasingly scarce scrub-shrub habitat. Consequently, the proposed Project will not result in a significant adverse impact or impairment or reduce the capacity of the RA to provide important wildlife habitat functions.

11.2.3 Massachusetts Stormwater Standards

MassDEP applies the Massachusetts Stormwater Management Standards pursuant to the wetlands regulations (310 CMR 10.00) and the water quality regulations (314 CMR 9.00) relating to stormwater. The Stormwater Standards define 10 performance management standards for development and redevelopment projects. Minimal impervious surfaces are proposed for the Project. Portions of the Project subject to the Stormwater Management Standards are limited to new caisson foundations.

Although the proposed work is considered to be eligible for limited project status, NEP will meet the stormwater standards to the maximum extent practicable. NEP will coordinate with engineers, regulators and local conservation commissions to develop stormwater management plans for these areas, as appropriate.

11.2.4 Surface Water Discharge Permit

Due to earth disturbing activities of more than one (1) acre, this Project will require a federal NPDES Construction General Permit ("CGP") and associated coverage pursuant to the Surface Water Discharge regulations (314 CMR 3.00) specifically 314 CMR 3.06. The NPDES CGP requires filing an NOI that provides information on the site and identifies the site's general operator, and development of a SWPPP that includes appropriate BMPs to minimize pollutant discharges.

The Project will comply with the requirements of the NPDES CGP. As a component to this compliance, a site-specific SWPPP will be prepared and implemented throughout the Project's construction and restoration phases. Implementation of this plan will include extensive use of erosion and sediment control measures designed to minimize site disturbance and prevent opportunities for sedimentation to occur offsite or toward wetland resource areas. The SWPPP will be included in each NOI, along with Bureau of Water Resources Surface Water Discharge (NPDES) Permitting Program WM 15 permit application and it is anticipated that the requirements of the SWPPP will be included in the OOC issued by each community within the Project area.

11.2.5 Waterways Permitting

The Project crosses several rivers and streams that are subject to waterways licensing jurisdiction by MassDEP under Massachusetts General Law c. 91 and the implementation regulations, 310 CMR 9.00. However, as described below, all of the jurisdictional Project-related crossings are exempt from licensing.

11.2.5.1 Jurisdictional Crossings

Chapter 91 geographic jurisdiction includes non-tidal rivers or streams "on which public funds have been expended for stream clearance, channel improvement, or any form of flood control or prevention work… except for any portion of any such river or stream which is not normally navigable during any season, by any vessel including canoe, kayak, raft, or rowboat…" 310 CMR 9.04(1)(e). All "structures" in these rivers and streams are subject to waterways licensing under 310 CMR 9.05(i). A "structure" is defined as "any man-made object which is intended to remain in place . . . over . . . waterways." 310 CMR 9.02. Thus, MassDEP requires a c. 91 license for electric transmission crossings over rivers and streams even where there is no physical structure in the stream or river.

Perennial Streams: Based on field reviews, 68 perennial streams were identified within or immediately adjacent to the Project ROW. All perennial stream crossings that intersect with the A1/B2 ACR were assumed, for purposes of determining c. 91 jurisdiction, to be "normally navigable" by canoe, kayak, raft or rowboat.

Intermittent Streams: 60 intermittent streams were identified within or immediately adjacent to the Project ROW. All other streams delineated within or immediately adjacent to the ROW are either not shown on the most recent USGS topographic maps as intermittent, or are depicted as intermittent waterways. According to the field reviews conducted in 2020, bank heights and width are variable.

To determine whether intermittent streams were "normally navigable" under §9.04(1)(e), bank height, width and water depth were all considered. In particular, intermittent streams were determined to be navigable if all of the following criteria were met:

- Discernable channel/bank
- Bank width of three feet or greater
- Water depth of twelve inches or greater

Based on field reviews to date, many of the intermittent streams within the Project ROW meet these criteria. Of the 128 streams reviewed, there are 66 occurrences of tree removal intersecting intermittent streams and 100 occurrences of tree removal intersecting perennial streams. There are 47 occurrences where work envelopes/pull pad envelopes intersect intermittent streams and 26 occurrences where these activities intersect with perennial streams.

11.2.5.2 Exempt Crossings

All of the jurisdictional crossings listed above are expressly exempt from c. 91 if they are covered by a final wetland OOC and meet the following related tests: they are constructed and maintained in accordance with the NESC and do not reduce the space available for navigation (310 CMR 9.05(3)(g)).

All of the Project crossings are exempt from c. 91 licensing because they will require an OOC from the applicable local Conservation Commission. Moreover, the Project crossings will be "overhead wires … constructed and maintained in accordance with the National Electrical Safety Code," as all electrical transmission lines are required to be constructed and maintained in accordance with all applicable legal standards, including the NESC and 220 CMR 125.00 Installation and Maintenance of Electric Transmission Lines. Finally, due to the significant increase in the height of the replacement structures, there will be an increase in the crossing height above the waterway surface and thus will not "reduce the space available for navigation."

In sum, the required OOCs for this Project will fulfill the requirements of 310 CMR 9.05(3)(g) to exempt all of the crossings of navigable water streams from c. 91 licensing requirements. [34]

11.2.6 Massachusetts Department of Transportation

MassDOT is responsible for the Permit to Access State Highway/Non-Municipal Utility Permits for crossing over of state roads with utility lines and for Permanent Access Permit with the Highway Layout.[35] The proposed Project's impacts relative to MassDOT are associated with the installation of new overhead wires across state roadways by a non-municipal utility, a proposed permanent access from a MassDOT roadway, and permanent structure installations within the highway layout. The installation could temporarily affect traffic flow of the roadway but does not involve physical modifications to the roadway or roadway ROW. NEP will comply with all required measures to ensure a safe environment for traffic flow and construction crews in and around the roadways.

BSC on behalf of NEP conducted a consultation with MassDOT on 08/25/22 to discuss change in alignment due to removal of existing structure 537-1, two proposed structures located within state highway layout along Depot Road, and the proposed access road to Great Wolf Lodge.

As a result of the consultation, it has been identified:

- A clearing permit can be submitted for any required clearing on MassDOT property for the realignment.
- Continued consultation required for the proposed structures within the state highway layout, MassDOT Engineer to follow up with MassDOT Operations regarding the access rights to the area.
- New access from Great Wolf Lodge requires roadway plans including proposed tree removals to be reviewed when permanent access permit is submitted. MassDOT also requires a chain fence gate at the property line to prevent unauthorized vehicle access.

11.2.5 Massachusetts Endangered Species Act

NEP will coordinate closely with NHESP pursuant to MESA (G.L. c. 131A) and WPA (G.L. c. 131, §40) to avoid impacts to listed species and their habitat, and to provide mitigation for any unavoidable impacts. Although impacts will be avoided and minimized to the maximum practicable extent without compromising the safety of Project construction and future maintenance personnel, there is some potential "take". A CMP will be provided, if required.

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34 NEP has researched whether each of the waterway crossings along the Project Route is likely to require an Order of Conditions, eliminating the need for a c. 91 license. For each crossing where NEP has determined that an OOC is required, there is some possibility that the local conservation commission could require construction plan revisions that would change the wetlands and waterways analysis. One possible scenario is this change could eliminate the need for an OOC, in which case NEP would submit a c. 91 license application. NEP has determined that each of the poles near the crossings must be in the proposed location for constructability purposes, making a scenario where the conservation commission insists on relocating poles outside of wetlands areas unlikely. If pole locations must be changed in a way that relieves the OOC requirement, however, NEP will determine at that time whether a c. 91 license application is necessary for the relevant crossing.

35 NEP is evaluating the location of replacements structures along Depot Road in Westminster. The original easement CRT 87 (*Charles H. Dupee et ux*), granted rights to NEP that allow the structure relocation. In addition, the highway taking/relocation in 1985 reserved the rights of all electric transmission easements. The structure relocation is being proposed as an "in-kind" replacement. Should MassDOT deem it to be otherwise, a permanent access permit may be required. NEP will consult with MassDOT.

The NHESP analysis will not be complete until NEP files for MESA Review. As such, coordination will continue until the submittal of the MESA Project Review Checklist. NEP will work closely with NHESP to develop a mutually agreed upon protection plan for the state-listed species, if needed.

11.2.6 Massachusetts Historical Commission

Any projects that require funding, licenses, or permits from any state agency must be reviewed by MHC in compliance with G.L. c. 9, §26-27C. This law created the MHC, the office of the State Archaeologist, and the State Register of Historic Places, among other historic preservation programs. It provides for MHC review of state projects, State Archaeologist's Permits, the protection of archaeological sites on public land from unauthorized digging, and the protection of unmarked burials. The regulations that guide MHC review of state funded, licensed or permitted projects are published in Chapter 9, Section 26-27C (950 CMR 70-71). If the Project is found to have an adverse effect to a significant historic property or archaeological site, NEP will consult with MHC and other parties, as appropriate, to determine the feasible measures to avoid, minimize or mitigate the adverse effect.

11.2.7 Energy Facilities Siting Board

A Petition for Approval to Construct and Operate the Project will be filed with the EFSB (or "Siting Board") pursuant to Chapter 164, Section 69J of the General Laws. Under Chapter 164, Section 69G, a "facility" requiring approval by the EFSB includes:

- A new electric transmission line having a design rating of 115 kV or more which is 10miles long or more on an existing transmission corridor except reconductoring or rebuilding of transmission lines at the same voltage.
- An ancillary structure which is an integrated part of the operation of any transmission line.

This Project meets both requirements. The EFSB approval process includes filing the Petition followed by an extensive and lengthy adjudicatory process. The Siting Board has a statutory requirement to implement its policies in order "to provide a reliable energy supply for the Commonwealth with a minimum impact upon the environment at the lowest possible cost." (G.L. c. 164, §69H and 69J). Further, G.L. c. 164, §69J requires the Siting Board to review alternatives to planned projects, including "other site locations." A petitioner to the Siting Board must demonstrate that it has examined a reasonable range of practical siting alternatives, and that its "proposed facilities are sited at locations that minimize costs and environmental impacts while ensuring supply reliability".

A Petition for Approval to Construct is expected to be submitted to the EFSB in late 2022, which will initiate their review process. Concurrently with its Petition to the Siting Board, NEP intends to file Petitions with the DPU: (1) requesting a determination that the Project is necessary and will serve the public convenience and be consistent with the public interest in accordance with G.L. c. 164, § 72 ("Section 72"); and (2) requesting exemptions from the Zoning Ordinances of the Project communities pursuant to G.L. c. 40A, § 3.

Some sections of this Expanded ENF are similar to what will be submitted to the Siting Board (e.g., Project Information, Alternatives Assessment and the Project route impacts). As required by the EFSB, the Petition will also document the load forecast methodology and the complex contingency analysis using computer modeling. These pieces of information will comprehensively establish the need for the Project as stipulated by applicable EFSB requirements.

NEP is confident that the Project represents the optimal solution because it meets the reliability needs; comparatively offers the best solution with the least amount of adverse impacts, and provides a cost-effective solution.

11.3 FEDERAL REGULATIONS

11.3.1 Section 404 of the Clean Water Act

As noted in the discussion of state permits, the wetlands along the ROW are subject to the jurisdiction of Sections 401 and 404 of the federal CWA. The CWA establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The Section 401 Water Quality Certification, as administered by MassDEP, was discussed previously. The Section 404 process is administered by the USACE.

The USACE (Federal Register 1982) and the EPA (Federal Register 1980) jointly define wetlands as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. "Section 404 of the CWA establishes permit programs to regulate the discharge of dredged or fill material into waters of the United States, as well as discharges of dredged or fill material into wetlands adjacent to nominal waters (33 CFR 328). The Project qualifies for Pre-Construction Notification ("PCN") in accordance with the USACE Massachusetts General Permits for activities within federal wetlands as defined by Section 404 of the CWA, primarily due to the temporary BVW impacts associated with construction mats, which are considered "fill". NEP anticipates submitting a PCN and continuing to consult with USACE through the permitting process.

The Project will meet the USACE's requirement that areas of permanent fill be mitigated. Mitigation will be determined using criteria defined in the 2016 New England District Compensatory Mitigation Guidance, and through consultation with the USACE New England District.

Permanent impacts to VPs have been avoided and no temporary work envelopes will be placed within VPs pools during spring and/or fall breeding seasons. Use of construction BMPs will be employed to avoid and minimize indirect impacts to the VPs in the vicinity of the Project. Construction-related details will be provided in permit applications and are also addressed in *Section 10: General Transmission Line Construction Procedures.*

11.3.2 Environmental Protection Agency

The NPDES program in Massachusetts requires that any construction project disturbing one (1) or more acres of land and will discharge stormwater (or dewatering discharges) from a site into municipal separate stormwater system or into water of the U.S., must first seek coverage under, and comply with, the EPA's Stormwater General Permit. The NPDES CGP requires filing an NOI that provides information on the site and identifies the site's general operator; development of a SWPPP that includes appropriate BMPs to minimize pollutant discharges; and submitting a Notice of Termination ("NOT") when the site has achieved final stabilization or stormwater is no longer being discharged.

The Project will comply with the requirements of the NPDES CGP. As a component to this compliance, a site-specific SWPPP will be prepared and implemented throughout the Project's construction and restoration phases. Implementation of this plan will include extensive use of erosion and sediment control measures designed to minimize site disturbance and prevent opportunities for sedimentation to occur offsite or toward wetland resource areas. The SWPPP will be included in each NOI, and it is anticipated that the requirements of the SWPPP will be included in the OOC issued by each community within the Project area.

11.3.3 U.S. Fish and Wildlife Service

Under the Endangered Species Act ("ESA"), any action requiring one (1) or more federal permits or licenses must also consult with the US Fish and Wildlife Service ("USFWS") to ensure that proposed actions do not jeopardize listed species or destroy or adversely modify critical habitat. Accordingly, the USFWS Endangered Species Consultation Procedure available on their website was followed. As a result, it was determined while the Project area is mapped for the Federally Listed northern long-eared bats (*Myotis septentrionalis*), but that there are no known hibernacula within 0.25 miles of the Project area and no known maternity roost trees within a 150-ft buffer. Therefore, currently, no additional consultation is required. However, note that a status review of the northern long-eared bat has been completed, and the final recommendations regarding its status will be published, reviewed, and accepted in 2022. Additional consultation may be required, pending the outcome of this process.

The Endangered Species Consultation determined that one (1) candidate insect, Monarch Butterfly (*Danaus plexippus*), one (1) endangered plant, and one (1) threatened plant may be present within the Project area along with the northern long-eared bat. In 2020, the USFWS concluded that listing the monarch under the ESA is warranted; but, precluded by higher priority listing actions. Based on the USFWS' priorities and workload, the USFWS intends to propose listing the monarch in Fiscal Year 2024, if listing is still warranted at that time. In the meantime, the Monarch is designated as a candidate under the ESA. Candidate species are not protected under the ESA, but the USFWS reviews their status annually, and could decide to initiate the listing process sooner than 2024.

Review is ongoing to determine permitting and/or avoidance measures for the two (2) plants identified.

11.3.4 Section 106 of the National Historic Preservation Act

Section 106 of the National Historic Preservation Act of 1966 ("NHPA" or "Section 106") requires Federal agencies to take into account the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation ("ACHP") a reasonable opportunity to comment (33 CFR 325 Appendix C and 36 CFR Part 800 and 33 CFR 325, Appendix C). Pursuant to 36 CFR 800.16, an undertaking consists of "a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a federal agency, those carried out with federal financial assistance, those requiring a federal permit, license or approval and those subject to State or local regulation administered pursuant to a delegation or approval by a federal agency."

For the Project, the undertaking is the Section 404 Permit, and the responsible federal agency is the USACE. "Section 106 review" follows a specific process, which is guided by federal regulations (36 CFR 800 and 33 CFR 325, Appendix C). These regulations have created a series of steps by which federal agencies identify and evaluate historic properties that may be affected by their undertakings, assess adverse effects to those properties, and take prudent and feasible measures to avoid, minimize, or mitigate those effects.

12 MITIGATION OVERVIEW AND SECTION 61 FINDINGS

12.1 INTRODUCTION

Mitigation is a means of offsetting potential adverse effects of human activity on the environment. The development of mitigation measures has become an integral part of the regulatory process and of conservation planning efforts. Most state legislation requiring mitigation measures does not prescribe the specific mitigation activity that must take place, and mitigation can take many forms, including the following:

- Avoiding an impact by not taking an action or redirecting/relocating an action;
- Minimizing an impact by limiting the degree of action taken;
- Restoring, rehabilitating or repairing the affected environment;
- Preservation and maintenance activities to reduce or eliminate the impacts over time; and
- Providing replacement or substitute resources or environments.

NEP is incorporating elements of these approaches in its overall mitigation plan to comprehensively address potential impacts associated with the proposed maintenance and improvements to the A1/B2 Lines. This section presents a comprehensive overview of the mitigation measures discussed in *Sections 3 through 8*, respectively, for land use, wetlands and wildlife, rare species, historic/archeological resources, EJ communities and climate change adaptation and resiliency.

MEPA requires state agencies to make findings on environmental damage and mitigation measures before issuing a state permit for a project requiring an EIR (301 CMR 11.07 (so-called Section 61 Findings)). The MEPA regulations at 301 CMR 11.07(6)(k) require that the EIR contain the proposed Section 61 Findings. In accordance with this requirement, NEP's proposed Section 61 Findings for the Project are also presented herein.

12.2 MITIGATION OVERVIEW

As noted throughout this document, NEP has incorporated an approach that avoids and minimizes impacts wherever practicable. For example, the proposed design utilizes existing utility corridors and, whenever feasible, locates replacement structures close to existing structures; relocates replacement structures such that they span wetland resource areas; clears vegetation only where necessary for safe operation; and utilizes upland access routes for construction purposes.

NEP has also evaluated alternative construction methodologies designed to reduce impacts to environmentally sensitive areas. Specifically, NEP and their consultant team assessed the constructability of the Project to identify ways to minimize impacts from installation of access roads and construction work envelopes. Work envelopes have been designed to safely facilitate construction on energized lines ("live line" construction). Live line construction is required due to outage constraints along the Lines. Within RFA, work pads will be loamed and seeded, and in the uplands, work envelopes will remain to ensure safe and stable work areas for future maintenance and emergency responses. Access roads have been designed to limit grading where necessary and will incorporate stormwater BMPs for stability and avoidance of impacts to adjacent water resources. Consultation with NHESP is ongoing.

Mitigation measures proposed for construction include appropriate BMPs such as erosion control barriers, use of construction mats, minimizing areas of disturbance, and restoration when necessary.

In terms of mitigation during construction, NEP has established BMPs that will be followed by all NEP employees and contractors for accessing sites and performing construction activities on transmission ROWs. These procedures, outlined in *Section 10.0 and Appendix C*, ensure that the Project will be completed in accordance with all applicable environmental laws and regulations as well as with NEP policies and compliance objectives.

Project impacts are largely associated with work within wetland resource areas and include temporary and permanent impacts that may be mitigated by implementing a variety of measures that comprise a comprehensive mitigation package. Such measures may include restoration of temporarily impacted areas and replication to compensate for permanent impacts. Mitigation will be determined using criteria defined in the 2016 New England District Compensatory Mitigation Guidance and through consultation with the USACE New England District, MassDEP, and local Conservation Commissions.

NEP is committed to developing a mitigation package that addresses potential Project impacts to the greatest practicable extent. NEP anticipates that the final mitigation package will be developed during the federal, state and local permitting processes outlined in Section 1 of this Project Narrative, and that the mitigation package will fully address the concerns and required permit conditions. Proposed mitigation measures will be reviewed by the Conservation Commission in each town, MassDEP, NHESP, MHC, and the USACE, and ultimately will be incorporated into the permits and OOCs issued for the Project.

12.3 SECTION 61 FINDINGS

The remainder of this section presents the proposed Section 61 Findings in compliance with 301 CMR 11.07(6)(k). These proposed findings have been developed considering consultations with various state agencies. While NEP will continue to consult with certain agencies concerning mitigation, this Expanded ENF contains the most up-to-date information on the Project's mitigation measures, including those to which NEP has committed to and those under discussions with agencies. Each Section 61 Finding is essentially a stand-alone document, so it does not incorporate previously defined acronyms.

Proposed Section 61 Findings for Massachusetts Department of Environmental Protection (Mass DEP)

DRAFT FINDINGS PURSUANT TO G.L. CHAPTER 30, SECTION 61

Project Name: A1/B2 Transmission Lines Asset Condition Refurbishment Project

Project Location: Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, Athol, and Sterling.

Project Proponent: New England Power Company ("NEP")

EOEA Number: To Be Determined

Agency Actions: Massachusetts Department of Environmental Protection Section 401 Water Quality Certification

Intent of These Section 61 Findings: MEPA regulations 301 CMR 11.12(5) stipulate that in "accordance with G.L. c.30, §61, any Agency that takes Agency Action on a Project for which the Secretary required an EIR shall determine whether the Project is likely, directly or indirectly, to cause any damage to the environment and make a finding describing the damage to the environment and confirming that all feasible measures have been taken to avoid or minimize the damage to the environment." The Section 61 Findings are incorporated into the conditions or restrictions to the relevant permit or authorization. The following proposed Section 61 Findings have been prepared by the Project Proponent and are intended to assist the state permit-issuing agency in fulfilling its obligations in accordance with G.L. c. 30, §61. These Findings are limited to the subject matter jurisdiction of the Section 401 Water Quality Certification sought from the Massachusetts Department of Environmental Protection.

Project Description: The Project includes complete refurbishment of 54 miles of 69 kV Transmission Line assets including structures replacements and installations, access improvements or re-establishment and construction of new access, and vegetation cutting. New construction is proposed for this Project.

Comprehensive inspections have identified structures and wires are in need of replacement due to asset condition and aging infrastructure and lack of safe access for maintenance and emergency needs. From a safety and reliability perspective, in order to extend asset life, the following activities are proposed:

- Replacement of 711 structures
- Installation of approximately 305 concrete caisson foundations
- Installation of six (6) new vertical jumper switch structures
- Reconductoring of both circuits with 795 Aluminum-conductor steel-supported conductor (ACSS), installation of two (2) OPGW
- Construction of new and/or re-establishment of access roads
- Relocation of ~5.2 miles of centerline, approximately 41.5-ft north towards the I135S/J136STransmission Lines within an existing ROW, in Leominster.
- ROW vegetation cutting to obtain a minimum horizontal clearance of 30-ft to the edge of ROW/easement under all horizontal clearance weather conditions. On average, the existing ROW vegetation removal is 85-ft. The ROW will be cleared to 100-ft on the mainline and Crystal Lake Tap Line and 125-ft Athol Tap Line to obtain the necessary horizontal clearance requirements.
- Some tree removal may be required to accommodate Project access.

In addition, the existing shield wire will be replaced with OPGW to provide high speed communications between substations. .

This Project requires an Individual Section 401 Water Quality Certification, primarily due to the anticipated “Take” determination from NHESP under MESA. The Project also requires a Water Quality Variance due to the placement of temporary construction matting within wetlands that are located within 400-ft of the OHWM of a Class A Surface Water. Applications will be filed with MassDEP for review under 314 CMR 9.00. MassDEP evaluation criteria for applications are the incorporation of all appropriate and practicable measures for avoiding and minimizing impacts to wetland resource areas. The Project’s design avoids, minimizes, and mitigates adverse impacts, as described in this section and *Section 11*.

MEPA History: Pursuant to G.L. c. 30, §61- §62A-H, of the Massachusetts Environmental Policy Act (“MEPA”) and its implementing regulations at 301 CMR 11.00, the Proponent (“NEP”) has prepared and submitted this Expanded (“ENF”) to the MEPA office. The Expanded ENF is the first MEPA filing associated with this Project. The Project is subject to MEPA review as it requires one or more state permits and exceeds the following thresholds requiring the filing of an:

- ENF and an EIR for Wetlands, Waterways and Tidelands because a permit is required, and there is expected to be alteration of one or more acres of bordering vegetated wetlands (301 CMR 11.03(3)(a)(1)(a)).
- EIR for Land because there is expected to alter 50 or more acres of land (301 CMR 11.03(1)(1)).
- EIR for Wetlands, Waterways and Tidelands because a permit is required, and there is expected to be an alteration of ten or more acres of other wetlands (301 CMR 11.03(3)(a)(1)(b).
- EIR for Environmental Justice Populations as the Project is located within a Designated Geographic Area around an Environmental Justice Population (301 CMR 11.06(7)(b).

Additionally, the proposed Project requires state permits from the 401 Water Quality Certification, Natural Heritage and Endangered Species, Department of Conservation and Recreation, Massachusetts Department of Waterways, Energy Facilities Siting Board, Department of Public Utilities, Massachusetts Department of Environmental Protection and Massachusetts Department of Transportation.

Project Impacts: Impacts relative to the Section 401 Water Quality Certificate include the permanent fill of approximately 1,896 sf of BVW due to structure foundations, approximately, 667,928 sf (~15 acres) of forested wetland conversion due to tree removals, and approximately 51 acres (2,200,651 sf) of BVW temporarily impacted by construction mats, and the anticipated take for work within rare species habitat by NHESP.

Project Mitigation: Mitigation was considered as a matter of course during the planning and design process as an overall approach to avoiding impacts whenever possible. In terms of mitigation during construction, NEP has established procedures that are to be followed by all NEP employees and its contractors for accessing sites and performing construction activities on transmission ROWs. These procedures ensure that this Project will be completed in accordance with all applicable environmental laws and regulations as well as with NEP policies and compliance objectives. NEP completed field investigations and a constructability review along the Project Route to determine access routes and construction techniques to be implemented during construction of the Project to provide an accurate impact assessment and to design work to avoid and minimize impacts within wetlands and other sensitive resources (e.g., cultural resources) to the greatest extent practicable. Accordingly, the below-listed commitments are to be carried out by NEP to ensure that all proposed wetlands and waterways mitigation strategies will be implemented as the Project proceeds.

Table 26: Wetlands & Waterways Mitigation Strategies for the Project

Wetland Resource Area	Impact	Mitigation Measures	Responsible Party/ Implementation
BVW	Temporary alterations during construction; permanent fill for structure installation	Use construction mats for access through wetlands, across streams and other sensitive areas to minimize compression of soils, rutting, and disturbance of vegetation. Provide mitigation to be determined in consultation with agencies to offset any permanent wetland impacts. Habitat enhancement in wetland resource areas affected by tree removal to minimize impacts from change in wetland function. Implement SWPPP.	Contractor/Construction Contractor/Construction/ Potential post-construction monitoring Contractor/Construction Contractor/Construction
BLSF	Temporary alteration and permanent fill of floodplain for access, work envelopes and structures	Restore areas temporarily impacted, as appropriate. Provide mitigation for permanent flood storage loss due to structure installation and potential grading required for access and construction work envelope. Employ temporary erosion controls (e.g., silt fence, hay/straw bales, filter socks, mulching, temporary and/or permanent reseeding) and sedimentation controls, as appropriate.	Contractor/ NEP Construction/Potential post-construction monitoring Contractor/ Construction
RA	Temporary impact to Riverfront Area for access and work envelopes.	Restore areas temporarily impacted. Employ temporary erosion controls (e.g., silt fence, hay/straw bales, filter socks, mulching, temporary and/or permanent reseeding) and sedimentation controls, as appropriate.	Contractor/ Construction Contractor/ Construction
Bank	Temporary impact to bank due to access and work envelopes. In most cases, construction mat crossing will span the Bank of rivers and stream; however, the potential for alteration has been	Use construction mats to minimize compression of soils, rutting, and disturbance of vegetation.	Contractor/ Construction

	accounted for in the Project impact calculations.		
LUW	Temporary impact to LUW for access, work envelopes and pull pads. Permanent impact for two (2) concrete caissons.	Use construction mats to minimize compression of soils, rutting, and disturbance of vegetation.	Contractor/ Construction
Waterways	Potential impacts to non-tidal waterways from overhead wires.	Overhead crossings designed to avoid conflicts and allow for unimpeded access by foreseeable watercraft.	NEP/ Planning

Proposed Section 61 Findings Massachusetts Department of Transportation (MassDOT)

DRAFT FINDINGS PURSUANT TO G.L. CHAPTER 30, SECTION 61

Project Name: A1/B2 Transmission Lines Asset Condition Refurbishment Project

Project Location: Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, Athol, and Sterling.

Project Proponent: New England Power Company ("NEP")

EOEA Number: To Be Determined

Agency Action: Massachusetts Department of Transportation Permit to Access State Highway and Permanent Access Permit within the Highway Layout

Intent of These Section 61 Findings: MEPA regulations 301 CMR 11.12(5) stipulate that in "accordance with G.L. c. 30, §61, any Agency that takes Agency Action on a Project for which the Secretary required an EIR shall determine whether the Project is likely, directly or indirectly, to cause any damage the environment and make a finding describing the damage to the environment and confirming that all feasible measures have been taken to avoid or minimize the damage to the environment." The Section 61 Findings are incorporated into the conditions or restrictions to the relevant permit or authorization. The following proposed Section 61 Findings have been prepared by the Project Proponent and are intended to assist the state permit-issuing agency in fulfilling its obligations in accordance with G.L. c. 30, §61. These Findings are limited to the subject matter jurisdiction of the State Highway Access Permit sought from the Massachusetts Department of Transportation ("MassDOT").

Project Description: The Project includes complete refurbishment of 54 miles of 69 kV Transmission Line assets including structures replacements and installations, access improvements or re-establishment and construction of new access, and vegetation cutting. New construction is proposed for this Project.

Comprehensive inspections have identified structures and wires are in need of replacement due to asset condition and aging infrastructure, and lack of safe access for maintenance and emergency needs. From a safety and reliability perspective, in order to extend asset life, the following activities are proposed:

- Replacement of 711 structures
- Installation of approximately 305 concrete caisson foundations
- Installation of six (6) new vertical jumper switch structures
- Reconductoring of both circuits with 795 Aluminum-conductor steel-supported conductor ("ACSS"), installation of two (2) OPGW
- Construction of new and/or re-establishment of access roads
- Relocation of ~5.2 miles of centerline, approximately 41.5-ft north towards the I135S/J136S Transmission Lines within an existing ROW, in Leominster.
- ROW vegetation cutting to obtain a minimum horizontal clearance of 30-ft to the edge of ROW/easement under all horizontal clearance weather conditions. On average, the existing ROW vegetation cutting is 85-ft. The ROW will be cleared to 100-ft on the mainline and Crystal Lake Tap Line and 125-ft Athol Tap Line to obtain the necessary horizontal clearance requirements.
- Tree removals to accommodate construction access.

In addition, the existing shield wire will be replaced with OPGW to provide high speed communications between substations.

The Project includes installation of structures and access routes within the highway layout, as well as temporary access to pull conductor across the highway subject to 700 CMR 13.00.

MEPA History: Pursuant to G.L. c. 30 §61- §62A-H, of the Massachusetts Environmental Policy Act ("MEPA") and its implementing regulations at 301 CMR 11.00, the Proponent ("NEP") has prepared and submitted this Expanded ENF to the MEPA office. The Expanded ENF is the first MEPA filing associated with this Project. The Project is subject to MEPA review as it requires one or more state permits and exceeds the following thresholds requiring the filing of an:

- ENF and an EIR for Wetlands, Waterways and Tidelands because a permit is required, and there is expected to be alteration of one or more acres of bordering vegetated wetlands (301 CMR 11.03(3)(a)(1)(a)).
- EIR for Land because there is expected to alter 50 or more acres of land (301 CMR 11.03(1)(1)).
- EIR for Wetlands, Waterways and Tidelands because a permit is required, and there is expected to be an alteration of ten or more acres of other wetlands (301 CMR 11.03(3)(a)(1)(b).
- EIR for Environmental Justice Populations as the Project is located within a Designated Geographic Area around an Environmental Justice Population (301 CMR 11.06(7)(b).

Additionally, the proposed Project requires state permits from the 401 Water Quality Certification, Natural Heritage and Endangered Species, Department of Conservation and Recreation, Massachusetts Department of Waterways, Energy Facilities Siting Board, Department of Public Utilities, Massachusetts Department of Environmental Protection and Massachusetts Department of Transportation.

Project Impacts: The proposed Project's impacts relative to MassDOT are associated with the installation of new overhead wires across state highways by a non-municipal utility. Guard structures, situated on the site of the state roadways in the NEP ROW, may be utilized to ensure safe installation, locations of such structures are still under review. The installation could temporarily affect traffic flow of the roadway but does not involve permanent physical modifications to the roadway. In addition, an access road from the highway to the ROW is proposed as is the installation of several structures within the highway layout.

Project Mitigation: Mitigation was considered as a matter of course during the planning and design process as an overall approach to avoiding impacts whenever possible. In terms of mitigation during construction, NEP has established procedures that are to be followed by all NEP employees and its contractors for accessing sites and performing construction activities on NEP transmission ROWs. These procedures ensure that this Project will be completed in accordance with all applicable environmental laws and regulations as well as with NEP policies and compliance objectives.

MassDOT's Districts 2 and 3 will be contacted to discuss specific design information and anticipated Project activities within highway jurisdiction. With MassDOT input, a Traffic Management Plan will be developed and submitted for review and approval prior to the start of construction. Enforceable commitments in the Traffic Management Plan will be carried out by NEP to ensure that all proposed traffic mitigation strategies will be implemented as the Project proceeds. Such strategies may include, as appropriate, traffic management procedures; construction time restrictions; signage; installation of track pads to minimize soil in roadways; and/or restoration of vegetation along soft shoulders after construction. All work will occur in accordance with NEP Guidance Document for ROW Access, Maintenance and Construction Best Management Practices.

Findings: After the draft findings herein have been reviewed by Massachusetts Department of Transportation, and revised by the Proponent, as appropriate, the Massachusetts Department of Transportation will make a finding that the foregoing information adequately describes the traffic impacts associated with the proposed Project, and that with the implementation of the mitigation measures described above, all feasible means will have been taken to avoid or minimize adverse environmental impacts subject to Massachusetts Department of Transportation's authority. Appropriate conditions consistent with this Section 61 Finding are included in the State Permit to Access State Highway, and Permanent Access Permit within the Highway Layout issued by Massachusetts Department of Transportation to describe more fully and ensure implementation of said measures.

Proposed Section 61 Findings for Natural Heritage and Endangered Species (NHESP)

DRAFT FINDINGS PURSUANT TO G.L. CHAPTER 30, SECTION 61

Project Name: A1/B2 Transmission Lines Asset Condition Refurbishment Project

Project Location: Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, Athol, and Sterling.

Project Proponent: New England Power Company ("NEP")

EOEA Number: To Be Determined

Agency Action: Conservation and Management Permit from the Natural Heritage and Endangered Species Program of the Massachusetts Division of Fisheries and Wildlife under 321 CMR 10.23.

Intent of These Section 61 Findings: MEPA regulations 301 CMR 11.12(5) stipulate that in "accordance with G.L. c. 30, §61, any Agency that takes Agency Action on a Project for which the Secretary required an EIR shall determine whether the Project is likely, directly or indirectly, to cause any damage to the environment and make a finding describing the damage to the environment and confirming that all feasible measures have been taken to avoid or minimize the damage to the environment." The Section 61 Findings are incorporated into the conditions or restrictions to the relevant permit or authorization. The following proposed Section 61 Findings have been prepared by the Project Proponent and are intended to assist the state permit-issuing agency in fulfilling its obligations in accordance with G.L. c. 30, §61. These Findings are limited to the subject matter jurisdiction of the Conservation and Management Permit ("CMP") sought from the Natural Heritage and Endangered Species Program of the Massachusetts Division of Fisheries and Wildlife under 321 CMR 10.23.

Project Description: The Project includes complete refurbishment of 54 miles of 69 kV Transmission Line assets including structures replacements and installations, access improvements or re-establishment and construction of new access, and vegetation cutting. New construction is proposed for this Project.

Comprehensive inspections have identified structures and wires are in need of replacement due to asset condition and aging infrastructure, and lack of safe access for maintenance and emergency needs. From a safety and reliability perspective, in order to extend asset life, the following activities are proposed:

- Replacement of 711 structures
- Installation of approximately 305 concrete caisson foundations
- Installation of six (6) new vertical jumper switch structures
- Reconductoring of both circuits with 795 Aluminum-conductor steel-supported conductor (ACSS), installation of two (2) OPGW
- Construction of new and/or re-establishment of access roads
- Relocation of ~5.2 miles of centerline, approximately 41.5-ft north towards the I135S/J136S Transmission Lines within an existing ROW, in Leominster.
- ROW vegetation cutting to obtain a minimum horizontal clearance of 30-ft to the edge of ROW/easement under all horizontal clearance weather conditions. On average, the existing ROW vegetation cutting is 85-ft. The ROW will be cleared to 100-ft on the mainline and Crystal Lake Tap Line and 125-ft Athol Tap Line to obtain the necessary horizontal clearance requirements.
- Tree removals to accommodate construction access.

In addition, the existing shield wire will be replaced by OPGW to provide high speed communications between substations.NEP is the process of consulting with NHESP pursuant to MESA (G.L. c. 131A) and WPA (G.L. c. 131, §40) to avoid impacts to listed species and their habitat, and to provide mitigation for any unavoidable impacts. Although impacts will be avoided and minimized to the maximum practicable extent without compromising the safety of Project construction and future maintenance personnel, there is some potential "take". A CMP will be provided, if required.

MEPA History: Pursuant to G.L. c. 30, §61- §62A-H, of the Massachusetts Environmental Policy Act ("MEPA") and its implementing regulations at 301 CMR 11.00, the Proponent ("NEP") has prepared and submitted this Expanded ENF to MEPA. The Expanded ENF is the first MEPA filing associated with this Project. The Project is subject to MEPA review as it requires one or more state permits and exceeds the following thresholds requiring the filing of an:

- ENF and an EIR for Wetlands, Waterways and Tidelands because a permit is required, and there is expected to be alteration of one or more acres of bordering vegetated wetlands (301 CMR 11.03(3)(a)(1)(a)).
- EIR for Land because there is expected to alter 50 or more acres of land (301 CMR 11.03(1)(1)).
- EIR for Wetlands, Waterways and Tidelands because a permit is required, and there is expected to be an alteration of ten or more acres of other wetlands (301 CMR 11.03(3)(a)(1)(b).
- EIR for Environmental Justice Populations as the Project is located within a Designated Geographic Area around an Environmental Justice Population (301 CMR 11.06(7)(b).

Additionally, the proposed Project requires state permits from 401 Water Quality Certification, Natural Heritage and Endangered Species, Department of Conservation and Recreation, Massachusetts Department of Waterways, Energy Facilities Siting Board, Department of Public Utilities, Massachusetts Department of Environmental Protection and Massachusetts Department of Transportation.

Project Impacts: Impacts relative to the CMP include a potential "take" due to activities proposed within protected species habitat.

Project Mitigation: Mitigation was considered as a matter of course during the planning and design process as an overall approach to avoiding impacts whenever possible. In terms of mitigation during construction, NEP has established procedures that are to be followed by all NEP employees and its contractors for accessing sites and performing construction activities on transmission ROWs. These procedures ensure that this Project will be completed in accordance with all applicable environmental laws and regulations as well as with NEP policies and compliance objectives. NEP completed field investigations and a constructability review along the Project Route to determine access routes, clearing techniques, and construction techniques to be implemented during construction of the Project to provide an accurate impact assessment and to design work to avoid and minimize impacts within sensitive resources to the greatest extent practicable.

NEP is working closely with NHESP and consultation is ongoing. The Project will implement the necessary actions to avoid, minimize, and mitigate Project-related impacts to comply with the MESA permit issued for the Project.

A detailed mitigation plan will be prepared in conjunction with NHESP during the MESA Review in 2022.

Findings: After the draft findings herein have been reviewed by Massachusetts Division of Fisheries and Wildlife, NHESP, and revised by the Proponent, as appropriate, the NHESP will make a finding that the foregoing information adequately describes the environmental impacts associated with the proposed

Project, and that with the implementation of the mitigation measures described above, all feasible means will have been taken to avoid or minimize adverse environmental impacts subject to NHESP authority.

Proposed Section 61 Findings for Department of Conservation and Recreation (DCR)

DRAFT FINDINGS PURSUANT TO G.L. CHAPTER 30, SECTION 61

Project Name: A1/B2 Transmission Lines Asset Condition Refurbishment Project

Project Location: Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, Athol, and Sterling.

Project Proponent: New England Power Company ("NEP")

EOEA Number: To Be Determined

Agency Action: Department of Conservation and Recreation Construction Access Permits

Intent of These Section 61 Findings: MEPA regulations 301 CMR 11.12(5) stipulate that in "accordance with G.L. c. 30, §61, any Agency that takes Agency Action on a Project for which the Secretary required an EIR shall determine whether the Project is likely, directly or indirectly, to cause any damage to the environment and make a finding describing the damage to the environment and confirming that all feasible measures have been taken to avoid or minimize the damage to the environment." The Section 61 Findings are incorporated into the conditions or restrictions to the relevant permit or authorization. The following proposed Section 61 Findings have been prepared by the Project Proponent and are intended to assist the state permit-issuing agency in fulfilling its obligations in accordance with G.L. c. 30, §61. These Findings are limited to the subject matter jurisdiction of the Construction Access Permit sought from the Massachusetts DCR.

Project Description: The Project includes complete refurbishment of 54 miles of 69 kV Transmission Line assets including structures replacements and installations, access improvements or re-establishment and construction of new access, and vegetation cutting. New construction is proposed for this Project.

Comprehensive inspections have identified structures and wires are in need of replacement due to asset condition and aging infrastructure, and lack of safe access for maintenance and emergency needs. From a safety and reliability perspective, in order to extend asset life, the following activities are proposed:

- Replacement of 711 structures
- Installation of approximately 305 concrete caisson foundations
- Installation of six (6) new vertical jumper switch structures
- Reconductoring of both circuits with 795 Aluminum-conductor steel-supported conductor (ACSS), installation of two (2) OPGW
- Construction of new and/or re-establishment of access roads
- Relocation of ~5.2 miles of centerline, approximately 41.5-ft north towards the I135S/J136S Transmission Lines within an existing ROW, in Leominster.
- ROW vegetation cutting to obtain a minimum horizontal clearance of 30-ft to the edge of ROW/easement under all horizontal clearance weather conditions. On average, the existing ROW vegetation cutting is 85-ft. The ROW will be cleared to 100-ft on the mainline and Crystal Lake Tap Line and 125-ft Athol Tap Line to obtain the necessary horizontal clearance requirements.
- Tree removals to accommodate construction access.

In addition, the existing shield wire will be replaced with OPGW to provide high speed communications between substations. The Project includes on and off-ROW tree removal and construction activities on

DCR properties of the Commonwealth under the care, custody, and control of the DCR under 302 CMR 11.00.

MEPA History: Pursuant to G.L. c. 30, §61- §62A-H, of the Massachusetts Environmental Policy Act ("MEPA") and its implementing regulations at 301 CMR 11.00, the Proponent ("NEP") has prepared and submitted this Expanded ENF to MEPA. The Expanded ENF is the first MEPA filing associated with this Project. The Project is subject to MEPA review as it requires one or more state permits and exceeds the following thresholds requiring the filing of an:

- ENF and an EIR for Wetlands, Waterways and Tidelands because a permit is required, and there is expected to be alteration of one or more acres of bordering vegetated wetlands (301 CMR 11.03(3)(a)(1)(a)).
- EIR for Land because there is expected to alter 50 or more acres of land (301 CMR 11.03(1)(1)).
- EIR for Wetlands, Waterways and Tidelands because a permit is required, and there is expected to be an alteration of ten or more acres of other wetlands (301 CMR 11.03(3)(a)(1)(b).
- EIR for Environmental Justice Populations as the Project is located within a Designated Geographic Area around an Environmental Justice Population (301 CMR 11.06(7)(b).

Additionally, the proposed Project requires state permits from the 401 Water Quality Certification, Natural Heritage and Endangered Species, Department of Conservation and Recreation, Massachusetts Department of Waterways, Energy Facilities Siting Board, Department of Public Utilities, Massachusetts Department of Environmental Protection and Massachusetts Department of Transportation.

Project Impacts: Impacts relative to the DCR Construction Access Permits include tree removals, access road construction and structure replacement containing concrete caissons at 14 structures within DCR properties.

Project Mitigation: Mitigation was considered as a matter of course during the planning and design process as an overall approach to avoiding impacts whenever possible. In terms of mitigation during construction, NEP has established procedures that are to be followed by all NEP employees and its contractors for accessing sites and performing construction activities on transmission ROWs. These procedures ensure that this Project will be completed in accordance with all applicable environmental laws and regulations as well as with NEP policies and compliance objectives. NEP completed field investigations and a constructability review along the Project Route to determine access routes, clearing techniques, and construction techniques to be implemented during construction of the Project to provide an accurate impact assessment and to design work to avoid and minimize impacts within sensitive resources to the greatest extent practicable.

At this time, proposed mitigation may include, but is not limited to, the following:

- Any and all work will be conducted according to the Construction Access Permit terms and conditions, to the satisfaction of the Department.
- All work will be performed in accordance with applicable statutes, regulations, codes or standards.

A detailed mitigation plan will be prepared in conjunction with the anticipated filing of DCR Permits in 2023. Coordination with DCR is ongoing.

Findings: After the draft findings herein have been reviewed by DCR, and revised by the Proponent, as appropriate, the DCR will make a finding that the foregoing information adequately describes the environmental impacts associated with the proposed Project, and that with the implementation of the mitigation measures described above, all feasible means will have been taken to avoid or minimize adverse environmental impacts subject to DCR authority.

Proposed Section 61 Findings Executive Office of Energy and Environmental Affairs Environmental Justice

DRAFT FINDINGS PURSUANT TO G.L. CHAPTER 30, SECTION 61

Project Name: A1/B2 Transmission Lines Asset Condition Refurbishment Project

Project Location: Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, Athol, and Sterling.

Project Proponent: New England Power Company ("NEP")

EOEA Number: To Be Determined

Agency Action: Executive Office of Energy and Environmental Affairs ("EOEEA") - Environmental Justice

Intent of These Section 61 Findings: MEPA regulations 301 CMR 11.12(5) stipulate that in "accordance with G.L. c. 30, §61, any Agency that takes Agency Action on a Project for which the Secretary required an EIR shall determine whether the Project is likely, directly or indirectly, to cause any damage to the environment and make a finding describing the damage to the environment and confirming that all feasible measures have been taken to avoid or minimize the damage to the environment." The Section 61 Findings are incorporated into the conditions or restrictions to the relevant permit or authorization. The following proposed Section 61 Findings have been prepared by the Project Proponent and are intended to assist the state permit-issuing agency in fulfilling its obligations in accordance with G.L. c. 30, §61. These Findings are limited to the subject matter jurisdiction of the MEPA Interim Protocol for Analysis of Environmental Justice (EJ) Impacts, which implements requirements related to the content of Environmental Impact Reports (EIRs) as set forth in Section 58 of the Act.

Project Description: Project Description: The Project includes complete refurbishment of 54 miles of 69 kV Transmission Line assets including structures replacements and installations, access improvements or re-establishment and construction of new access, and vegetation cutting. New construction is proposed for this Project.

Comprehensive inspections have identified structures and wires are in need of replacement due to asset condition and aging infrastructure, and lack of safe access for maintenance and emergency needs. From a safety and reliability perspective, in order to extend asset life, the following activities are proposed:

- Replacement of 711 structures
- Installation of approximately 305 concrete caisson foundations
- Installation of six (6) new vertical jumper switch structures
- Reconductoring of both circuits with 795 Aluminum-conductor steel-supported conductor ("ACSS"), installation of two (2) OPGW
- Construction of new and/or re-establishment of access roads
- Relocation of ~5.2 miles of centerline, approximately 41.5-ft north towards the I135S/J136S Transmission Lines within an existing ROW, in Leominster.
- ROW vegetation cutting to obtain a minimum horizontal clearance of 30-ft to the edge of ROW/easement under all horizontal clearance weather conditions. On average, the existing ROW vegetation cutting is 85-ft. The ROW will be cleared to 100-ft on the mainline and Crystal Lake Tap Line and 125-ft Athol Tap Line to obtain the necessary horizontal clearance requirements.
- Tree removals to accommodate construction access.

In addition, the existing shield wire will be replaced with OPGW to provide high speed communications between substations.

MEPA History: Pursuant to G.L. c. 30, §61- §62A-H, of the Massachusetts Environmental Policy Act ("MEPA") and its implementing regulations at 301 CMR 11.00, the Proponent ("NEP") has prepared and submitted this Expanded ENF to MEPA. The Expanded ENF is the first MEPA filing associated with this Project. The Project is subject to MEPA review as it requires one or more state permits and exceeds the following thresholds requiring the filing of an:

- ENF and an EIR for Wetlands, Waterways and Tidelands because a permit is required, and there is expected to be alteration of one or more acres of bordering vegetated wetlands (301 CMR 11.03(3)(a)(1)(a)).
- EIR for Land because there is expected to alter 50 or more acres of land (301 CMR 11.03(1)(1)).
- EIR for Wetlands, Waterways and Tidelands because a permit is required, and there is expected to be an alteration of ten or more acres of other wetlands (301 CMR 11.03(3)(a)(1)(b).
- EIR for Environmental Justice Populations as the Project is located within a Designated Geographic Area around an Environmental Justice Population (301 CMR 11.06(7)(b).

Additionally, the proposed Project requires state permits from the 401 Water Quality Certification, Natural Heritage and Endangered Species, Department of Conservation and Recreation, Massachusetts Department of Waterways, Energy Facilities Siting Board, Department of Public Utilities, Massachusetts Department of Environmental Protection and Massachusetts Department of Transportation.

Project Impacts: Impacts relative to the EOEEA EJ Populations include approximately 24 acres of tree removal within the EJ Populations, 29 acres of cut/fill associated with establishment of access roads, work envelopes and pull pads, and 322 lf of Standard Road Type 1 & 2, and 19,054 lf of Designed Road Type 3-5. In total, 10% of Project impacts are located within the EJ Populations, which represents 10% of the Project ROW, whereas 90% of Project impacts are within non-EJ Populations, which represents 90% of the Project Right-of-Way (ROW). Therefore, NEP anticipates that the Project will not have unfair or inequitable impacts on the EJ Populations within the designated geographic area.

Project Mitigation: The Project will occur within the existing ROW, thereby minimizing adverse environmental impacts to the nature of the Project, outage constraints in the region, and NEP's efforts to reduce impacts to the natural and human environment, Project activities will be sequenced in both the mainline and tap lines. No long-term impacts on soil, bedrock, vegetation, surface water, groundwater, wetland resources or air quality will occur. Any potential sedimentation impacts, and other short-term construction impacts to wetlands and surface waters, will be mitigated through the use of soil erosion and sediment control BMPs and temporary construction mats to protect wetland soils, vegetation root stock, and streams. As part of the Project, an Environmental Monitor will be part of the Project team to ensure compliance with all regulatory programs and permit conditions, and to oversee the proper installation and maintenance of the soil erosion and sediment control BMPs.

At this time, proposed mitigation includes, but is not limited to, the following:

Air Quality

Construction-period activities, such as grading, roadbuilding, vehicle travel, and other earth-disturbing work may result in a temporary increase in airborne dust. Impacts to air quality will be minimized by managing the control of dust movement with practices such as spreading wood mulch or straw and using water trucks to spray dried soil to keep it moist. The potential for dust generation is only anticipated during the construction period. Post construction, soil will be stabilized and re-vegetated.

In addition, diesel-powered equipment is required to use ultra-low sulfur diesel fuel. Any diesel-powered non-road construction equipment rated 50-horsepower or more that will be used on the Project for 30 days or more will be required to install emission control devices. The impacts from these emissions will be minimal and are not anticipated to cause impacts to public health. Additionally, idling times are limited to five (5) minutes except when engine power is necessary for the delivery of materials or to operate accessories to the vehicle such as power lifts. Vehicle idling is to be minimized during construction activities and be in compliance with the Massachusetts Anti-idling Law, G.L. c. 90 § 16A, c. 111 §§ 142A – 142M, and 310 CMR 7.11.

Water Quality

The project will incorporate protective and preventative measures to minimize and avoid impacts to water quality. The ROWs cross many wetland areas, streams and rivers. To protect water quality and these sensitive areas, temporary roads will be constructed using construction mats. Construction mats are comprised of wooden beams, bolted together, and are typically 4-ft wide by 16-ft long. They are laid temporarily on top of the ground and vegetation. These mats allow heavy machines and vehicles to cross sensitive areas without damaging the soil or roots of vegetation and are also placed in a manner that do not affect the flow of water in streams. These mats will be removed when construction is completed, and the wetlands will be restored. In addition, BMPs, such as the use of straw wattles, silt fencing, stormwater management features, and other control measures will be used to prevent soil and other material from being transported into wetlands and streams. Using these BMPs, any impacts to water quality will be negligible and temporary and are not anticipated to cause impacts to public health.

Land Protection and Open Space

Project activities will be limited to the existing ROW. Access to Protected Land and Open Space within EJ Populations will not be impacted.

Noise

Noise impacts associated with construction-period activities are temporary in nature and expected to be minimal. Where construction will occur adjacent to residences, NEP will notify landowners prior to the commencement of work. Noise-generating activities will be conducted in accordance with any local and state requirements and are not anticipated to cause impacts to public health.

Traffic

Impacts to traffic during the construction of the Project will be minor and intermittent. The work areas will be accessed primarily from NEP-owned access routes or minor town roadways. NEP will obtain the necessary permits from Massachusetts Department of Transportation for access. Once on-site, vehicle traffic will be limited to within or in proximity to the ROW. Since the ROW is an un-manned facility, there will be no permanent impacts to traffic patterns or use of existing roadways and no impacts to public health are anticipated from traffic

Findings:

After the draft findings herein have been reviewed by the EOEEA - EJ Program, and revised by the Proponent, as appropriate, the EOEEA - EJ Program will make a finding that the foregoing information adequately describes the environmental impacts to the EJ Populations associated with the proposed Project, and that with the implementation of the mitigation measures described above, all feasible means will have been taken to avoid or minimize adverse environmental impacts subject to EOEEA's EJ authority.

Proposed Section 61 Findings Climate Protocol
DRAFT FINDINGS PURSUANT TO G.L. CHAPTER 30, SECTION 61

Project Name: A1/B2 Transmission Lines Asset Condition Refurbishment Project

Project Location: Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, Athol, and Sterling.

Project Proponent: New England Power Company ("NEP")

EOEA Number: To Be Determined

Agency Action: Executive Office of Energy and Environmental Affairs ("EOEEA") - Climate Change

Intent of These Section 61 Findings: MEPA regulations 301 CMR 11.12(5) stipulate that in "accordance with G.L. c. 30, §61, any Agency that takes Agency Action on a Project for which the Secretary required an EIR shall determine whether the Project is likely, directly or indirectly, to cause any damage to the environment and make a finding describing the damage to the environment and confirming that all feasible measures have been taken to avoid or minimize the damage to the environment." The Section 61 Findings are incorporated into the conditions or restrictions to the relevant permit or authorization. The following proposed Section 61 Findings have been prepared by the Project Proponent and are intended to assist the state permit-issuing agency in fulfilling its obligations in accordance with G.L. c. 30, §61. These Findings are limited to the subject matter jurisdiction of the Massachusetts Environmental Policy Act ("MEPA") Interim Protocol on Climate Change Adaptation and Resiliency ("Interim Protocol") which complies with Executive Order 569.

Project Description: Project Description: The Project includes complete refurbishment of 54 miles of 69 kV Transmission Line assets including structures replacements and installations, access improvements or re-establishment and construction of new access, and vegetation cutting. New construction is proposed for this Project.

Comprehensive inspections have identified structures and wires are in need of replacement due to asset condition and aging infrastructure, and lack of safe access for maintenance and emergency needs. From a safety and reliability perspective, in order to extend asset life, the following activities are proposed:

- Replacement of 711 structures
- Installation of approximately 305 concrete caisson foundations
- Installation of six (6) new vertical jumper switch structures
- Reconductoring of both circuits with 795 Aluminum-conductor steel-supported conductor ("ACSS"), installation of two (2) OPGW
- Construction of new and/or re-establishment of access roads
- Relocation of ~5.2 miles of centerline, approximately 41.5-ft north towards the I135S/J136S Transmission Lines within an existing ROW, in Leominster.
- ROW vegetation cutting to obtain a minimum horizontal clearance of 30-ft to the edge of ROW/easement under all horizontal clearance weather conditions. On average, the existing ROW vegetation cutting is 85-ft. The ROW will be cleared to 100-ft on the mainline and Crystal Lake Tap Line and 125-ft Athol Tap Line to obtain the necessary horizontal clearance requirements.
- Tree removals to accommodate construction access.

In addition, the existing shield wire will be replaced with OPGW to provide high speed communications between substations.

MEPA History: Pursuant to G.L. c. 30, §61- §62A-H, of the Massachusetts Environmental Policy Act ("MEPA") and its implementing regulations at 301 CMR 11.00, the Proponent ("NEP") has prepared and submitted this Expanded ENF to MEPA. The Expanded ENF is the first MEPA filing associated with this Project. The Project is subject to MEPA review as it requires one or more state permits and exceeds the following thresholds requiring the filing of an:

- ENF and an EIR for Wetlands, Waterways and Tidelands because a permit is required, and there is expected to be alteration of one or more acres of bordering vegetated wetlands (301 CMR 11.03(3)(a)(1)(a)).
- EIR for Land because there is expected to alter 50 or more acres of land (301 CMR 11.03(1)(1)).
- EIR for Wetlands, Waterways and Tidelands because a permit is required, and there is expected to be an alteration of ten or more acres of other wetlands (301 CMR 11.03(3)(a)(1)(b).
- EIR for Environmental Justice Populations as the Project is located within a Designated Geographic Area around an Environmental Justice Population (301 CMR 11.06(7)(b).

Additionally, the proposed Project requires state permits from the 401 Water Quality Certification, Natural Heritage and Endangered Species, Department of Conservation and Recreation, Massachusetts Department of Waterways, Energy Facilities Siting Board, Department of Public Utilities, Massachusetts Department of Environmental Protection and Massachusetts Department of Transportation.

Project Impacts: Impacts relative to the Massachusetts Department of Energy Resources Climate Change include Project asset impacts of high exposure to Extreme Precipitation - Urban Flooding, Extreme Precipitation - Riverine Flooding and Extreme Heat.

Project Mitigation: The Project has incorporated measures that seek to reduce potential vulnerability to anticipated climate risks and improve resiliency for future climate conditions. The EOEEA Climate Change and Adaptation Report (Report) documents that with increasing temperatures as a result of climate change, electricity demand in the Commonwealth could increase by 40 percent in 2030. The Massachusetts State Hazard Mitigation & Climate Adaptation Plan states in its risk assessment, that, "in addition to increasing demand for heating and cooling, periods of both hot and cold weather can stress energy infrastructure…Electricity consumption during summer may reach three times the average consumption rate of the period between 1960 and 2000; more than 25 percent of this consumption may be attributable to climate change." [36] The Report identifies that without reliable energy service, the basic needs of residents, visitors, businesses, and governments cannot be met. The Project, which is designed to improve reliable energy service within the region, serves this overall purpose.

NEP has taken steps to promote climate change adaptation and resiliency in the design of the Project and continues to consider climate change and long-term infrastructure resiliency an important goal in its long-term infrastructure planning. The Project will result in a more climate-ready and resilient transmission system that can withstand more extreme weather events; address existing system capacity shortages and increased demand; and support future interconnections from renewable energy projects. In addition, NEP's preferred solution uses substantial portions of the existing ROW, thereby minimizing alteration of new land resources to construct the Project. The purpose of the Project is to address existing asset conditions along the A1/B2 Lines that pose a threat to electrical reliability.

36 EOEEA, 2011 as cited in Massachusetts State Hazard Mitigation and Climate Action Plan, 2018, p. 265. Retrieved 6/14/2022, https://resilientma.org/shmcap-portal/static/media/SHMCAP-September2018-Full-Plan-web.286acceb.pdf#page=90

Findings: After the draft findings herein have been reviewed by the EOEEA - Climate Change Program, and revised by the Proponent, as appropriate, the EOEEA - Climate Change Program will make a finding that the foregoing information adequately describes the environmental impacts to the climate associated with the proposed Project, and that with the implementation of the mitigation measures described above, all feasible means will have been taken to avoid or minimize adverse climate impacts subject to the MEPA Interim Protocol on Climate Change Adaptation and Resiliency.

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October 31, 2022

CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS
ON THE
EXPANDED ENVIRONMENTAL NOTIFICATION FORM

PROJECT NAME	: A1/B2 Asset Condition Refurbishment (ACR) Project
PROJECT MUNICIPALITY	: Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, Athol, and Sterling
PROJECT WATERSHED	: Nashua, Connecticut River, and Millers River
EEA NUMBER	: 16607
PROJECT PROPONENT	: New England Power Company (NEP)
DATE NOTICED IN MONITOR	: September 23, 2022

Pursuant to the Massachusetts Environmental Policy Act (MEPA; M.G.L. c. 30, ss. 61-62L) and Section 11.06 of the MEPA Regulations (301 CMR 11.00), I have reviewed the Expanded Environmental Notification Form (EENF) and hereby determine that this project **requires** the preparation of a Draft Environmental Impact Report (DEIR). The EENF identifies baseline environmental conditions and potential environmental impacts but contains an inadequate alternatives analysis and a limited description of mitigation measures. In particular, the DEIR should explore alternatives to reduce the extent of tree clearing so as to avoid or minimize impacts to environmental resources. The DEIR should discuss whether a Wetlands Variance or Article 97 legislation is needed, and if so, include a full description of how the project will comply with applicable requirements. The Proponent should offer meaningful mitigation measures to offset the environmental impacts in project areas where impacts to wetlands and undisturbed forests cannot be avoided or minimized. As an adequate alternatives analysis is a central component of the MEPA review process, the request to file a Single EIR is denied.

Project Description

As described in the EENF, the project is part of a larger refurbishment effort that continues north of the Massachusetts border and terminates at the Vernon Substation located in Vernon, Vermont. The A1/B2 Line ("mainline") is approximately 61.12 miles long, including 54 miles of Right-of-Way (ROW) within Massachusetts. In addition to the mainline, work will be conducted on three tap lines: the Athol Taps 1 and 2, Crystal Lake Tap, and East Westminster Tap. The project consists of refurbishment of the mainline and all three tap lines. Work will be conducted in the Towns of Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, Athol, and Sterling. The refurbishment project includes replacement of 711 structures and installation of six new structures (vertical jumper switches). The 711 structures to be removed and replaced at adjacent locations include 406 poles to be directly embedded in the ground and 305 structures to be placed on concrete caisson foundations. Additional work includes construction of new and improvement of existing access roads, reconductoring of both circuits with 795 ACSS (Aluminum Conductor Steel Supported) conductor, installation of two Optical Ground Wires (OPGWs),[1] and relocation of the centerline (for a 5.2 mile section). Tree removal will be done to obtain a minimum horizontal clearance of 30-feet[2] (38-feet assuming a stationary position) from the conductor to the edge of ROW/easement under all horizontal clearance weather conditions. The EENF states the existing maintained ROW on the mainline, the Crystal Lake Tap Line and the Athol Tap Line is roughly 85-ft, 75-ft, and 100-ft, respectively. To provide the necessary clearances for the replacement and new structures, the mainline and Crystal Lake Tap ROWs will be cleared to 100-ft, and the Athol Tap ROW will be cleared to 125-ft. Following the completion of construction. The East Westminster Tap Line is located within the mainline ROW and would be part of the mainline vegetation clearing.

As part of the project and based on the results of a 2050 ISO-NE transmission study,[3] the Proponent proposes to upgrade the existing 69 kV line to support 115 kV capacity (lines will be larger in capacity and size which will allow more electricity to flow during times of high usage); however, the Proponent will continue to operate the new line at 69 kV until additional capacity is needed. The EENF states that the upgrade is based on forecasts for future renewable energy connections and customer needs which will require the system to operate at the higher voltage at some point in the future. Due to outage constraints associated with the A1/B2 lines, the project will need to utilize live line construction techniques (meaning that construction activities are conducted while the overhead lines are energized). The EENF states that this requires the replacement structures and engineered steel structures to be installed at a height above the existing structures to ensure worker and equipment safety. The replacement and new structure height for the mainline and tap lines is approximately 93-ft above ground (110-ft for direct embed structures), which is approximately twice as tall as the existing mainline and tap line structures standing at 51-ft and 45-ft, respectively.

Project Corridor

As described in the EENF, the project activities will be located within the Towns of Warwick, Royalston, Athol, Winchendon, Gardner, Westminster, Fitchburg, Leominster, and Sterling. The project

[1] The current shield wire located at the top of the structures (for lightening protection) will be replaced with two OPGWs to provide grounding and support high-speed relay and system communication.
[2] 30 ft assumes some movement of the conductor away from the conductor and toward the edge of the ROW.
[3] Independent System Operator – New England ("ISO-NE") 2050 Transmission Study: *https://www.iso-ne.com/static-assets/documents/2022/03/a4_2050_transmission_study_preliminary_n_1_and_n_1_1_thermal_results_presentation.pdf*

ROW is generally oriented northwest-to-southeast from Warwick to Sterling, MA. The existing mainline consists of two 69 kV overhead electric transmission lines ("wires") that are supported primarily on lattice towers ("structures"). The existing 69 kV tap lines consist of the existing Athol Taps 1 and 2 in Athol and Royalston, the existing Crystal Lake Tap in Gardener, and the existing East Westminster Tap in Westminster. Tap lines are comprised of wood pole structures. As noted above, the mainline is generally located within a 100-ft easement; however, in Sterling and Leominster, the mainline is co-located with the I135S/J136S Lines and the ROW is wider in these locations to accommodate required clearances. The East Westminster Tap is a two structure tap line located within the mainline ROW. Along the Athol Tap, lines are generally within a 125-ft easement/ROW and the Crystal Lake Tap Line is generally within a 100-ft wide easement/ROW.

Conditions within the project area include moderately level terrain, as well as steeply sloping river terraces and cliffs. Upland portions of the ROW consist of shrubby and herbaceous vegetation communities. Where undeveloped, the edge of the ROW consists of forested upland and wetland. Land use adjacent to the project ROW includes agricultural, recreational, as well as commercial and residential development. The ROW crosses multiple reservoirs, rivers, ponds, as well as numerous streams and wetland systems. The EENF states that there are approximately 40 Certified Vernal Pools (CVPs) located within a half-mile of the ROW in Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, and Sterling. There are no CVPs mapped within the ROW; however, the Proponent identifies at least one potential vernal pool where temporary construction mats are proposed.

The project corridor crosses Outstanding Resource Waters (ORWs) including Notown Reservoir, Fall Brook Reservoir, Goodfellow Pond, Simonds Pond, Distributing Reservoir, Morse Reservoir (all in Leominster) and Parleys Brook Reservoir (in Gardner). The ROW contains Bordering Vegetated Wetlands (BVW), Isolated Vegetated Wetlands (IVW), Inland Bank, Land Under Water (LUW), Bordering Land Subject to Flooding (BLSF), Riverfront Area (RFA), and associated buffer zones. The project corridor includes mapped areas that are inundated during a 100-year storm as mapped on the Federal Emergency Management Act (FEMA) Flood Insurance Rate Maps (FIRMs); however, the map legend color is not easily distinguishable on the plans included in the EENF. The EENF identifies areas of Priority Habitat and Rare Species as determined by the 15th Edition of the Massachusetts Natural Heritage Atlas including nine species present in Warwick, Royalston, Winchendon, Athol, Fitchburg, and Leominster. The site contains several historic and archaeological sites previously recorded in the Massachusetts Historical Commission's (MHC) Inventory of Historic and Archaeological Assets of the Commonwealth.

The project site is located within five Environmental Justice (EJ) populations in four municipalities[4] characterized by Income, Minority, and Minority and Income and within one mile of 13 EJ populations in five municipalities[5] also characterized by Income, Minority, and Minority and Income. The site is located within five miles of 65 EJ populations, within eight municipalities, characterized by Income, Minority, Minority and Income, and Minority, Income, and English Isolation. As described below, the EENF identified the "Designated Geographic Area" (DGA) for the project as one mile around EJ populations, included a review of potential impacts and benefits to the EJ populations within this DGA, and described public involvement efforts undertaken to date.

[4] Athol, Gardner, Leominster, and Fitchburg.
[5] Athol, Gardner, Fitchburg, Leominster, and Lancaster.

Environmental Impacts and Mitigation

According to the EENF potential environmental impacts associated with the project include the alteration of ±216 acres of land consisting of 164 acres of permanent impacts associated with tree clearing and 52 acres associated with new/improved access. Potential impacts to wetland resource areas are listed in the table below.

Wetland Resource Area	Temporary Construction Mat sf/acre	Permanent Wetland Impacts sf/acre	Total Impact sf/acre
BVW	2,200,651 / 51	661,928 /15	2,868,580 / 66
IVW	73,181/1.7	11,8400 /0.3	85,021/ 2
BLSF[6]	13,939 /0.3	375,578/ 8.6	389,517 / 9
RFA[7]	513,137 / 12	2,101,678 / 48	2,614,816 / 60
LUW	32,206/0.74	158 sf	32,364/ 0.74
Bank[8]	67,954 linear feet (lf)	26,572 lf	94,526 lf

Temporary impacts are associated with construction mats for access roads, work pads and pull pad envelopes, and mowing associated with the current Vegetation Management Plan (VMP). Permanent impacts are associated with fill for structure foundations (2 within LUW), cut and fill for access roads, work envelopes, pull pads, retaining walls,[9] stabilization material for access roads, and tree removal. The EENF does not identify acres of impact in priority habitat of state-listed rare species. Greenhouse Gas (GHG) emissions and other air pollutants are associated with the clearing of trees and loss of carbon sequestration.

Measures to avoid, minimize, and mitigate project impacts include use of existing access roads to avoid new land disturbance, where feasible; use of temporary construction mats where crossing wetlands or water courses is unavoidable; spanning of streams to avoid impacts to bank; replacing structures outside of BVW where feasible; use of erosion and sedimentation controls and other best management practices (BMPs) during construction; restoration of any disturbed areas to existing grades to allow for revegetation with compatible species; and restoration of temporarily impacted wetland resources to pre-construction conditions. Tree stumps will be left in place except at work envelopes and structure locations, and within access roads. The EENF does not describe tree clearing methods that might be used to minimize site disturbance such as clearing by hand in sensitive areas or use of feller bunchers (as recommended in comments from the Massachusetts Department of Environmental Protection (MassDEP)). Compensatory flood storage and wetland replication are proposed to mitigate for permanent fill in BVW and BLSF. The EENF indicates that significant archaeological resources will be avoided if safe/practicable alternatives are available and the Proponent will conduct investigations for archaeological resources in accordance with a Massachusetts State Archaeologist's permitted plan prior to any site preparation or excavation. The EENF states that a compensatory mitigation plan will be

[6] Impacts are the result of 56,521 sf of access road and 237,402 sf of cut associated with work envelopes, pull pads and access proposed in BLSF; however, areas will be over-excavated and not result in fill.
[7] Note that impacts located within the limits of Riverfront Area overlap with impacts to BLSF, BVW, and the 100-ft Buffer Zone. Therefore, the total impacts to the project site are not equal to the sum of alterations.
[8] Construction mats will span the Bank of rivers and streams; however, the totals reflect the potential for alteration.
[9] Permanent retaining walls will be gabion basket, large block gravity, mechanically stabilized earth, sheet pile. Construction mats may be used but would only be temporary.

developed in consultation with MassDEP and the nine local conservation commissions to mitigate for permanent wetland conversion and to form the conditions for a 401 Water Quality Certification (WQC) to be issued by MassDEP. A more comprehensive discussion of mitigation, including for the extensive tree clearing proposed by the project, should be provided in the DEIR.

Jurisdiction and Permitting

The project is undergoing MEPA review and is subject to a mandatory EIR pursuant to 301 CMR 11.03(1)(a)1. and 301 CMR 11.03(3)(a)1.a. & b. of the MEPA regulations because it requires Agency Actions and will result in the alteration of 50 or more acres of land, one or more acres of BVW, and ten or more acres of any other wetland, respectively. Additionally, the project exceeds the Environmental Notification Form (ENF) thresholds at 301 CMR 11.03(3)(b)(1)b., 301 CMR 11.03(3)(b)(1)f., 301 CMR 11.03(2)(b)2. for alteration of 500 or more linear feet of bank along a fish run or inland bank, alteration of on half or more acres of any other wetlands, and greater than two acres of disturbance of designated priority habitat, respectively. In addition to exceeding mandatory EIR thresholds, the project requires the preparation of an EIR under 301 CMR 11.06(7)(b) of the MEPA regulations because it is located within one mile of one or more EJ populations. The project requires a WQC from MassDEP and review by the Natural Heritage Endangered Species Program (NHESP) and potentially a Conservation Management Permit (CMP). The project will require a Construction Access Permit (CAP) from DCR and an Access Permit from the Massachusetts Department of Transportation (MassDOT). The project will file a Petition for Approval to Construct Transmission Lines with the Energy Facilities Siting Board (EFSB) pursuant to G.L. c. 164, §69J and with the Department of Public Utilities (DPU) pursuant to G.L. c. 164 requesting exemptions from municipal Zoning Ordinances (Petition for Determination of Public Necessity and Convenience). The project is subject to review under the May 2010 MEPA GHG Emissions Policy and Protocol (GHG Policy). Comments from the MassDEP Waterways Program indicate additional information is required to determine if Chapter 91 (c. 91) authorization may be required.

The project requires Orders of Conditions from the Athol, Fitchburg, Gardner, Leominster, Royalston, Sterling, Warwick, and Winchendon Conservation Commissions (or in the case of an appeal, a Superseding Order of Conditions from MassDEP); a Section 404 General Permit from the U.S. Army Corps of Engineers (USACE); a National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) from the U.S. Environmental Protection Agency (EPA); Section 7 clearance renewal from the U.S. Fish and Wildlife Service; and review by MHC acting as the State Historic Preservation Officer (SHPO) pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended (36 CFR 800).

The project is not receiving Financial Assistance from the Commonwealth. Therefore, MEPA jurisdiction is limited to those aspects of the project that are within the subject matter of any required or potentially required Agency Actions and that may cause Damage to the Environment, as defined in the MEPA regulations.

Request for Single EIR

The MEPA regulations at 301 CMR 11.06(8) indicate that a Single EIR may be allowed provided I find that the EENF:

a) describes and analyzes all aspects of the project and all feasible alternatives, regardless of any jurisdictional or other limitation that may apply to the Scope;

b) provides a detailed baseline in relation to which potential environmental impacts and mitigation measures can be assessed; and,

c) demonstrates that the planning and design of the project use all feasible means to avoid potential environmental impacts.

For any Project for which an EIR is required in accordance with 301 CMR 11.06(7)(b), I must also find that the EENF:

d) describes and analyzes all aspects of the Project that may affect Environmental Justice Populations located in whole or in part within the Designated Geographic Area around the Project; describes measures taken to provide meaningful opportunities for public involvement by Environmental Justice Populations prior to filing the expanded ENF, including any changes made to the Project to address concerns raised by or on behalf of Environmental Justice Populations; and provides a detailed baseline in relation to any existing unfair or inequitable Environmental Burden and related public health consequences impacting Environmental Justice Populations in accordance with 301 CMR 11.07(6)(n)1.

Consistent with this request, the EENF was subject to an extended comment period under 301 CMR 11.05(8).

<u>Review of the EENF</u>

The EENF provides a description of existing and proposed conditions; preliminary project plans; a limited analysis of alternatives; assessment of impacts; a review of construction methods; and a discussion of the project's compliance with the MEPA Greenhouse Gas (GHG) Policy. It also included a description of measures taken to enhance public involvement by EJ populations and a baseline assessment of any existing unfair or inequitable Environmental Burden and related public health consequences impacting EJ Populations in accordance with 301 CMR 11.07(6)(n)1. Consistent with the MEPA Interim Protocol on Climate Change Adaptation and Resiliency, the EENF contained an output report from the Climate Resilience Design Standards Tool prepared by the Resilient Massachusetts Action Team (RMAT) (the "MA Resilience Design Tool"),[10] together with information on climate resilience strategies to be undertaken by the project. The EENF included a copy of National Grid's Vegetation Management Plan for 2019-23 and a Wildlife Habitat Analysis.

Alternatives Analysis

The EENF describes the need for the project, stating that the mainline was originally constructed in 1909 and that the original lattice structures remain. The lines were reconductored in the 1920s and were reinsulated in 2004. Structures and wires are in need of replacement due to asset condition and aging infrastructure. In addition, the access conditions vary considerably throughout the ROW. The EENF indicates that existing access is present in some areas, but in others, the historic access route requires significant repair and does not meet New England Power's standard to safely support specialized equipment. The Proponent states that the primary objective is to complete required system improvements to address poor asset condition, mitigate potential risks of electrical failure, and to provide long-term reliable delivery of electrical service and maintenance of the lines. The EENF

[10] https://resilientma.org/rmat_home/designstandards/

describes the criteria for evaluating alternatives including:

- Meets the identified project need and reliability;
- Addresses the various regulatory and permitting objectives;
- Minimizes environmental impacts;
- Provides a cost-effective solution to customers.

The EENF includes analysis of a No Build Alternative, a Critical Asset Repair Alternative, and a 69 kV Rebuild Alternative. The No Build Alternative establishes a baseline against which the project can be evaluated but is not a feasible option because deteriorating structures would pose a safety risk to personnel, would affect the reliability of electrical service to customers, and would not provide the high speed communication line between substations that is needed. For these reasons, the No Build Alternative was dismissed.

The EENF describes the Critical Asset Repair Alternative which would address only asset related issues that are deemed “critical” to repair, and would not address the entirety of asset condition concerns. This alternative would not improve the reliability of the existing communications between substations served by the circuits, and would result in inefficiencies in revisiting the same ROW to conduct additional work within a short time span. For these reasons, this alternative was dismissed.

The 69 kV Rebuild Alternative would rebuild the structures along the mainline and tap lines to meet 69kV standards as described further below. As noted above, the Proponent proposes to upgrade the carrying capacity of the lines to 115 kV to meet the future needs of customers and renewable energy production, while making needed repairs to the line. Rebuilding the line to meet 69 kV standards would decrease the height of the new structures required, but only by approximately 5.5 ft. The horizontal clearance requirements for the slightly shorter structures would be the same as for the structures to meet the 115 kV requirements; therefore, tree removal would not be reduced. Refurbishing the lines at 69 kV would not reduce environmental impacts and would not provide the benefit of operating the Lines at 115 kV in the future; therefore, this alternative was dismissed.

The EENF describes the replacement structure design as double-circuit davit arms for the mainline, and single-circuit davit arms for the tap lines. The EENF included the table below describing the alternative structures, alternative davit arm length, and installation methods considered for the mainline and tap lines.

Table 5: 115 kV Structure Design Alternative Evaluated and Reasons for Elimination

	Alternative	Reasons for Elimination
Mainline	Two single circuit structures	Two single circuit structures were eliminated as the design for the mainline as it would have required an increase in work footprint, additional concrete caisson foundations, and doubled the number of steel poles required.
	7-ft Davit Arm	A 7-ft davit arm was evaluated and rejected for use along the mainline structures. This is due to the findings of the ice jumping study, which identified that a 10-ft middle davit arm is required to maintain adequate clearance during ice-shedding.
	Direct embed all structures	Direct embed structures were evaluated for all locations along the mainline. However, due to wide range of soil conditions on the ROW, the direct embed method will not be feasible at all locations. Where possible, structures will be direct embedded 10% of their height plus 6-ft. Where soil conditions do not support direct embed structures, concrete caissons will be utilized.
	Light Duty Steel Poles	Due to the proximity of the proposed A1 structure to the existing B2 line, the diameter of light duty poles would not maintain safe clearance distance.
Athol Tap	Delta davit arm configuration structures	The Athol Tap #2 Line was first proposed as delta configuration structures since the line is being rebuilt in place and will allow this type. This scope was changed to a vertical configuration to match the structures on the Athol #1 Tap. Reliability of inward facing circuits are believed to be better than delta by limiting risk of tree contact. 2 single circuit H-frames would require 150-ft of ROW width vs the proposed 125-ft total.
		Vertical: both circuits will be the same height, better visually, would require taller structures and caisson foundations. Delta: Structures are shorter, but less visually pleasing. If skipping structures, direct embed foundations may be similar in cost to caisson foundations.
Athol and Crystal Lake Tap Lines	Double circuit structures	Because of reliability concerns associated with having both tap lines on the same structure, it was preferred to install single circuit structures.

Each of the alternatives was excluded due to increased footprint, ice jump condition,[11] soil conditions, and safe clearance distance. For the tap lines, alternative structure types were evaluated and excluded due to outage constrains, reliability concerns, and risk of tree contact.

The EENF does not describe alternatives related to location of new access roads (where needed) or reduced or varying tree clearing widths, or a scenario that would avoid or reduce clearing within

[11] The maximum jump height of a transmission line after ice-shedding. Ice-shedding from conductors can cause significant vertical vibration of the transmission line.

sensitive environmental resource areas. The EENF indicates that the new structures will be over 30 ft higher than the existing structures (new structures 93 to 100 ft above ground). It does not discuss how the required clearing width was established related to site topography such that transmission lines would be located higher than the existing trees.[12] The EENF indicates that the Preferred Alternative will best address the identified purpose and need for the project and will improve transmission system reliability. As stated in the Scope, the DEIR should evaluate "Reduced Build" alternatives that avoid or minimize environmental impacts. Comments from MassDEP state that the DEIR should provide a serious evaluation of reasonable alternatives to the proposed activity (including alternatives to reduce the full extent of the proposed cutting), an evaluation of the extent to which adverse impacts are minimized, and documentation that full mitigation is provided for unavoidable impacts. Based on this demonstration, a Variance to the WPA regulations may be required pursuant to 310 CMR 10.05(10). The Proponent should respond to the MassDEP comment letter incorporated by reference herein and the Scope below.

Environmental Justice

The EENF indicates that the DGA for the project is one mile; as noted above, the project site/ROW is located within five EJ populations, characterized by Income, Minority, and Minority and Income, and within one mile of 13 additional EJ populations characterized by Income, Minority and Minority and Income. The site is located within five miles of 65 EJ populations characterized by Minority, Income, and Minority and Income, and Minority, Income, and English Isolation. Within the census tracts containing the above EJ populations within the DGA, the following languages are identified as those spoken by 5% of more of residents who also identify as not speaking English very well: Spanish or Spanish Creole.

Effective January 1, 2022, all new projects in the DGA (as defined in 301 CMR 11.02, as amended) around EJ populations are subject to new requirements imposed by Chapter 8 of the Acts of 2021: *An Act Creating a Next-Generation Roadmap for Massachusetts Climate Policy* (the "Climate Roadmap Map") and amended MEPA regulations at 301 CMR 11.00.[13] Two related MEPA protocols – the MEPA Public Involvement Protocol for Environmental Justice Populations (the "MEPA EJ Public Involvement Protocol") and MEPA Interim Protocol for Analysis of project Impacts on Environmental Justice Populations (the "MEPA Interim Protocol for Analysis of EJ Impacts") – are also in effect for new projects filed on or after January 1, 2022.[14] Under the new regulations and protocols, all projects located in a DGA around one or more EJ populations must take steps to enhance public involvement opportunities for EJ populations and must submit analysis of impacts to such EJ populations in the form of an EIR.

The EENF describes public involvement activities conducted prior to filing, including advance notification of the project circulated to a list of community-based organizations (CBOs) and tribes/indigenous organizations (the "EJ Reference List") provided by the MEPA Office in consultation with the EEA EJ Director. The EENF indicates that no additional CBOs, tribes/indigenous organizations, or other EJ community members were identified during the outreach program that would require continued notices during the course of MEPA review. Circulated information included the EJ

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[12] The Proponent provided additional information after the close of the comment period (October 25, 2022) related to guidance on tree clearing widths. A summary of the guidance should be included in the DEIR.
[13] MEPA regulations have been amended to implement Sections 55-60 of the Climate Roadmap Act and took effect on December 24, 2021. More information is available at https://www.mass.gov/service-details/information-about-upcoming-regulatory-updates.
[14] Available at https://www.mass.gov/service-details/eea-policies-and-guidance.

Screening Form, including a copy translated into Spanish, and information on ways to request additional information or a community meeting including language interpretation. The EJ screening form included a link to a public project website (http://www.newenglanda1b2.com/) which is available in English and Spanish and provides an interactive mapper and contact information. A copy of the EENF and supporting documentation, as well as the MEPA remote consultation meeting notice, were distributed to the EJ Reference List. The Proponent also held a virtual public meeting on July 11, 2022 prior to filing the EENF; information pertaining to this meeting was advertised in the *Athol Daily News, Sentinel & Enterprise (Fitchburg and Leominster), Gardner Magazine and The Gardner News, Winchendon Recorder, Worcester Telegram & Gazette, and the Greenfield Recorder*, and was also provided to the EJ Reference list via email and to the abutters of the A1/B2 Lines via mail. Interpretation services were provided at the public meeting upon request but no requests were received. Supplemental information submitted by the Proponent indicates that there were less than ten attendees at the public meeting.[15] Two additional virtual presentations were provided to the public on October 14, 2021 and February 17, 2022, and less than ten individuals participated in each of these events. The DEIR should provide plans for future outreach, including to EJ populations, during the remainder of the MEPA review process. The Proponent should conduct further public engagement activities prior to filing the DEIR as outlined in the Scope.

The EENF contains a baseline assessment of existing unfair or inequitable Environmental Burden and related public health consequences impacting EJ populations in accordance with 301 CMR 11.07(6)(n)1 and the MEPA Interim Protocol for Analysis of EJ Impacts. The EENF indicates that "vulnerable health EJ criteria" for municipalities located within one mile of the project area were identified using the Massachusetts Department of Public Health (DPH) EJ Tool; this term is defined in the DPH EJ Tool to include any one of four environmentally related health indicators that are measured to be 110% above statewide rates based on a five-year rolling average.[16] Within the project's DGA, the Proponent indicates that the communities of Gardner, Athol, Fitchburg, Leominster, and Lancaster meet at least one of the four "vulnerable heath EJ criteria"; however, the EENF does not identify which communities and census tracts exceed 110% of the statewide rate for each criteria: Heart Attack Rate, Pediatric Asthma Rate (available at the community level), Low Birth Weight, and Blood Lead Prevalence (available at the census tract level). The DEIR should provide additional analysis of impacts on EJ populations consistent with the MEPA Interim Protocol including fully analyzing the data available in the DPH tool at the municipal and census tract level.

The EENF also includes a review of the mapping layers available in the DPH EJ Tool to identify sources of potential pollution existing within the identified EJ population. The information is summarized in the table below.

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[15] Email from BSC Group, October 25, 2022.

[16] See https://matracking.ehs.state.ma.us/Environmental-Data/ej-vulnerable-health/environmental-justice.html. Four vulnerable health EJ criteria are tracked in the DPH EJ Viewer.

Table 23: Other Potential Sources of Pollution within EJ Boundaries (1 - Mile)

Municipality	EJ Census Tracts	Air Operating Permits	Large quantity generators	Large quantity toxic user	M.G.L. c. 21E Sites	"Tier II" toxics use reporting facilities	MassDEP sites with AULs	MassDEP groundwater discharge permits	Wastewater treatment plants	MassDEP public water suppliers	Underground storage tanks	EPA facilities	Energy generation and supply	Total
ATHOL	7031, Block Group 1 and 2	0	0	0	0	2	4	0	1	0	3	2	0	12
	7032, Block Group 3	0	0	0	1	0	0	0	0	0	1	0	0	2
	7033, Block Group 1	0	0	0	1	3	1	0	0	0	4	0	0	9
GARDNER	7075, Block Group 1	0	0	0	0	4	0	0	1	1	1	0	1	8
	7075, Block Group 2	0	1	0	0	1	0	0	0	0	1	1	1	5
	7075, Block Group 3	0	1	0	0	0	1	0	0	0	2	0	0	4
FITCHBURG	7103, Block Group 2	2	2	4	4	7	3	0	1	0	6	2	1	32
LEOMINSTER	7092.02, Block Group 2	0	0	0	0	0	0	0	0	0	1	0	0	1
LANCASTER	7131, Block Group 4	0	0	0	1	0	0	0	1	1	3	1	0	7

Based on the baseline assessment of existing burdens, the EENF does not conclude whether or not there is an existing "unfair or inequitable" burden; however, it asserts that the project will not result in disproportionate adverse effects on the EJ populations. In particular, the EENF asserts that the project will benefit surrounding communities by increasing reliability of the overall transmission line through refurbishment of the existing structures and wires on more robust structures. Higher strength conductor will be installed which is better suited to withstand storm events and is less prone to experiencing line outages, and the new overhead lines will be larger which will allow more electricity to flow during times of high usage, such as extreme heat events, which are anticipated to increase in frequency due to climate change. The EENF asserts that approximately 10% of the project's overall impacts within the ROW and access roads will occur within EJ populations with 90% of the project work occurring in non-EJ populations. The EENF further identifies that 24 acres (15% of project total) of tree removal will occur within EJ populations. An examination of the proposed conditions in all EJ neighborhoods reveals that in one section of the ROW, approximately 0.31 miles long parallel to Park Street in Gardner, proposed tree removal intermittently extends to the existing tree line on the east side of some properties. Where this occurs, the EENF notes that shade to these properties in the morning will be reduced, though not fully eliminated, and portions of the property near the ROW may experience a minor short-term increase in temperature; although it is not clear that the impact would be short-term if trees are not allowed to regrow and the area will be maintained through the Proponent's VMP. The EENF also indicates that none of the concrete caisson foundations, some of which are located within the 100-yr flood zone, are located within EJ populations and only temporary impacts (mats) will impact the 100-yr flood zone in EJ neighborhoods. The EENF asserts that the project will minimize construction-phase impacts to air quality, water quality, and noise through the use of BMPs. The Proponent commits to using ultra-low sulfur diesel fuel, emission control devices, and limits on idling of construction vehicles.

As discussed in the Climate Change section below, the project has a high exposure and risk rating based on the project's location for extreme precipitation (riverine flooding) and extreme heat. The project plans to engage in large-scale tree removal along the entirety of the mainline and tap lines. Implications for GHG emissions and heat island effects should continue to be analyzed as set forth in the Climate Change Scope below. To the extent tree clearing will affect adjacent EJ populations with heightened vulnerabilities as shown by the DPH EJ Tool or EPA EJ Screen, specific mitigation should be considered.

The EENF also describes potential impacts to open space and notes project work within the Gardner Municipal Golf Course and Leominster State Forest; both properties are within EJ populations. Comments from DCR indicate concerns for recreational impacts to the access point in Warwick State Forest that is proposed to be co-located with the Metacomet Monadnock Trail and requests additional specific protection and restoration measures to be taken for sensitive natural and cultural resources on public conservation lands. These issues should be discussed in the DEIR.

Land Alteration

The EENF indicates that the land area within the project ROW is approximately 844.4 acres. Land uses were evaluated within the ROW and for a 300-ft buffer on either side of the ROW and consist primarily of "Exempt Property"[17] (46 percent of ROW and 43 percent of buffer) and residential (28 percent of ROW and 32 percent of buffer). The mainline crosses four DCR properties including Leominster State Forest in Leominster and Fitchburg; Royalston State Forest in Royalston; Otter River State Forest in Royalston and Winchendon; and Warwick State Forest in Warwick. These properties account for 78.54 acres of land within the project area. The EENF also lists federal, municipal, and land trust properties adjacent to the ROW in each municipality but does not identify the acreage impacted by the project. According to the EENF, the majority of new land alteration will occur as the result of the construction of new access roads and the modification of previously existing access roads and required tree removals to obtain required clearances to the edge of the ROW. As noted above, approximately 216 acres of permanent impacts are proposed and will result from the construction of access roads, work pads/envelopes and pull pads, and vegetation removal/tree clearing.

Access Roads

The EENF describes the need for significant improvement of historic access roads to meet the access requirements for the project (to accommodate construction materials and equipment). These roads are categorized as either Standard Road Type 1-2 or Designed Road Type 3-5. The construction of access roads will include import, placement, and compaction of gravel to create a new road to access structures for construction. The EENF describes Standard Roads Type 1-2 to include upland areas where the terrain is relatively level and will not require significant cut/fill to construct. Designed Road Type 3-5 are proposed where the existing terrain is steeper and will, in turn, require additional cut/fill to construct. The EENF notes that designed roads include stormwater BMPs to control runoff and mitigate erosion of the constructed roads and/or adjacent slopes. The EENF states swales, stone check dams, water bars, or other similar measures will be installed as necessary based on the access road design. The EENF states new access roads were sited within the existing ROW easement to the extent feasible; however, due to existing site constraints (e.g., steep slopes, rocky outcrops, proximity to wetland resource areas), some access routes are sited beyond the existing easement boundaries. The Proponent proposes to maintain all new access roads (including those which extend beyond the existing easement)

[17] Exempt Property are properties that qualify from exemption from taxation under various provisions of the law and include public land and facilities, hospitals, schools, churches and cultural institutions, M.G.L. c. 59, §5.

once they are constructed, meaning that it will need to obtain additional easements from landowners. Land alteration associated with new/improved access (assuming a 12-ft wide travel lane) is approximately 52 acres total for the project.

Work Pads/Envelopes and Pull Pads

The EENF describes work envelopes that will be placed at all structures where work is proposed. In upland areas, stone work pads will be constructed and have been designed to be approximately 157 ft by 80 to 100 ft depending on the width of the ROW and the extent of grading required to create a level work area and provide adequate space for work adjacent to a live/electrified line. In wetlands and agricultural fields, construction matting will be utilized to create the work area. While the majority of work envelopes are within the existing ROW, there are ten work envelopes in Westminster, seven in Leominster, five in Sterling, and three in Athol that are partially or completely off the ROW. Construction of work and pull pads, and in some cases access road improvements, will require the use of retaining walls. The EENF notes that retaining walls will be selected during construction based on geotechnical and site constraints and may be constructed of gabion baskets, large block, mechanically stabilized earth (MSE), or construction mats (temporary). Comments from MassDEP state that the area and extent of impacts of any proposed retaining wall within a resource area, or within the buffer zone of a resource area, should be identified, and should avoid, minimize and mitigate impacts to the maximum extent practicable.

Vegetation Removal/Tree Clearing

The EENF states that a horizontal distance of 30 ft must be maintained from the conductor to the edge of the ROW under all weather conditions (38 ft assumed when conductor is in a stationary position). As noted above, the existing maintained ROW on the mainline, Crystal Lake Tap Line and Athol Tap Line is roughly 85 ft, 75 ft, and 100 ft, respectively. To provide the necessary clearances for the replacement and construction of new structures, the mainline and Crystal Lake Tap ROWs will be cleared to 100-ft and the Athol Tap ROW will be cleared to 125-ft. It is anticipated that approximately 105 acres on ROW and 18 acres off ROW will be cleared to meet the required horizontal clearances. The EENF states that all vegetation removal on DCR property will remain within the ROW and all off-ROW clearing will be coordinated with private landowners. Following the completion of construction, maintenance activities will be consistent with the Five-Year Vegetation Management Plan (2019-23), which was included in the EENF (subject to renewal by the Massachusetts Department of Agricultural Resources (MDAR) pursuant to 333 CMR 11.00).[18] A summary of tree removal impacts in the ROW and off-ROW is included below.

[18] The Proponent's VMP takes into account not only 333 CMR 11.00 and Chapter 132B, but all applicable state and federal regulations that mandate the management of utility rights-of-way including but not limited to: all pertinent clauses in Chapter 85 of the Acts of 2000; MESA; MGL c. 131 A and 321 CMR 10.00; 310 CMR 10.00 and 310 CMR 22.00; 310 CMR 40.0000; applicable Federal Energy Regulatory Commission standards including NERC Standard FAC-003-1, Commissioner Order 693, FAC-003-2 (effective July 1, 2014), and all applicable Federal Occupational Safety and Health Act, Department of Transportation and Department of Environmental Protection regulations.

Tree Removal Location	Approximate Acres on ROW	Approximate Acres Off ROW
Project Wide in MA	109	55
Wetlands	14	2
Riverfront Area[21]	14	3
Open Space	50	9
State Article 97 Land (DCR Property)	18	1
Municipal Article 97 Lands	10	2
Private Article 97 Lands	2	< 0.25
Federal Property	2	3
Land Trust Property	3	< 2
DFW/WMA	14	1

Comments from MassDEP indicate concern for the increase in the peak runoff rate and land destabilization associated with tree clearing. The DEIR should provide greater detail regarding proposed mitigation to prevent erosion and stabilize soils in these areas. Further analysis of land alteration impacts, including GHG and EJ implications, should be conducted as indicated in the Scope. Appropriate mitigation should be provided, including in accordance with WQC permitting.

Rare Species

According to the EENF and the *Massachusetts Natural Heritage Atlas* (15th Edition), portions of the project area are mapped as *Priority* and *Estimated Habitat* for state-listed species, including nine state-listed species (two reptiles, one amphibian, two invertebrates, three birds, and one plant), along portions of the project route in Warwick, Royalston, Winchendon, Athol, Fitchburg and Leominster. Specific species are not identified in the EENF at NHESP's request. These species and their habitats are protected pursuant to the Massachusetts Endangered Species Act (M.G.L. c.131A) and its implementing regulations (MESA; 321 CMR 10.00). The EENF does not detail the acres of designated Priority Habitat of state-listed rare species to be altered as a result of the project. The DEIR should identify both temporary and permanent impacts to Priority Habitat and the corresponding municipality in which habitat is located. The Proponent proposes to implement the necessary actions to avoid, minimize, and mitigate project-related impacts to comply with the MESA permit issued for the project and notes that if, after consultation with NHESP, it is determined that a Take will occur, a Conservation Management Plan (CMP) will be prepared.

The Proponent has submitted a preliminary memo to NHESP and indicates that consultation with NHESP is required to determine if the project can be permitted using the "Checklist" option or if a CMP will be required. Comments from NHESP state that it may be possible to design the project in order to avoid a Take, and indicates the Proponent is actively consulting with the Division to address rare species concerns. NHESP anticipates being able to resolve any outstanding concerns during the MESA review process. Additional information should be provided in the DEIR in accordance with comments from NHESP and the Scope.

Wetlands / Water Resources

Water resources, including wetlands and streams, were delineated within the project area in Spring of 2020, Summer of 2021, and Spring of 2022. According to the EENF, the project is proposed to result in significant unavoidable impacts to BVW, IVW, Bank, BLSF, RFA, Bank, and associated buffer zones of resource areas. The EENF reviews the performance standards for each wetland resource area and describes the potential impacts from access roads, construction areas, and vegetation management. Impacts associated with each activity are detailed below:

- BVW (sf): Total - 2,868,580 (concrete caissons – 1,896; tree clearing – 666,032; mats – 2,200,651)
- BLSF (sf): Total - 95,593 (concrete caissons - 632; tree clearing - 81,022, mats – 13,939; work envelopes, pull pads and access – 293,924 (no loss in flood storage will occur from work envelopes, pull pads and access))
- RFA (sf): Total 2,614,816 (concrete caissons – 3,479; grading and retaining walls – 1,177,862; new or established access roads - 171,544; tree removals – 748,796; mats – 513,137)
- Inland Bank (sf): Total – 94,526 (tree removals – 26,572; mats - 67,954)
- LUW (sf): Total - 32,364 (concrete caissons – 158(Crystal Lake Tap Line); Mats - 32,206)
- Isolated Wetland (sf): Total – 85,021 (mats - 73,181; caisson foundations – 79; trees - 11,761)

The project will also impact ORWs including 15 streams that have been designated by the Massachusetts Division of Fisheries and Wildlife (DFW) as significant cold-water resources. As noted above, no CVPs are located within the ROW but one potential vernal pool is identified where temporary construction mats are proposed. As noted above, work is proposed in seven additional ORWs two of which are Public Water Supplies. The nine Town Conservation Commissions will review the project for its consistency with the Limited Project provisions of the Wetlands Protections Act (WPA), the Wetland Regulations (310 CMR 10.00), and associated performance standards. Comments from MassDEP indicate the project may qualify to be permitted as a Limited Project pursuant to 310 CMR 10.53(3)(d) provided that no such project may be permitted which will have any adverse effect on Rare Species habitat, as identified by procedures established under 310 CMR 10.59 (unless a variance is issued). The Proponent should document why the project qualifies for Limited Project status as requested by MassDEP and outlined in the Scope.

MassDEP will review the project for its consistency with the 401 WQC regulations (314 CMR 9.00). The EENF states the project requires a WQC due to the anticipated "Take" determination from NHESP under MESA and will require a Water Quality Variance due to the placement of temporary construction matting within wetlands that are located within 400-ft of the ordinary high water mark (OHWM) of a Class A Surface Water. Comments from MassDEP note that the WPA and associated regulations do not have a designation of "temporary impacts" to resource areas. The activities proposed in the EENF meet the definition of "Alter" contained in 310 CMR 10.04. The WQC regulations, 314 CMR 9.00 specifically include "temporary" activities as being subject to the regulations (310 CMR 9.02); however, MassDEP states temporal impacts to resource areas can be mitigated through "in-situ" replication and/or restoration, as well as via off-site considerations. The EENF states that a compensatory mitigation plan will be developed in consultation with MassDEP and the nine local conservation commissions to mitigate for permanent wetland conversion and to form the conditions for a 401 Water Quality Certification (WQC) to be issued by MassDEP. Mitigation measures described in the EENF include use of construction mats to minimize compression of soils, rutting and vegetation disturbance; habitat enhancement in wetland resource areas affected by tree removal; mitigation for permanent flood storage loss due to structure installation and grading; and use of erosion and sedimentation controls. Additional information regarding mitigation for permanent wetland impacts should be provided in the DEIR.

Chapter 91

The EENF includes discussion of c. 91 jurisdiction which includes non-tidal rivers or streams "on which public funds have been expended for stream clearance, channel improvement, or any form of flood control or prevention work… except for any portion of any such river or stream which is not normally navigable during any season, by any vessel including canoe, kayak, raft, or rowboat…" per 310 CMR 9.04(1)(e). All "structures" in these rivers and streams are subject to waterways licensing under 310 CMR 9.05(i). A "structure" is defined as "any man-made object which is intended to remain in place . . . over . . . waterways." pursuant to 310 CMR 9.02. Thus, MassDEP requires a c. 91 license for electric transmission crossings over rivers and streams even where there is no physical structure in the stream or river. The EENF states that based on field reviews, there are 66 occurrences of tree removal intersecting intermittent streams and 100 occurrences of tree removal intersecting perennial streams. There are 47 occurrences where work envelopes/pull pad envelopes intersect intermittent streams and 26 occurrences where these activities intersect with perennial streams. The EENF states that all of the jurisdictional crossings listed above are expressly exempt from c. 91 if they are covered by a final wetland OOC and meet the following related tests: they are constructed and maintained in accordance with the National Electric Safety Code (NESC) and do not reduce the space available for navigation per (310 CMR 9.05(3)(g)).

Comments from MassDEP Waterways Program state that the exemption is limited to "placement in a non-tidal river or stream subject to jurisdiction under 310 CMR 9.04(1)(e) of fill or structures for which a final Order of Conditions has been issued under, and which does not reduce the space available for navigation; such fill or structures *are limited to overhead wires*, conduits, or cables to be attached to an existing bridge, without substantial alteration thereof, or constructed and maintained in accordance with the NESC." The EENF describes work that will occur within waterways in addition to the overhead wires, such as construction mats, work pads and pull pad envelopes, and fill for two new/or replacement structure foundations. Comments from MassDEP Waterways recommend that the DEIR include details on the scope of work within each waterway in c. 91 jurisdiction, in order for the to provide feedback on any c. 91 authorization that may be required. This information should be provided in the DEIR.

Article 97

The EENF provides a summary of estimated tree removal on DCR property/Article 97 land and shows that approximately 18 acres will be impacted on the ROW and approximately one acre will be impacted off ROW. The EENF states that tree removal and construction activities will remain within the Proponent's easements on Article 97 land; thus, no change in land use is proposed. The Proponent notes that as the project design advances, modifications, such as adding additional retaining walls, may be necessary to stay within the confines of the easement. Comments from DCR, however, indicate the use and improvement of five woods roads outside of the ROW to enable access through DCR forest land to the ROW for project activities; four of the paths are in Warwick State Forest and one is in Royalston State Forest. Proposed changes to the access corridors include tree clearing and widening of the corridors, which will result in permanent impacts and potentially increase total off-ROW impacts on DCR land. Comments from DCR indicates that the proposed changes and the need to access DCR property in the future for ongoing maintenance appear to require permanent easements, triggering Article 97 of the Amendments to the Massachusetts Constitution and that additional information from the Proponent is required. DCR notes that if the improved woods roads are to be used for ongoing maintenance on the ROW, that change in use of DCR property would also trigger Article 97.

Climate Change

The EENF describes the project as an important component in addressing climate change, noting that expansion of renewable energy will require upgraded infrastructure to deliver that energy. The replacement lines will have higher kV ratings that will support higher volumes of currently active and forecasted renewable energy resources in the region. The Proponent states that the replacement of the lines will have the benefit of allowing significantly more renewable energy resources to connect into the system if and when the lines are operated at 115kV. The EENF states the project will also result in a more climate-ready and resilient transmission system that can withstand more extreme weather events; address existing system capacity shortages, and increased demand.

Adaptation and Resiliency

Effective October 1, 2021, all MEPA projects are required to submit an output report from the MA Resilience Design Tool to assess the climate risks of the project. Based on the output reports attached to the EENF, the project has a high exposure rating based on the project's location for extreme precipitation (riverine flooding) and extreme heat, and moderate exposure rating for extreme precipitation (urban flooding). Based on the 50-year useful life identified and the self-assessed criticality of the project asset (various segments of the line), the Tool recommends a planning horizon of 2070 and a return period associated with a 50-year (2% chance) storm event when designing the project (a "utilities" asset) for the extreme precipitation parameter. The EENF states that floodplain design standards will be followed during construction, and states that the project is designed to account for more frequent extreme weather events including extreme heat. However, the EENF does not assess how the proposed clearing or other design elements, such as the height of structures or foundations, would affect resiliency as measured by future storm scenarios. The design incorporates materials (including steel structures and state of the art conductors) that have long useful lives and respond well to corrosive environments. The project is also equipped to respond to increases in temperature. The new transmission line conductors are designed to operate at higher maximum operating temperatures, at a higher carrying capacity, and under fluctuations in air temperature.

GHG Emissions from Land Alteration

The project is subject to the MEPA GHG Policy because it exceeds thresholds for a mandatory EIR. This project will permanently alter 216 acres as a result of tree clearing and new/improved access. In accordance with the GHG Policy, projects that alter over 50 acres of land are generally required to analyze the carbon associated with land and soil disturbance during the construction period and loss of carbon sequestration. The purpose of this analysis is to develop an estimate, not an exact accounting of GHG emissions associated with land alteration, including removal of trees and release of sequestered carbon in soil. The DEIR should provide an analysis consistent with the Scope included in this Certificate.

The EENF indicates that the Proponent is evaluating potential approaches to analyze GHG implications, including field analysis, available datasets and research, and emissions mitigation evaluation. The EENF describes one potential analysis which would include two steps:

1. Estimate the existing carbon stocks using height adjusted land cover values with LiDAR: Estimation of above ground (trees) and below ground (roots) biomass applies average biomass carbon values for each land cover, as classified in the 2016 1-m High Resolution Land Cover layer. The biomass carbon values are derived from the best available datasets for New England land covers. To account for stand age and density, available LiDAR data would be used to calculate forest height and adjust against the average height of forest trees in the data sets used to assign biomass carbon values. Deviation from the average will be used as a factor to increase or decrease the value assigned to that portion of the land cover. To verify the GHG values, five (5) sample sites will be chosen to be evaluated in the field to confirm assumptions.
2. Carbon Flux Analysis: Comparison between the existing and proposed land cover would be conducted by calculating the differential between existing carbon values and estimated carbon values taking into account soil type and proposed land cover. The flux would include sequestration rates and growth between the time of construction and the MEPA proposed time horizon of 2050

While the use of LiDAR data appears beneficial to characterize the age and height of trees along the project corridor, this approach does not appear to consider difference in forest and tree types that may be present in the entirety of the 216 acres of land alteration estimated for the project. In addition, it is unclear what "best available datasets" the Proponent intends to use to assume carbon stocks, and whether such datasets would take into account variations in tree types. The Proponent should revise its approach to carbon analysis to consider such variations, and should use data from the U.S. Forestry Service, as further specified in the Scope. The Proponent is directed to consult with the MEPA Office prior to finalizing the methodology for conducting this analysis.

Transportation

According to the EENF, construction activities will intersect with the state jurisdictional highway layout at multiple locations, including Route 202 in Winchendon, Route 2 in Westminster, Fitchburg, and Leominster, Central Street in Leominster, Depot Road in Westminster, and State Road in Westminster. Project-related construction in these locations will require an access permit issued by the appropriate MassDOT District (either District 2 or 3). Comments from MassDOT indicate that permits will be required for temporary construction access, overhead wire crossings of the above listed state routes, and new access roadways proposed within the state highway right-of-way. The EENF describes the type of equipment that will be used to install the new structures and overhead lines and to remove existing structures. The EENF did not quantify the extent of truck traffic that may be required and did not identify equipment that will be used to remove trees as a result of the project.

Historic and Archaeological Resources

The project is subject to review under Section 106 of the National Historic Preservation Act of 1966 as amended (36 CFR 800) and M.G.L. c. 9, ss. 26-27C (950 CMR 71). A cultural resources due diligence review and archaeological sensitivity assessment was conducted for the project. The sensitivity assessment was completed on January 6, 2021 and formed the basis for developing a field testing plan related to the structure replacement locations. A project consultant developed a research proposal based on the background research and sensitivity assessment, which was submitted to the MHC in April 2021. The Proponent conducted fieldwork and testing which recovered cultural material at four sites in

Massachusetts. The EENF indicates that none of the sites in Massachusetts are considered significant and no further survey was recommended. Additional testing was completed in 2022 for proposed new and/or re-established access roads. This additional field testing was sent in a research proposal to MHC on March 28, 2022. MHC modified their permit (#4001) to include the access road testing on April 8, 2022. The Proponent will submit the archaeological locational survey technical report to the MHC in October 2022. The EENF indicates that should any archaeological site examinations be recommended; an additional research proposal will be submitted to the MHC at that time.

The EENF states that if the project is found to have an adverse effect to a significant historic property or archaeological site, the Proponent will consult with MHC and other parties, as appropriate, to determine the feasible measures to avoid, minimize or mitigate the adverse effect. Comments from DCR request coordination with the Staff Archaeologist related to potential archaeological resources on DCR property. Comments from the Franklin Regional Council of Governments (FRCOG) recommends the Proponent consider documenting portions of the historical mainline[19] as the Vernon Dam, which became operational in 1909, was the first power plant in the northeastern U.S. to transmit power across state lines to manufacturing centers in Gardner and Fitchburg, MA (in 1920).

Hazardous Materials

Comments from MassDEP note the EENF indicates one RTN (1-12349-Pratts Junction Substation, Sterling) which had a historical release of mineral oil dielectric fluid (MODF) within the confines of the substation; however, comments indicate no subsurface work is proposed in this area which limits potential impacts. Additional comments from MassDEP state the proposed project encompasses a large geographic area with several identified sites regulated under the Massachusetts Contingency Plan (MCP) (with identified release tracking numbers (RTNs)). Sites include those that are "open" and closed; some with Response Action Outcomes (RAOs) and/or Permanent Solutions (with or without conditions), and sites with an Activity and Use Limitation (AUL). The Proponent is advised to retain a Licensed Site Professional (LSP) as outlined in the Scope.

Construction Period

During the construction-phase of the project there may be intermittent and localized increases in noise, dust and emissions from construction vehicles and related equipment. The EENF included an appendix outlining the Proponents transmission line maintenance and construction procedures and the EENF listed BMPs related to air quality, water quality, noise, and traffic. The EENF also indicates that the project will be overseen by an Environmental Monitor, a qualified environmental professional designated by NEP who can capably monitor on-site construction conditions in relation to permit and regulatory requirements. The Proponent will submit a Stormwater Pollution Prevention Plan (SWPPP) for the project in compliance with the EPA's NPDES program under the Stormwater CGP.

All construction activities should be managed in accordance with applicable MassDEP regulations regarding Air Pollution Control (310 CMR 7.01, 7.09-7.10), and Solid Waste Facilities (310 CMR 16.00 and 310 CMR 19.00, including the waste ban provision at 310 CMR 19.017 and the handling of clean wood associated with tree removal. The EENF states the Proponent will incorporate anti-idling measures in accordance with the Air Quality regulations (310 CMR 7.11) including no unnecessary idling. On- and off-road vehicles and engines used during construction will minimize

[19] See https://www.hydroreview.com/world-regions/hydro-hall-of-fame/#gref

emissions by using vehicles adhering to the more stringent EPA Tier 4 emissions standards or will be retrofitted with USEPA verified emission control devices. The Proponent requires that construction equipment use ultra-low sulfur diesel fuel. If oil and/or hazardous materials are found during construction, the Proponent should notify MassDEP in accordance with the MCP (310 CMR 40.00). All construction activities should be undertaken in compliance with the conditions of all State and local permits.

Conclusion

As noted, the EENF identifies baseline environmental conditions and potential environmental impacts, but contains an inadequate alternatives analysis and a limited description of mitigation measures. Comments from MassDEP indicate a Variance to the WPA regulations may be required pursuant to 310 CMR 10.05(10) if full mitigation is not provided for unavoidable impacts, and a Variance to the 401 WQC will be required pursuant 314 CMR 9.08 since the project will result in a discharge of dredged or fill material in wetlands or waters of the Commonwealth within 400 feet of a Class A surface water (314 CMR 9.06(4)).Comments from DCR indicate that additional information is required to determine whether proposed changes to DCR property will require permanent easements triggering Article 97, ensuring no net loss of protected lands. Based on review of the EENF and consultation with Agencies, I hereby require the Proponent to submit a DEIR that provides further analysis of alternatives which avoid impacts to sensitive resources and describes a robust package of mitigation for project impacts. A carbon analysis of tree clearing activities should also be provided. The Proponent should submit a DEIR that provides updated project information and analyses as specified in the Scope below.

SCOPE

General

The DEIR should follow Section 11.07 of the MEPA regulations for outline and content, as modified by this Scope. Recommendations provided in this Certificate may result in a modified design that would further avoid, minimize, and/or mitigate Damage to the Environment. The DEIR should identify measures the Proponent will include to further reduce the impacts of the project since the filing of the EENF, or, if certain measures are infeasible, the DEIR should discuss why these measures will not be adopted.

Project Description and Permitting

The DEIR should describe the project and identify any changes to the project since the filing of the EENF. It should include updated site plans for existing and post-development conditions. Conceptual plans should be legible and provided at a reasonable scale. The current plans contain multiple overlapping layers making it difficult to identify resource areas and assess impacts. Plans should clearly identify: all major project components (structures, transmission lines, access roads, etc.); public areas; wetland resource areas; priority habitat; impervious areas; ownership of parcels including easements; and stormwater and utility infrastructure. The DEIR should identify potential infrastructure located within in the ROW including those identified in comments by the Town of Leominster. The revised maps should show the height of the transmission lines in each map section. The DEIR should indicate alternative easements that were considered and any additional permanent and temporary easements that will be required to create access to the ROW.

The DEIR should provide a brief description and analysis of all applicable statutory and regulatory standards and requirements and describe how the project will meet those standards. It should include a list of required Agency Permits, Financial Assistance, or other state or local approvals and provide an update on the status of each.

Alternatives Analysis

The EENF does not explore alternatives to clearing trees within a uniform width to the edge of the ROW (100 ft on the mainline and Crystal Lake Tap and 125 ft on the Athol Tap). The Preferred Alternatives proposes significant impacts to wetland resource areas, including BVW, and to sensitive resources such as potential vernal pools.

The DEIR should include an expanded alternatives analysis that provides full justification for dismissing the Rebuild Alternative and evaluates alternatives that consider reduced or varying tree clearing widths, alternative access routes, and work area scenarios that avoid and minimizes environmental impacts and tree clearing within sensitive resource areas such as potential vernal pools, ORWs, wetlands, and rare species habitat. The DEIR should document proposed conditions for these alternatives, quantify environmental impacts and provide a conceptual plan. It should compare the environmental impacts with the Preferred Alternatives, in particular, with respect to land alteration, wetland resource areas, potential vernal pools, ORWs, rare species habitat, archaeological resources, GHG emissions impacts and climate resiliency. Impacts should be reported in total and broken out for each community. The DEIR should justify why, within the new area proposed to be cleared, it is likely that much of the non-target vegetation will also be cut or in some way impacted. The DEIR should describe how more vegetation could be preserved in more sensitive areas. The DEIR should consider and describe opportunities to vary the width of the clearing particularly in areas where the topography is low, and transmission wires are high.

The DEIR should provide additional justification for the proposed new maintained ROW of 100 and 125 feet given the elevation of the new structures (93-110 ft above ground) in relation to the adjacent forested areas. This should include the identification of tall growing trees or other vegetation within the ROW that pose a risk of vegetation-related outages, to the extent this information is available. The DEIR should also indicate whether there are any alternatives that could proceed without a Wetlands Variance or Article 97 land disposition.

Environmental Justice/Public Health

The DEIR should provide an update on efforts to conduct outreach and promote public involvement of nearby communities, including EJ populations to meaningfully engage those located within the DGA in decision-making for the project. It should contain a full description of measures the Proponent intends to undertake to promote public involvement by such EJ populations during the remainder of the MEPA review process including a discussion of any of the best practices listed in the MEPA EJ Public Involvement Protocol that will be employed. The DEIR should detail how public involvement efforts will continue throughout subsequent permitting and through the construction period for the project. It should describe any outreach that will be conducted as part of local review processes, including the procedures for providing abutter notice and opportunities for public input into project design and timing. The DEIR, or a summary thereof, should be distributed to the EJ Reference List, and an updated list should be obtained from the MEPA Office to ensure that outdated contacts are removed and new ones added.

The DEIR should provide an updated baseline assessment of any existing unfair or inequitable Environmental Burden and related public health consequences impacting EJ Populations in accordance with 301 CMR 11.07(6)(n)1 and the MEPA Interim Protocol for Analysis of EJ Impacts. The DEIR should fully analyze the data available in the DPH tool at the municipal and census tract level to characterize existing unfair or inequitable Environmental Burdens. The DEIR should also survey the air-related environmental indicators identified in EPA EJ Screen to determine whether any of the identified EJ populations within the DGA are subject to elevated environmental burdens measured at 80th percentile of statewide average or higher. For any EJ population corresponding to that metric, the DEIR should describe in detail the proximity of the project site to those neighborhoods and discuss the specific activities, including the extent of forest clearing and construction activity, that will take place near those neighborhoods. Based on the additional analyses required by the Scope included in this Certificate, the DEIR should provide an updated assessment of whether the project's impacts may result in disproportionate adverse effects, or increase the risks of climate change, on the identified EJ population, particularly in light of the GHG emissions, air pollutants, and heat island effects that may be associated with large-scale forest clearing activities. The DEIR should consider any loss of open space or recreational opportunities that may affect EJ populations lacking access to such resources. The DEIR should discuss what mitigation will be provided for any properties located directly adjacent to tree clearing activities, in light of the loss in shading and other impacts that may be anticipated.

As discussed below, the DEIR should contain a GHG analysis for the significant loss and conversion of forested land to a scrub-shrub habitat and a discussion of mitigation measures to reduce the GHG emissions of the project. The DEIR should analyze land alteration associated with the project including implications for potential stormwater flooding and heat effects in surrounding neighborhoods. Analysis of the stormwater should specifically assess whether flooding risks may be exacerbated for nearby EJ populations, including under future climate conditions, and whether existing conditions would be worsened or improved by the project. The DEIR should also analyze other short-term and long-term environmental or public health impacts of the project, including construction period activities. If any disproportionate adverse effects or increased risks of climate change are identified, the DEIR must include a discussion of proposed mitigation and include such measures in draft Section 61 findings.

Rare Species

The DEIR should provide an update on potential impacts to state-listed rare species habitat, including the acreage of priority habitat with the ROW and amount impacted by the project. The DEIR should include proposed measures to avoid, minimize and mitigate those impacts. As noted above, comments from NHESP indicate it may be possible to avoid a Take, and the Proponent should work to avoid and minimize impacts to state-listed species by consulting with NHESP to address the following:

- Evaluating reductions to permanent habitat loss associated with gravel work pads and access roads within the ROW;
- Conducting botanical surveys suitable habitat in accordance with an approved botanical survey protocol;
- Providing calculations of temporary and permanent impacts to state-listed species habitat;
- Evaluating reductions to permanent habitat loss associated with gravel work pads and access roads within the ROW; and

- Developing robust rare-species protection plan(s) focusing on time-of-year restrictions for active and breeding seasons, daily sweeps of the work area during any active season work, and if necessary, radio telemetry and tracking of state-listed turtles.

Comments from NHESP state that the Division anticipates being able to resolve any outstanding concerns related to state-listed species during the MESA review process. The DEIR should provide a summary of the outcome of continued consultation with NHESP and mitigation to be provided.

Wetland Resource Areas

MassDEP comments recommend that the Proponent consider waiting to file Notices of Intent (NOIs) with the Conservation Commissions until the conclusion of MEPA review to ensure sufficient opportunities for public involvement and to avoid any potential conflict with the final Certificate, Orders of Conditions, or the WQC. Should the Proponent file a NOI prior to the conclusion of MEPA review, MassDEP recommends the Proponent request that the local Conservation Commissions defer a decision on the filing and keep the meeting open until the Secretary has issued the final Certificate, and MassDEP has issued the WQC, to ensure consistency with any requirements in the Certificate and conditions of the WQC. According to MassDEP comments, the project may be eligible for review under the Limited Project provisions pursuant to 310 CMR 10.53(3)(d) at the discretion of the local Conservation Commission and to the extent practicable, work must comply with the General Performance Standards. As indicated above, the Proponent should document why the project qualifies for Limited Project status given the magnitude of the alteration and the significance of the project site to the interests of the WPA; the proponent should provide a serious evaluation of reasonable alternatives to the proposed activity (including alternatives to reduce the full extent of the proposed cutting), an evaluation of the extent to which adverse impacts are minimized, and documentation that full mitigation is provided for unavoidable impacts. Based on this demonstration, a Variance to the WPA regulations may be required pursuant to 310 CMR 10.05(10).

The DEIR should provide an update on the impact analysis for each resource area and demonstrate how the project will comply with performance standards outlined in the WPA as the project has the potential to result in significant changes to the hydrology of the affected resource areas and downstream reaches. The DEIR should clearly indicate whether a Wetlands Variance will be needed for the project, and if so, discuss how the project will meet the requirements for the Variance. The DEIR should consider impacts associated with surface and subsurface hydrology, wildlife habitat, and describe compliance with BMPs for stormwater management and sedimentation and erosion control. The DEIR should ensure that estimates for impacts to wetland resource areas are conservative and account for all temporary impacts. The DEIR should describe tree clearing details, potential TOY restrictions, specific locations of proposed construction mats, and implementation sequencing. The EENF indicates that at stream crossings, construction matting will span the stream channel to the extent feasible to avoid impacts to the stream bank and bed. The includes conservative estimates for temporary stream-crossings; however, the DEIR should describe to what extent the construction matting would necessitate alteration of Bank or LUW. The DEIR should also note whether any temporary or permanent stream crossings are proposed as requested in comments from MassDEP. If any crossings are proposed, the DEIR should include an alternatives analysis to ensure that the crossing will be designed to facilitate aquatic organism and wildlife passage, and not increase flood levels of the resource area. Any stream crossing should meet the criteria listed in 310 CMR 9.06(2)(b). As noted above, potential vernal pools should be analyzed to determine whether they are eligible to be certified (including the one potential vernal pool to be impacted) and the results presented in the DEIR.

The DEIR is required to provide sufficient information to adequately describe cumulative impacts to "Waters of the Commonwealth" (BVW, IVW and LUW) pursuant to 314 CMR 9.00 and identify efforts to avoid, minimize, and mitigate impacts. The EENF indicates that compensatory mitigation is not expected to be required for impacts to most resources impacted by the project. MassDEP comments provide clarification that mitigation for impacts is a requirement of the 401 WQC regulations. The DEIR should propose appropriate mitigation measures in consultation with MassDEP to demonstrate consistency with the WQC regulations. The DEIR should discuss mitigation in the form of off-site preservation of forested land or wetlands, and culvert and stream enhancements. Temporary impacts to resource areas are subject to the WPA regulations (310 CMR 9.02) and can be mitigated through "in-situ" replication and/or restoration, as well as via off-site considerations. The MassDEP comment letter states that the Proponent provides no mitigation for land alteration or wetland impacts beyond measures required by regulations associated with the WPA and related stormwater requirements. In light of the variety of indirect impacts that may flow from tree clearing, including stormwater runoff, GHG emissions and heat island effects for neighboring residences, the Proponent should offer additional meaningful mitigation measures to offset the environmental impacts in project areas where impacts to wetlands and undisturbed forests cannot be avoided or minimized. The DEIR should address the comments from the Franklin Regional Council of Governments (FRCOG) regarding wetland impacts, proposed mitigation (including pollinator habitat conservation), and invasive species management.

The DEIR should include an analysis of Stormwater Management as outlined in comments from MassDEP. Comments note that removal of trees increases the peak runoff rate, triggering compliance with 310 CMR 10.05(6)(k)2. and 314 CMR 9.06(6)(a)2. 10.05(6)(k)2. which apply to alterations in resource areas regardless of if the project qualifies as a limited project. In addition to traditional stormwater management as mitigation, MassDEP recommends the Proponent evaluate replacement of trees to reduce the peak runoff rate. Any trees replaced would need to be within the same sub-watershed to be considered as peak rate mitigation. A discussion should be included about canopy area lost due to the project and estimate the time period likely to recover the same or larger tree canopy. The recharge and TSS treatment standards apply when impervious area is being created or redeveloped. The DEIR should include a discussion as to whether the proposed caissons or access roads will create new impervious area. Special requirements apply to Critical Areas, such as ORWs (310 CMR 10.05(6)(k)6. and 314 CMR 9.06(6)(a)6.). In addition, the DEIR should demonstrate that compensatory flood storage provided for permanent fill in BLSF has an unrestricted hydraulic connection to same waterway or water body displaced by the project as stated in 310 CMR 10.57(4)(a)1. The compensatory flood storage analyzed in the DEIR must be proposed near where the fill is proposed so as to provide an unrestricted connection to the same waterway. In addition, the Proponent must demonstrate that seasonal high groundwater is at or below the elevation which the compensatory flood storage will be provided. The DEIR should analyze alternatives to provide the compensatory flood storage and provide a cut-and-fill table for each alternative analyzed.

<u>Chapter 91</u>

As requested above, the DEIR should include details on the scope of work within each waterway in c. 91 jurisdiction in order for the MassDEP Waterways Program to provide feedback on any c. 91 authorization that may be required.

Article 97

As noted previously, the project includes improvements to five woods roads outside of the ROW to enable access through DCR forest land to the ROW. The Proponent indicates that it may have existing rights to access the ROW through DCR property; however, as indicated in comments from DCR, additional information is needed to determine if new permanent easements are required which would require disposition of state-owned land protected by Article 97 of the Amendments to the Massachusetts Constitution. A disposition of a property interest over this land requires approval by a 2/3rds vote of the legislature, and compliance with the Division of Capital Asset Management and Maintenance's (DCAMM) disposition process as well as the Executive Office of Energy and Environmental Affairs (EEA) Article 97 Land Disposition Policy (the Disposition Policy). The Article 97 Policy was established to ensure No Net Loss of public conservation lands under the ownership and control of the Commonwealth. It provides for transfer of ownership or interests in Article 97 Land only under exceptional circumstances. The Policy establishes six criteria for determining when "exceptional circumstances" exist such that a disposition of Article 97 land may be appropriate. These include:

- The Proponent of the disposition must conduct an analysis of alternatives, commensurate with the type and size of the proposed disposition, that achieve the purpose of the disposition without the use of Article 97 land, such as the use of other land available within the appropriate market area;
- The disposition of the subject parcel and its proposed use may not destroy or threaten a unique or significant resource (e.g., significant habitat, rare or unusual terrain, or areas of significant public recreation);
- Real estate of equal or greater value, and of significantly greater resource value is granted to the disposing agency;
- The minimum necessary area of Article 97 should be included in the disposition and the existing resources continue to be protected to the maximum extent possible;
- The disposition serves an Article 97 purpose or another public purpose without detracting from the mission, plans, policies and mandates of EEA and its appropriate department or division; and
- The disposition is not contrary to the express wishes of the person(s) who donated or sold the parcel or interests to the Commonwealth.

The DEIR must identify impacts (temporary and permanent) to Article 97 Land and proposed measures to avoid, minimize and mitigate impacts. The alternatives analysis and proposed mitigation in the DEIR should address compliance with the EEA Article 97 Policy. As noted above, work activities on DCR property outside of existing easements associated with the ROW, or requiring access across DCR property, will require a CAP. As requested in comments, the Proponent should coordinate with DCR's Senior Ecologist and Staff Archaeologist related to wetlands, rare species habitat, and potential archaeological resources, including the amount of proposed tree clearing within the state forest sections of the ROW, and along access routes identified by the Proponent. Comments from DCR express concerns about recreational impacts at the access point in Warwick State Forest that is proposed to be co-located with the Metacomet Monadnock Trail for approximately 2,300 feet and impacts that may result in increased Off-Highway Vehicle (OHV) access to the state forests, potentially causing degradation of natural and cultural resources. DCR requests coordination with the Proponent to develop and implement strategies to deter this unauthorized trail use. The DEIR should provide an update on these consultations.

Climate Change

Adaptation and Resiliency

While the EENF describes the general resiliency benefits of the project achieved by updating aging infrastructure to current design standards, it does not specifically address the design recommendations from the MA Resilience Design Tool. The DEIR should include a narrative explaining whether proposed tree clearing and infrastructure improvements will make the project assets more resilient to risks associated with riverine flooding from a 50-year (2%) storm event estimated as of 2070. The DEIR should discuss the extent to which existing electrical lines are exposed to riverine flooding, and what measures the Proponent is taking to improve asset resiliency over a longer-term horizon. In particular, the DEIR should discuss whether new foundations are being elevated above any defined base flood elevations or other similar water/flood elevation measure to ensure that the structures are resilient to future flooding risks. Where impervious area is created and stormwater management is required, the DEIR should address the recommendations from the MA Resilience Design Tool, including whether the stormwater management designs will be resilient to future climate conditions such as the 25-year or 50-year storm as of 2070. The Tool now provides 24-hour rainfall volumes for various storm scenarios, which can be consulted as a resource. The DEIR should further describe mitigation in areas of tree clearing and access road creation where there are steep slopes and severe erosion potential including temporary and permanent stabilization methods.

Land Alteration

The DEIR should provide a quantitative carbon analysis of tree clearing activities that should consider both the one-time direct emissions from tree cutting as well as loss of potential carbon sequestration over a certain time period (e.g., 30 or 40 years). To the extent tree cover is replaced with scrub-shrub habitat, the net loss in carbon sequestration potential may be estimated. As discussed above, the Proponent has proposed to use LiDAR data, confirmed with select sampling, to estimate the age and height of trees to be cleared and to assign carbon values to those trees based on "best available datasets." The Proponent should make use of the EVALIDator tool from the U.S. Forestry Service,[20] which provides estimates of carbon stocks (including above ground and below ground biomass) specific to Massachusetts forests and considers variations among forest types based on region. To the extent the Proponent desires to use an alternative dataset, it should provide a justification for why such alternative data are appropriate and indicate whether the dataset considers variations in forest types that may be present over the entire 216 acres proposed for clearing. Any sampling methodology used to verify LiDAR results should similarly consider forest type variations to ensure that representative samples are collected. As the EVALIDator tool does not provide an estimate of annual carbon sequestration rates (carbon flux over time), the Proponent may rely on other sources of data, including the EPA GHG Emissions Calculator, for this value and estimate annual rates over a 30 year time period from the date of construction. The DEIR should describe the methodology and data used to develop the analysis, identify associated impacts on GHG emissions, and identify measures to avoid, minimize and mitigate impacts. The DEIR should account for carbon sequestration from any trees that are removed and not replaced/converted to scrub shrub. The Proponent is directed to consult with the MEPA Office on the development of this analysis, and, in particular, sampling methodology, prior to filing the DEIR.

[20] https://www.fia.fs.fed.us/tools-data/

Given the extent of tree clearing proposed, I expect the DEIR to identify mitigation measures commensurate with the project's impacts on the project corridor's capacity to sequester and store carbon. Potential mitigation measures may include funding programs that add or maintain biomass for sequestration purposes (such as tree planting, carbon credits, forest conservation or commitments to implement forest restoration practices) and preserving/protecting forested land through a Conservation Restriction or other means. At a minimum, the Proponent should clearly explain its plan for disposition of the trees cleared through the project, including the process for identifying potential markets for reuse of wood and a process for tracking and reporting. The Proponent should commit to reuse of cleared trees for long-lived wood products to the greatest extent practicable and should indicate how the ultimate disposition of the trees will be tracked and documented. Potential mitigation for carbon emissions due to land alteration might include donation of harvested wood to benefit an affordable housing project; tree planting in EJ populations near the project area (recommendation of 50 trees/acre with a commitment to water and replace for two years); and donation of harvested wood (cut and split to a wood bank) in Massachusetts.

Transportation

The Proponent should work with MassDOT to address the details of the permitting process and any traffic and construction management plans that may be required for temporary work within the state highway layout. The DEIR should describe the location of roadways under MassDOT jurisdiction. The DEIR should confirm that the Proponent will implement a traffic management plan consistent with MassDOT requirements. It should describe the outcome of any consultation with MassDOT. The DEIR should describe the extent of truck traffic that will result from refurbishment and tree clearing activities, including the number of truck trips required.

Historic and Archaeological Resources

The EENF indicates that the Proponent will submit the archaeological locational survey technical report to MHC in October of 2022. MHC has indicated that comments will be provided following review of that report. The DEIR should provide an update on coordination with MHC.

Mitigation and Section 61 Findings

The EENF included draft Section 61 Findings and proposed mitigation measures. The DEIR chapter should include an updated comprehensive list of all commitments made by the Proponent to avoid, minimize and mitigate the impacts of the project, and should include a separate section outlining mitigation commitments relative to EJ populations. The DEIR should contain clear commitments to implement these mitigation measures, estimate the individual costs of each proposed measure, identify the parties responsible for implementation, and contain a schedule for implementation. The list of commitments should be provided in a tabular format organized by subject matter (traffic, water/wastewater, GHG, EJ, etc.) and identify the Agency Action or Permit associated with each category of impact. Draft Section 61 Findings should be separately included for each Agency Action to be taken on the project.

Responses to Comments

The DEIR should contain a copy of this Certificate and a copy of each comment letter received. It should include a comprehensive response to comments on the EENF that specifically address each issue raised in the comment letter; references to a chapter or sections of the DEIR alone are not adequate and should only be used, with reference to specific page numbers, to support a direct response. This directive is not intended to, and shall not be construed to, enlarge the Scope of the DEIR beyond what has been expressly identified in this certificate.

Circulation

In accordance with 301 CMR 11.16, the Proponent should circulate the DEIR to each Person or Agency who commented on the EENF, each Agency from which the project will seek Permits, Land Transfers or Financial Assistance, and to any other Agency or Person identified in the Scope. Pursuant to 301 CMR 11.16(5), the Proponent may circulate copies of the DEIR to commenters in a digital format (e.g., CD-ROM, USB drive) or post to an online website. However, the Proponent should make available a reasonable number of hard copies to accommodate those without convenient access to a computer to be distributed upon request on a first come, first served basis. The Proponent should send correspondence accompanying the digital copy or identifying the web address of the online version of the DEIR indicating that hard copies are available upon request, noting relevant comment deadlines, and appropriate addresses for submission of comments. If submitted in hard copy, the DEIR submitted to the MEPA office should include a digital copy of the complete document. A copy of the DEIR should be made available for review in the Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, Athol, and Sterling.

October 31, 2022
Date

Bethany A. Card

Comments received:

09/27/2022	Town of Leominster, DPW
10/24/2022	Massachusetts Department of Conservation and Recreation (DCR)
10/24/2022	Franklin Regional Council of Governments (FRCOG)
10/25/2022	Massachusetts Department of Environmental Protection (MassDEP) Waterways Program
10/26/2022	MassDEP, Western & Central Regional Offices (WERO & CERO)
10/26/2022	Massachusetts Division of Fisheries and Wildlife (DFW) Natural Heritage and Endangered Species Program (NHESP)

BAC/JAH/jah

View Comment

Comment Details

EEA #/MEPA ID
16607

Comments Submit Date
9-27-2022

Certificate Action Date
10-24-2022

Reviewer
Jennifer Hughes, (617)455-7063, Jennifer.Hughes@mass.gov

First Name
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State
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Zip Code
01453

Organization
LEOMINSTER Dept Of Public Works

Affiliation Description
Municipality

Status
Opened

Comment Title or Subject

Topic: Leominster DPW Comments

Comments

Segoe UI 10 pt Paragraph

Page xi - Water Resources: The "NO" box is checked for ORW. Most of the Leominster portion of this project is located in the City's Water Supply Watershed.

Many parcels in the watershed are now encumbered with a Conservation Restriction which is held by the DCR. W.N.R.D. book 10309-252

LE-W28 is shown as a wetland but is actually a detention basin serving Samoset Drive. There are also drainage pipes in the vicinity of Proposed structure 577 and the associated Pull Pad.

There are sewer and water mains in the vicinity of Proposed structure 587.

There is a water diversion pipe in the vicinity of Existing structures 619 & 620.

Ground disturbance should be minimized when existing structure is removed. It is at the base of the No-Town dam. Not only is it a High Hazard Dam but it's also the dam to the City's largest drinking water source.

Attachments

Update Status

Status

Accepted

SUBMIT

Share Comment

SHARE WITH A REGISTERED USER

BACK TO SEARCH RESULTS

Franklin Regional Council of Governments

October 24, 2022

Attn: MEPA Office, Jennifer Hughes
Bethany A. Card, Secretary
Executive Office of Energy and Environmental Affairs
100 Cambridge St, Suite 900
Boston, MA 0211

Submitted by email to: Jennifer.Hughes@mass.gov

Re: **EEA 16607**
Expanded Environmental Notification Form (EENF) for the A1/B2 Asset Condition Refurbishment Project (Warwick and towns outside of Franklin County)

Dear Ms. Card,

The Franklin Regional Council of Governments (FRCOG) hereby submits comments on the Expanded Environmental Notification Form (EENF) for EEA Project 16607. FRCOG is a regional service organization serving the 26 towns of Franklin County. We advocate on behalf of our communities and the county at the federal, state and regional levels. Our Planning Department serves as the Regional Planning Agency for the 26 communities in Franklin County. We provide planning technical assistance to our member towns for projects related to climate change resiliency, natural resource protection and land use. This proposed project will go through the town of Warwick in Franklin County.

New England Power Company d/b/a National Grid ("NEP") is proposing this refurbishment project within an existing electric transmission right-of-way (ROW) containing the existing 69 kV A1 and B2 Lines, also referred to as "the mainline" and three intersecting tap lines that are outside of Franklin County. The A1/B2 mainline extends from the Massachusetts border in Warwick through Royalston, Winchendon, Gardner, Westminster, Fitchburg, and Leominster to the Pratts Junction #255 Substation in Sterling. The Project is part of a larger refurbishment effort that continues through NH and terminates at the Vernon #12 Switchyard located in Vernon, Vermont.

The Project's stated purpose is to complete required system improvements that will address poor asset condition, mitigate potential risks of electrical failure, and to provide long-term reliable delivery of electrical service and maintenance of the lines. The A1/B2 Lines were originally constructed in 1909 and the original lattice structures remain. The Lines were re-conductored in the 1920s and were reinsulated in 2004. Structures and wires are in need of replacement and access routes are in need of repair. In addition, a transmission study conducted by the Independent System Operator – New England (ISO-NE) predicted that these lines will need to be upgraded to 115 kV in order to support renewable energy and customer needs of the next few decades. Therefore, NEP proposes to construct the lines with 115 kV capacity, but operate the lines at 69 kV until the additional capacity is needed.

12 Olive Street, Suite 2, Greenfield, MA 01301-3318 · 413-774-3167 · *www.frcog.org*

The Project includes various refurbishment activities and replacement of 711 tower structures that will entail removing the existing structure (height is 39-45 ft.) and installing a new 90-ft. structure in an adjacent location. Of the 711 replacements, NEP anticipates 305 will need to be built on concrete caisson foundations and 406 poles will be directly embedded into the ground and will not require caisson foundations. The Project also involves clearing vegetation to a consistent total width of 100 ft. on the mainline and 125 ft. on the tap line. According to Section 3.3.2 of the EENF narrative, the existing maintained width on the mainline is 85 ft. National Grid's Vegetation Management Plan for 2019-2023 was included as Appendix D to the EENF.

The Project exceeds review thresholds set forth by the MEPA regulations requiring an ENF and a mandatory Environmental Impact Report (EIR). The proponent has requested that MEPA allow the preparation of a Single EIR in accordance with 301 CMR 11.06(8). The project involves impacts to 66 acres of bordering vegetated wetlands and 60 acres of Riverfront. The project overlaps with estimated or priority habitat for three bird species, three "herptile" species, two insect species and one plant species listed by the Natural Heritage and Endangered Species Program (NHESP), but the species names have been withheld at the request of NHESP. Table 9 in section 3.3.2 indicates that 105 acres of trees will be removed within the ROW and 58 acres of trees will be removed outside of the ROW to meet "required horizontal distances."[1]

MEPA Alternatives

Under MEPA regulations 301 CMR 11, a proponent may file an Expanded Environmental Notification Form (ENF), which includes "extensive and detailed information describing and analyzing the Project and its alternatives." Section 301 CMR 11.07(6)f gives guidelines for the discussion of project alternatives in the Environmental Impact Report (EIR) phase. The EENF described several project alternatives. It would also be helpful during the EIR stage to evaluate sub-project alternatives that would look at reduced impacts to particularly sensitive resources. Sensitive locations to be avoided could include priority habitat for state-listed species, all wetland areas, Riverfront Areas, Coldwater Fisheries habitat, vernal pools, historical and culturally sensitive locations, wellhead protection areas, areas near private wells, national scenic trails, or combinations of any of these features.

Understanding project impacts

We request that more of the impacts be summarized by town in the EIR, so that it's clear what the impacts are in each community. It would also be useful to know the forested acreage proposed to be cut in each town.

Appendix A Figure 2 maps shows proposed tree removal outside of the ROW in many areas, and it appears that the tree removal is not necessarily a consistent width as described in the narrative. FRCOG was unable to attend the MEPA virtual site visit. Perhaps this could be made more clear in the EIR.

Appendix A Figure 3 shows structure details of the proposed tower configurations. These diagrams are helpful, but it would also be helpful to include a diagram that justifies the vegetation management needs based on the height of the proposed towers (or lines) and the width of the proposed vegetation management.

[1] These numbers differed in the narrative.

FRCOG requests that the proponent include information in an EIR about information about long-term vegetation management or construction impacts in the area of public drinking water or private wells.

The ROW crosses and comes in close contact with the New England Trail, a national scenic trail, in Warwick.[2] The narrative in the EENF generally mentions trails, but we could not find a specific mention of this trail. We request the EIR include a description of the potential impacts on the trail, and whether or not trail access will be affected during and after construction.

Opportunities to expand pollinator habitat

The FRCOG recently completed a regional pollinator plan with funding from an EEA Planning Assistance Grant. FRCOG's regional pollinator plan describes utility rights of way (ROWs) as areas that cover a variety of landscapes and sometimes contain greater plant diversity than adjacent lands, which might make them excellent pollinator forage and nesting habitat. Where utility corridors cross open wetlands, the pollinator habitat value could be even greater. ROWs create a linear open space that is generally free of major disturbances and protected from future development. While these conditions could create highly valuable connected corridors of high-quality habitat, the use of herbicides to manage vegetation in these areas can negate their value as habitat. The report documents can be found here: https://frcog.org/program-services/natural-resources-planning/

The FRCOG requests that NEP consult the Regional Pollinator Plan and other documents such as EPRI's "Overview of Power Companies and Pollinators" published in 2018, and EPRI's "Conservation Actions for Electric Power Companies to Support Monarch Butterflies" published in 2019. These ideas should be incorporated into project planning. There are a number of state-listed butterfly, moth, bee, and bird species that could benefit from planning this project to encourage pollinator habitat. Notwithstanding the project impacts, this project also represents an opportunity that should not be lost.

Historical and culturally sensitive locations

Section 6.0 in the EENF states that NEP contracted SWCA Environmental Consultants ("SWCA") to conduct cultural resource due diligence on the Project. SWCA staff conducted background research and a physical inspection of the Project area. Based on the results of the cultural resources due diligence, SWCA recommended conducting an archaeological sensitivity assessment along the A1/B2 Lines to define areas of high archaeological sensitivity that might be impacted. Just over one thousand test pits were dug in Massachusetts, and though 142 pieces of cultural material were recovered in MA, none were considered significant and no further analysis is recommended.

FRCOG is aware that the Vernon Dam, which became operational in 1909, was the first power plant in the northeastern U.S. to transmit power across state lines to manufacturing centers in Gardner and Fitchburg, MA (in 1920)[3]. The transmission of power generated miles away became the basis for our grid system in operation today. This particular power line therefore marks a significant moment in time for electrical infrastructure history in the region. As the power line towers being replaced were installed in 1909, FRCOG recommends that

[2] See map online at https://newenglandtrail.org/interactive-map/, and choose imagery as the base of the map to see the power line.

[3] See https://www.hydroreview.com/world-regions/hydro-hall-of-fame/#gref

consideration be given to documenting the towers, or allow for some kind of preservation of a representative small number of the towers.

Stone walls are shown on some of the map sheets in Appendix A, Figure 2. It is not clear if any methods are proposed to avoid, minimize, or mitigate impacts to stone walls.

Thank you for the opportunity to comment on this EENF. I can be reached at KMacPhee@frcog.org or 413-774-3167 x. 130.

Sincerely,

Kimberly Noake MacPhee, P.G., CFM
Land Use & Natural Resources Program Manager
Climate Resiliency Specialist

Charles D. Baker, Governor
Karyn E. Polito, Lieutenant Governor
Jamey Tesler, Secretary & CEO

massDOT
Massachusetts Department of Transportation

October 24, 2022

Bethany A. Card, Secretary
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114-2150

RE: Fitchburg et al – A1/B2 Asset Condition Refurbishment Project
(EEA #16607)

ATTN: MEPA Unit
Jennifer Hughes

Dear Secretary Card:

On behalf of the Massachusetts Department of Transportation, I am submitting comments regarding the Environmental Notification Form filed for the proposed A1/B2 asset condition refurbishment project starting in Warwick and running through Winchendon, Leominster, Sterling, Royalston, Gardner, Fitchburg, Athol, and Westminster as prepared by the Office of Transportation Planning. If you have any questions regarding these comments, please contact J. Lionel Lucien, P.E., Manager of the Public/Private Development Unit, at (857) 368-8862.

Sincerely,

David Mohler

David J. Mohler
Executive Director
Office of Transportation Planning

DJM/jll

Ten Park Plaza, Suite 4160, Boston, MA 02116
Tel: 857-368-4636, TTY: 857-368-0655
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cc: Jonathan Gulliver, Administrator, Highway Division
Carrie Lavallee, P.E., Chief Engineer, Highway Division
James Danila, P.E., State Traffic Engineer
Patricia Leavenworth, P.E., District 2 Highway Director
Barry Lorion, P.E., District 3 Highway Director
Franklin Regional Council of Governments (FRCOG)
Montachusett Regional Planning Commission (MRPC)

MEMORANDUM

TO: David J. Mohler, Executive Director
Office of Transportation Planning

FROM: J. Lionel Lucien, P.E., Manager
Public/Private Development Unit

DATE: October 24, 2022

RE: Fitchburg et al – A1/B2 Asset Condition Refurbishment Project
(EEA #16607)

The Public/Private Development Unit (PPDU) has reviewed the Environmental Notification Form (ENF) for the A1/B2 Asset Condition Refurbishment Project (the "Project") entering Massachusetts in Warwick and running through Winchendon, Leominster, Sterling, Royalston, Gardner, Fitchburg, Athol, and Westminster submitted by the BSC Group, Inc. on behalf of New England Power Company (the "Proponent"). The Project entails the refurbishment of existing overhead electrical utility lines, including replacing existing infrastructure, trimming vegetation, and in some cases providing new access drives to maintain the power lines. The overhead lines to be refurbished in this Project run from the Massachusetts state boundary in Warwick to the Pratts Junction #225 Substation in Sterling.

The Project surpasses MEPA thresholds for review of an Environmental Notification Form (ENF) and an Environmental Impact Report (EIR) due to impacts on wetlands per 301 CMR 11.03(3) and land per 301 CMR 11.03(1). The Project additionally requires an ENF due to impacts on priority habitat per 301 CMR 11.03(2). The Project also requires an Environmental Impact Report (EIR) per 301 CMR 11.06(7)(b) as the utility route intersects several Designated Geographic Areas surrounding Environmental Justice (EJ) Populations.

The Project route will intersect with the state jurisdictional highway layout at multiple locations, including Route 202 in Winchendon, Route 2 in Westminster, Fitchburg, and Leominster, Central Street in Leominster, Depot Road in Westminster, and State Road in Westminster. Project-related construction in these locations will require an access permit issued by the appropriate MassDOT District (either District 2 or 3). Further MassDOT permits will be required for temporary construction access, overhead wire crossings of the above-listed state routes, and new access roadways proposed within the state highway right-of-way.

Once completed, the Project is anticipated to result in fewer than one vehicle trip per day. Based on the limited trip generation and limited expansion of the proposed electrical infrastructure, MassDOT does not anticipate that the transportation impacts resulting from Project development would significantly impact the transportation system and recommends no further review for environmental impacts. The Proponent should coordinate with MassDOT

Districts 2 and 3 to minimize traffic disruption during Project construction and prevent impacts on state jurisdictional roadways. If you have any questions regarding these comments, please contact *Curtis.B.Wiemann@dot.state.ma.us*.

MASSWILDLIFE

DIVISION OF
FISHERIES & WILDLIFE

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October 24, 2022

Secretary Bethany Card
Executive Office of Energy and Environmental Affairs
Attention: MEPA Office
Jennifer Hughes, EEA No. 16607
100 Cambridge St.
Boston, Massachusetts 02114

Project Name:	*A1/B2 Asset Condition Refurbishment (ACR) Project*
Proponent:	*New England Power Company*
Location:	*Existing Right-of-way in Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, Athol, and Sterling*
Project Description:	*Structure Replacements and access roadway installation and upgrades on existing Right-of-way*
Document Reviewed:	*Expanded Environmental Notification Form*
EEA File Number:	*16607*
NHESP Tracking No.:	*22-41082*

Dear Secretary Card:

The Natural Heritage & Endangered Species Program of the Massachusetts Division of Fisheries & Wildlife (the Division) has reviewed the *Expanded Environmental Notification Form* (ENF) for the "A1/B2 Asset Condition Refurbishment (ACR) Project" (the "Project") and would like to offer the following comments regarding state-listed species and their habitats.

According to the information provided in the ENF and the *Massachusetts Natural Heritage Atlas* (15th Edition), portions of the Project site are mapped as *Priority* and *Estimated Habitat* for multiple state-listed species, including Wood Turtle (*Terrapene carolina*; Special Concern), American Bittern (*Botaurus lentiginosus,* Endangered) and Sand Violet (*Viola adunca*, Special Concern). These species and their habitats are protected pursuant to the Massachusetts Endangered Species Act (MGL c.131A) and its implementing regulations (MESA; 321 CMR 10.00). Fact Sheets for state-listed species can be found on our website, www.mass.gov/nhesp.

The Proponent has engaged the Division in pre-filing consultations to discuss proposed impacts associated with the Project, and has been actively working with the Division to avoid and minimize permanent and temporary impacts to state-listed species and their habitats. A MESA filing has not yet been submitted, and at this time it is unclear whether the project will result in a Take (321 CMR 10.18 (2)(b)) of state-listed species. Projects resulting in a Take of state-listed species may only be permitted if they meet the performance standards for a Conservation and Management Permit (CMP; 321 CMR 10.23).

The Division recommends that the Proponent continue to work proactively with the Division to avoid and minimize impacts to state-listed species. These include, but may not be limited to: (1) evaluating reductions to permanent habitat loss associated with gravel work pads and access roads within the ROW; (2) conducting botanical surveys suitable habitat in accordance with an approved botanical survey protocol; (3) providing calculations of temporary and permanent impacts to state-listed species habitat; (4) evaluating reductions to permanent habitat loss associated with gravel work pads and access roads within the ROW; and (5) developing robust rare-species protection plan(s) focusing on time-of-year restrictions for active and breeding seasons, daily sweeps of the work area during any active season work, and if necessary, radio telemetry and tracking of state-listed turtles. The Division notes that it may be possible to design the Project in order to avoid a Take, and the Division anticipates being able to resolve any outstanding concerns related to state-listed species during the MESA review process. We look forward to continued coordination with the Proponent to ensure that the Project addresses all issues related to state-listed species.

The Division will not render a final decision until the MEPA review process and associated public and agency comment period is completed, and until all required MESA filing materials are submitted to the Division. As our MESA review is ongoing, no alteration to the soil, surface, or vegetation and no work associated with the Project shall occur until the Division has made a final determination. If you have any questions or need additional information, please contact Lauren Glorioso, Endangered Species Review Biologist, at lauren.glorioso@state.ma.us or 508-389-6361. We appreciate the opportunity to comment on the Project.

Sincerely,

Everose Schlüter, Ph.D.
Assistant Director

cc: Mike Tyrell, National Grid
Heidi Graff, VHB
MassDEP Central Regional Office
Town of Warwick Board of Selectmen
Town of Warwick Planning Board
Town of Warwick Conservation Commission
Town of Royalston Board of Selectmen
Town of Royalston Planning Board
Town of Royalston Conservation Commission
Town of Winchendon Board of Selectmen

Town of Winchendon Planning Board
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Town of Fitchburg Board of Selectmen
Town of Fitchburg Planning Board
Town of Fitchburg Conservation Commission
Town of Leominster Board of Selectmen
Town of Leominster Planning Board
Town of Leominster Conservation Commission
Town of Athol Board of Selectmen
Town of Athol Planning Board
Town of Athol Conservation Commission
Town of Sterling Board of Selectmen
Town of Sterling Planning Board
Town of Sterling Conservation Commission

October 24, 2022

Secretary Bethany A. Card
Executive Office of Energy and Environmental Affairs
Attn: Jennifer Hughes, MEPA Office
100 Cambridge Street, Suite 900
Boston, Massachusetts 02114

Re: EEA#16607 A1/B2 Asset Condition Refurbishment Project EENF

Dear Secretary Card:

The Department of Conservation and Recreation ("DCR" or "the Department") is pleased to submit the following comments in response to the Expanded Environmental Notification Form ("EENF") filed by New England Power Company ("NEP" or the "Proponent") for the proposed A1/B2 Asset Condition Refurbishment Project (the "Project") from Sterling to Warwick.

NEP's mainline right-of-way ("ROW") is of variable width, and the Project proposes tree clearing to 100 feet throughout. Additional tree clearing related to new or improved access roads is also proposed. NEP proposes to replace structures and wires within the ROW to address poor asset conditions. A fiber optic ground wire will be installed between substations. The ROW passes through Leominster State Forest, Otter River State Forest, Royalston State Forest, and Warwick State Forest. The ROW intersects with the Metacomet Monadnock Trail, one of the state's long distance hiking trails, in Warwick State Forest.

Article 97

The proposed Project includes the use and "improvement" of five woods roads outside of the ROW to enable access through DCR forest land to the NEP ROW for Project activities: four of the paths are in Warwick State Forest and one is in Royalston State Forest. Proposed changes to the access corridors include tree clearing and widening of the corridors, which will result in permanent impacts to the state forests. To the extent the Proponent believes it may have rights to access their ROW from DCR property, a determination which DCR does not have sufficient information to make at this time, it appears that the Proponent's proposed changes to DCR property will require permanent easements, triggering Article 97 of the Amendments to the Massachusetts Constitution. DCR also notes that if the improved woods road are to be used for ongoing maintenance on the NEP ROW, that change in use of DCR property would also trigger Article 97.

Transfers of interests in state conservation property must meet the requirements set forth in the Executive Office of Energy and Environmental Affairs ("EEA") Article 97 Land Disposition Policy (the "Policy"). The Policy has the stated goal of ensuring no net loss of lands protected under Article 97 in the ownership and control of the Commonwealth and its political subdivisions, and states as a general premise that EEA and its agencies shall not sell, transfer, or otherwise dispose of any right or interest in Article 97 lands. Transfer of ownership or interests therein only may occur under exceptional circumstances, as defined in

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Charles D. Baker
Governor

Karyn E. Polito
Lt. Governor

Bethany A. Card, Secretary
Executive Office of Energy & Environmental Affairs

Douglas J. Rice, Commissioner
Department of Conservation & Recreation

the Policy, including the determination that no feasible alternative is available, and a minimum amount of land or an interest therein is being disposed for the proposed use. Such a transfer also requires legislative authorization by the General Court through a two-thirds supermajority roll-call vote. DCR is coordinating with the Proponent to determine whether additional easement rights that would trigger an Article 97 disposition request will be needed. Work activities on DCR property outside of existing easements associated with the NEP ROW, or requiring access across DCR property, will require a Construction and Access Permit ("CAP").

Natural, Cultural and Recreational Resources

DCR requests coordination with DCR's Senior Ecologist and Staff Archaeologist related to wetlands, rare species habitat, and potential archaeological resources, including the amount of proposed tree clearing within the state forest sections of the ROW, and along access routes identified by the Proponent. The Senior Ecologist will review the flagged work limits and work with the Proponent to identify mitigation for the loss/conversion of forest habitat. The Staff Archaeologist will coordinate with the Proponent and their cultural resource consultant to develop and implement measures to avoid, minimize, or mitigate adverse effects to significant historic and archaeological resources within DCR property. We look forward to reviewing specific protection and restoration measures to be taken for sensitive natural and cultural resources on public conservation lands. Environmental permits for work activities on DCR land must be signed by the Department as 'Owner' following review by DCR staff members and prior to submission to regulatory agencies.

DCR is concerned about recreational impacts of the access point in Warwick State Forest that is proposed to be co-located with the Metacomet Monadnock Trail for approximately 2,300 feet. DCR is also concerned that the Project may result in increased Off Highway Vehicle access to the state forests, potentially causing degradation of natural and cultural resources. The Department requests coordination with NEP to develop and implement strategies to deter this unauthorized trail use.

Thank you for the opportunity to comment on the EENF. If you have any questions regarding these comments, or to request additional information or coordination with DCR, please contact andy.backman@mass.gov.

Sincerely,

Douglas J. Rice,
Commissioner

cc: Nancy Putnam, Jonathan Patton, Sean Grant, Dwayne Ericson, Priscilla Geigis, Patrice Kish,
Tom LaRosa

MassDEP
Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs
Department of Environmental Protection
One Winter Street Boston, MA 02108 • 617-292-5500

Memorandum

To: Bethany A. Card, Secretary, EOEEA

Through: Jennifer Hughes, MEPA

From: MassDEP Waterways Regulation Program

cc: Daniel Padien, MassDEP/Boston Waterways Regulation Program

Re: Comments from the Chapter 91 Waterways Regulation Program: EEA #16607 Environmental Notification Form (ENF), A1/B2 Asset Condition Refurbishment Project, Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, Athol, and Sterling

Date: October 25, 2022

The Department of Environmental Protection Waterways Regulation Program (the "Department") has reviewed the above referenced filing submitted by BSC Group on behalf of the New England Power Company (the "Proponent") for refurbishment activities and system improvements along approximately 54 circuit miles along the A1/B2 Lines ("the Project").

Chapter 91 Comments

As noted in the ENF, certain scopes of work that meet the standard at 310 CMR 9.05(3)(g)(1) are exempt from licensing under Chapter 91. However, that exemption is limited to "*placement in a non-tidal river or stream subject to jurisdiction under 310 CMR 9.04(1)(e) of fill or structures for which a final Order of Conditions has been issued under M.G.L. c. 131, § 40 and 310 CMR 10.00: Wetlands Protection, and which does not reduce the space available for navigation; such fill or structures are limited to* ***overhead wires****, conduits, or cables to be attached to an existing bridge, without substantial alteration thereof, or constructed and maintained in accordance with the National Electrical Safety Code*". The ENF describes work that will occur within waterways in addition to the overhead wires, such as construction mats, work pads and pull pad envelopes, and fill for two new/or replacement structure foundations. It is recommended that the EIR include details on the scope of work within each waterway in Chapter 91 jurisdiction, in order for the Department to provide feedback on any Chapter 91 authorization that may be required.

If there are any questions regarding the Department's comments, please contact DEP.Waterways@mass.gov or at (617) 292-5929.

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

Western Regional Office • 436 Dwight Street, Springfield MA 01103 • 413-784-1100

Charles D. Baker
Governor

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Bethany A. Card
Secretary

Martin Suuberg
Commissioner

October 26, 2022

Bethany A. Card, Secretary
Executive Office of Energy & Environmental Affairs
Massachusetts Environmental Policy Act Office
Jennifer Hughes, EEA No. 16607
100 Cambridge Street, 9th Floor
Boston, MA 02114-2524

Re: New England Power Company A1/B2 Asset Condition Refurbishment Project EENF – Athol, Royalston, Sterling, Warwick, Winchendon, Gardner, Westminster, Fitchburg, Leominster

Dear Secretary Card,

The Massachusetts Department of Environmental Protection (MassDEP) (Western Regional Office, Central Regional Office, and Boston Office) appreciates the opportunity to comment on the Expanded Environmental Notification Form (EENF) submitted for the proposed A1/B2 Asset Condition Refurbishment Project in Athol, Royalston, Sterling, Warwick, Winchendon, Gardner, Westminster, Fitchburg, and Leominster (EEA #16607).

The applicable MassDEP regulatory and permitting considerations regarding wetlands, surface waters, air pollution, solid waste, hazardous waste and waste site cleanup are discussed.

I. Project Description

The Proponent, New England Power Company (NEP), is proposing electric grid system improvements and refurbishment activities over 54 circuit miles along the A1/B2 lines in the NEP Rights-of-Way (ROW) in Warwick, Royalston, Athol, Winchendon, Gardner, Westminster, Fitchburg and Leominster. The circuit includes several tap lines: Athol Taps 1 & 2, the Gardner Tap (Crystal Lake Tap) and the East Westminster Tap. The NEP ROW intersects with Massachusetts Department of Conservation and Recreation properties and trails in several locations. Several off-ROW access routes will be utilized. The project includes upgrades to 733 structures, the installation of six new structures and will include reconductoring, improvements to current access roads, establishment of new access roads, tree cutting, vegetation management and the installation of concrete caisson foundations where necessary. The 711 structures to be removed and replaced at adjacent locations include 406 poles to be directly embedded in the ground and 305 structures to be on concrete caisson foundations. For some structure replacements, temporary structures will be installed in the existing ROW while permanent replacement structures are constructed. Six new embedded vertical jumper switch structures will be installed along the main and tap lines. Current structure heights are between 45 to 50 feet in height. New and replacement structures for the mainline and tap lines will be approximately 90 feet high. Optical Primary Ground Wires will be installed for grounding of lightning strikes and to increase/enhance telecommunications along the lines. The existing 69 kilovolt (kV) lines will be upgraded to 115 kV capacity to serve anticipated future needs. Construction is projected to begin in 2025.

The project passes through areas of Priority Habitat, some of which may result in a "take"; the Proponent is consulting with Natural Heritage Endangered Species Program (NHESP) on the project. Outstanding Resource Waters are crossed by the project and there are 41 certified vernal pools in various locations along the ROW.

Environmental Justice populations are identified within one and five-mile radii of the project site including in the municipalities of Athol, Clinton, Fitchburg, Gardner, Lancaster, Leominster, Orange and Winchendon. The categories are mainly Income, Minority, Minority and Income, and one block group in Leominster listed as Minority, Income and English Isolation. The Proponent posits the project will have neither short-term nor long-term environmental or public health impacts effecting Environmental Justice Populations.

Environmental Impacts associated with this project include:

- Total site acreage – 1,047 Acres
- New acres of land altered – 216
- Square feet (SF) of Bordering Vegetated Wetlands: 2,868,580 concrete caissons – 1,896 SF, tree clearing – 666,032 SF, Mats – 2,200,651 SF
- Square feet of new other wetland alteration –
    - Square feet of Bordering Land Subject to Flooding: 95,593 concrete caissons 632 SF, tree clearing- 81,022 SF, Mats – 13,939 SF, work envelopes, pull pads and access – 293,924 SF (no loss in flood storage will occur from work envelopes, pull pads and access)
    - Square feet of Riverfront Area– 2,614,816 concrete caissons – 3,479 SF, grading and retaining walls – 1,177,862, new or established access roads - 171,544 SF, tree removals – 748,796 SF, Mats – 513,137
    - Bank – 94,526 SF tree removals – 26,572 SF, Mats 67,954 SF
    - Square feet of Land Under Water – 32,364 concrete caissons – 158 SF (Crystal Lake Tap Line), Mats 32,206 SF

- Square feet of Isolated Wetland: 85,021 Mats – 73,181 SF - 11,840 SF Permanent impacts (79 SF caisson foundations), 11,761 SF forested wetland conversion to PSS

II. Required Mass DEP Permits and/or Applicable Regulations

Wetlands and Waterways
310 CMR 10.000
Water Quality Certificate
314 CMR 9.00
Surface Water Standards
314 CMR 4.00
Air Pollution
310 CMR 7.00
Solid Waste
310 CMR 16.00
Hazardous Waste
310 CMR 30.00
Bureau of Waste Site Cleanup
310 CMR 40.000

III. Permit Discussion

Bureau of Water Resources

Wetlands Protection Act

As described in the EENF, the project proposes to alter the following regulated wetland resource areas: Bordering Vegetated Wetland, Bordering Land Subject to Flooding, Riverfront Area. The proposed stream-crossings have the potential to alter Inland Bank and Land Under Waterbodies and Waterways. During the WPA permitting process, the Proponent will need to demonstrate how the project will protect the interests of the Act.
This project is subject to the Wetlands Protection Act (WPA) and the associated regulations. In the event a municipal Order of Conditions is appealed to MassDEP, MassDEP cannot issue a Superseding Order of Conditions (or a Water Quality Certificate) until after the Project has received a final Certificate from the Secretary. Therefore, to ensure full opportunities for public involvement and to avoid any potential conflict with the final Certificate from the Secretary or the Water Quality Certificate (WQC), MassDEP recommends that no such filing occur until after the project has received a final Certificate from the Secretary. Should the Proponent choose to file Notices of Intent prior to the issuance of a final Certificate from the Secretary, MassDEP recommends that Proponent request that the local conservation commissions defer a decision and keep the meeting open until such time as a final Certificate from the Secretary has been issued, as well as the WQC.

Limited Project Status

The project may be eligible for review under the Limited Project provisions contained at 310 CMR 10.53(3)(d). As for all Limited Projects, allowance under these provisions is at the discretion of the local Commission and to the extent practicable, work must comply with the General Performance Standards.

The proposed project has the potential to result in significant changes to the hydrology of the affected resource areas and downstream reaches. Therefore, the WPA permit applications for this project should consider both surface and subsurface hydrology, wildlife habitat, and comply with Best Management Practices for stormwater management and sedimentation and erosion control. Subsequent WPA permitting documents should include tree work details, time-of-year restrictions, specific locations of proposed construction mats, and implementation sequencing; as well as identifying appropriate mitigation for impacts to resource areas.

401 Water Quality Certification

The Proponent indicates the project will require a 401 Water Quality Certification (WQC). The MassDEP Wetlands program administers the WQC program on behalf of the US Army Corps of Engineers. Under regulation, 314 CMR 9.00, the Proponent is required to provide sufficient information to adequately describe cumulative impacts to "Waters of the Commonwealth" (isolated and bordering vegetated wetlands and land under water). During the WQC permitting process the Proponent will be required to document efforts to avoid, minimize, and mitigate impacts as required by regulation. Mitigation for any unavoidable impacts is a requirement of the regulations. Appropriate mitigation measures will be determined as part of the WQC application process. MassDEP staff are available for consultation.

In accordance with the MEPA process, some Resource Areas and Waters of the Commonwealth impacts are listed as "temporary" in the EENF; the Proponent should be aware that the WPA and associated regulations do not have a designation of "temporary impacts" to resource areas. The activities proposed in the EENF meet the definition of "Alter" contained in 310 CMR 10.04. The WQC regulations, 314 CMR 9.00 specifically include "temporary" activities as being subject to the regulations (310 CMR 9.02). However, temporal impacts to resource areas can be mitigated through "in-situ" replication and/or restoration, as well as via off-site considerations.

The Proponent indicates that the project is subject to the requirements of the National Pollutant Discharge Elimination System regulations to prepare a Stormwater Pollution Prevention Plan (SWPPP). MassDEP recommends that the Proponent ensure that the SWPPP includes clear, concise, and enforceable provisions specific to the management and protection of the wetland resource areas and their buffer zones within the project site. The Project Proponent indicates that several types of retaining walls may be constructed. These walls are proposed to protect existing structures and/or features, as well as adjacent wetland resource areas. The Proponent indicates that the specific retaining wall type will be chosen *during construction*, based on local geotechnical conditions and other site constraints. MassDEP wishes to clarify that the area and extent of impacts of any proposed retaining wall within a resource area, or within the buffer zone of a resource area, should be identified, all impacts disclosed and should avoid, minimize and mitigate impacts to the greatest extent practicable. Although some elements of the wall design may wait for identification during construction, the construction cannot exceed the impacts proposed in the Order of Conditions for the project.

Outstanding Resource Waters

In the Water Resources Section of the EENF Form, the Proponent checked the box indicating that no ORWs are present on or within a ½ mile of the project site; however, the Proponent then lists relevant ORW and the narrative sections describe work in ORWs. It appears this box was checked in error. MassDEP recommends the Proponent review and ensure that the correct box is checked.

The Proponent has identified one potential vernal pool where temporary construction mats are proposed. Because the estimated project commencement date is 2025, MassDEP recommends that the Proponent assess the area in question prior to any WPA or WQC filing (i.e., during Spring of 2023) to determine if the area in question meets the criteria for classification as a certified vernal pool.

Bureau of Water Resources-Boston Office

Wetlands

The proposed activities will substantially change and/or enlarge an existing service, and therefore the activity does not qualify as exempt from the WPA as maintenance pursuant to 310 Code of Massachusetts Regulations (CMR) 10.02(a)2.

The project may qualify to be permitted as a limited project pursuant to 310 CMR 10.53(3)(d) provided that no such project may be permitted which will have any adverse effect on specified habitat sites of Rare Species, as identified by procedures established under 310 CMR 10.59 (unless a variance is issued). Additionally, the proponent should document why the project qualifies for limited project status per 310 CMR 10.53(3) given the magnitude of the alteration and the significance of the project site to the interests of the Wetlands Protection Act; and the proponent should provide a serious evaluation of reasonable alternatives to the proposed activity (including alternatives to reduce the full extent of the proposed cutting), an evaluation of the extent to which adverse impacts are minimized, and documentation that full mitigation is provided for unavoidable impacts. Based on this demonstration, a Variance to the WPA regulations may be required pursuant to 310 CMR 10.05(10).

Based on the information provided in the EENF, a WQC application for Major Fill/Excavation (BRP WW 10) will be required since the Project is proposed to result in the loss of more than 5000 square feet cumulatively of ordering vegetated wetland (BVW) and land under water (LUW) (314 CMR 9.04(1)) and since there will be a discharge of dredge or fill material to Outstanding Resource Waters including Goodfellow Pond, Simonds Pond, Notown Reservoir, Distributing Reservoir, Morse Reservoir, Fall Brook Reservoir, and Perley Brook Reservoir. Furthermore, a Variance to the 401 WQC will be required pursuant 314 CMR 9.08 since the project will result in a discharge of dredged or fill material in wetlands or waters of the Commonwealth within 400 feet of a Class A surface water (314 CMR 9.06(4)).

The Applicant must demonstrate that all efforts have been made to avoid adverse impacts to BVW. When avoidance is not possible, demonstration must be made that the impacts have been minimized and that unavoidable impacts have been mitigated. The Draft Environmental Impact Report must identify all temporary and permanent roads and/or routes in relation to resource areas that will be utilized for mechanized equipment to be engaged in tree clearing and on-going vegetation management. The proposed route bed should be identified (e.g., swamp mats to be placed at-grade, gravel roads, etc.). The Environmental Impact Reports should analyze alternatives to avoid and minimize adverse impacts to BVW and propose alternatives to mitigate for resource area alteration.

Erosion and sediment control is required during the tree clearing and land destabilization phase pursuant to 310 CMR 10.05(6)(b) and Stormwater Management Standard 8 (310 CMR 10.05(6)(k)8. and 314 CMR 9.06(6)(a)8.). As such, a plan must be submitted with the Notice of Intent and WQC application to control construction related impacts including erosion, sedimentation, and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan (CP/PP Plan)). The CP/PP should include measures to reduce potential impacts to resource areas from areas used to store swamp mats and felled trees. Use of feller-bunchers during clearing, trimming, and removal operations should be analyzed as one alternative to reduce erosion and sediment control impacts to resource areas. Working from swamp mats should also be considered. However, any temporary impacts caused to resource area from swamp mats must be proposed to be fully mitigated. The proponent should note that the requirements at 310 CMR 10.05(6)(b), 10.05(6)(k)8., and 314 CMR 9.06(6)(a)8. to provide erosion and sediment controls apply even if the project qualifies as a limited project. The Environmental Impact Reports should include a conceptual level Erosion and Sediment control plan for comment. Note that any land disturbance greater than 1-acre requires coverage under the U.S. Environmental Protection Agency’s Construction General Permit (CGP). The Stormwater Pollution Prevention Plan (SWPPP) required by the CGP may serve as the CP/PP Plan, if it includes measures required to be in the CP/PP Plan in addition to the measures specifically required by the EPA Construction General Permit. The CP/PP Plan or SWPPP will need to be approved in the Final Order of Conditions and WQC prior to the commencement of any tree clearing and disturbance within resource areas.

If a project is within Estimated Habitat indicated on the most recent habitat map of State-Listed Rare Species published by the Natural Heritage and Endangered Species Program (NHESP), the applicant must demonstrate no short- or long-term adverse effects of habitat of local species in accordance with 310 CMR 10.59. The Environmental Impact Reports should overlay the proposed scope of work atop the Estimated Habitat maps. Where tree clearing and disturbance is proposed within Estimated Habitat of Rare Species, the Environmental Impact Reports should analyze alternatives to avoid adverse impacts.

The project activities including on-going vegetation management through numerous areas of Habitat of Potential Regional or Statewide Importance (MassDEP Important Habitat Maps can be found at: https://umasscaps.org/data_maps/massdep-maps.html); therefore, the applicant must submit a Detailed Habitat Evaluation and demonstrate no adverse impacts in accordance with 310 CMR 10.60 and MassDEP's *Massachusetts Wildlife Habitat Protection Guidance for Inland Wetlands* at: https://www.mass.gov/doc/massachusetts-wildlife-habitat-protection-guidance-for-inland-wetlands/download.

Although a Detailed Evaluation is required for permitting, the Environmental Impact Reports should include an alternatives analysis to avoid adverse impacts that may be caused by on-going vegetation management. This shall include an analysis of Potential Vernal Pools and NHESP Certified Vernal Pools in each Resource Area and identify those that are presumed significant in accordance with the *Massachusetts Wildlife Habitat Protection Guidance for Inland Wetlands*. Certified Vernal Pools are classified as Outstanding Resource Waters of the Commonwealth. Potential Vernal Pools should be analyzed by the proponent to determine whether they are eligible to be certified and present the results of this analysis in the Environmental Impact Reports.

Based on the EENF, the project will result in permanent fill in Bordering Land Subject to Flooding (BLSF) due to 632 square feet of concrete caissons. Compensatory flood storage must be provided for any fill in BLSF. Compensatory flood storage is a volume not previously used for flood storage and shall be incrementally equal to the theoretical volume of flood water at each elevation, on a foot-by-foot basis. The Applicant must demonstrate that seasonal high groundwater is at or below the elevation which the compensatory flood storage will be provided. The Environmental Impact Reports should analyze alternatives to provide the compensatory flood storage and provide a cut-and-fill table for each alternative analyzed.

The Applicant shall demonstrate that the proposed compensatory flood storage has an unrestricted hydraulic connection to same waterway or water body displaced by the Project as stated in 310 CMR 10.57(4)(a)(1). The compensatory flood storage analyzed in the Environmental Impact Reports must be proposed near where the fill is proposed so as to provide an unrestricted connection to the same waterway.

The Draft Environmental Impact Report must include an analysis about Stormwater Management. Removal of trees increases the peak runoff rate, triggering compliance with

310 CMR 10.05(6)(k)2. and 314 CMR 9.06(6)(a)2. 10.05(6)(k)2. applies to alterations in resource areas regardless of if the project qualifies as a limited project. Alternatives must be analyzed in the Draft Environmental Impact Report to reduce the peak runoff rate from the proposed alterations, including tree clearing. Tree clearing increases the peak runoff rate. Besides traditional methods to provide mitigation such as detention basins, replacement of trees should be analyzed as an alternative to reduce the peak runoff rate. Any trees replaced would need to be within the same sub-watershed to be considered as peak rate mitigation. A discussion should be included about canopy area lost due to the project and estimate the time period likely to recover the same or larger tree canopy. The recharge and TSS treatment standards apply when impervious area is being created or redeveloped. Towards those requirements, a discussion should be included in the Draft Environmental Impact Report about whether the proposed caissons or access roads will create new impervious area. Special requirements apply to Critical Areas, such as Outstanding Resource Waters (310 CMR 10.05(6)(k)6. and 314 CMR 9.06(6)(a)6.).

The Draft Environmental Impact Report should note whether any temporary or permanent stream crossings are proposed. If any crossings are proposed, the Draft Environmental Impact Report should include an alternatives analysis to ensure that the crossing will be designed to facilitate aquatic organism and wildlife passage, and not increase flood levels of the resource area. Any stream crossing should meet the criteria listed in 310 CMR 9.06(2)(b).

Bureau of Water Resources-Central Regional Office (CERO)

Alternatives Analysis

The Alternatives Analysis provided by the Proponent does not discuss whether the Rebuild Alternative can be accomplished with fewer impacts to the environment. MassDEP requests that the Proponent consider additional alternatives of the Rebuild Alternative that further reduce impacts to wetlands, forests, and water resources.

Wetlands

Section 4.4.1 of the EENF lists fifteen streams that have been designated by the Massachusetts Division of Fisheries and Wildlife as cold-water fishery resources. The Proponent should provide additional measures to avoid and minimize impacts to these streams both during construction and in the long-term maintenance of the A1/B2 Transmission line and associated easement. In addition, cold-water fishery resources are designated as Critical Areas in the Massachusetts Stormwater Handbook. The Proponent must account for the presence of these streams in the stormwater analyses of the project.

Bureau of Air and Waste

Air Quality

Construction Activities
Construction activity must conform to current Air Pollution Control Regulations. The Proponent should implement measures to alleviate dust, noise, and odor nuisance conditions that may occur. Such measures must comply with the MassDEP's Bureau of Air and Waste (BAW) Regulations 310 CMR 7.01, 7.09, and 7.10.

Construction Equipment
All non-road engines shall be operated using only ultra-low sulfur diesel (ULSD) with a sulfur content of no greater than 15 ppm pursuant to 40 CFR 80.510.

Solid Waste
The Proponent shall properly manage and dispose of all solid waste generated by this proposed project pursuant to 310 CMR 16.00 and 310 CMR 19.000, including the regulations at 310 CMR 19.017 (waste ban).

Hazardous Waste
Any hazardous wastes generated must be properly managed in accordance with 310 CMR 30.0000. If any hazardous waste, including waste oil, is generated at any of the sites, the Proponent must ensure that such generation is properly registered with MassDEP and managed in accordance with 310 CMR 30.0000.

Asbestos
Proponent shall ensure that all material is handled in accordance with all applicable state and federal regulations regarding asbestos handling, including testing prior to handling.

Bureau of Waste Site Cleanup

The proposed project encompasses a large geographic area. There are several identified sites regulated under the Massachusetts Contingency Plan (MCP) with identified release tracking numbers (RTNs). Sites include those that are "open" and closed; some with Response Action Outcomes and/or Permanent Solutions (with or without conditions) and sites with an Activity and Use Limitation (AUL). The Proponent is advised to retain a Licensed Site Professional to review MassDEP's oil and/or hazardous material disposal sites list and associated files periodically throughout the duration of the project to determine the current status of existing sites and if there are any newly listed contaminated sites within or adjacent proposed activities. The MCP details procedures to follow for the parties conducting work in these areas. In particular, in accordance with 310 CMR 40.1070 (2), activities conducted near sites with an AUL must be consistent with the obligations and conditions specified within the AUL.

In addition, a spills contingency plan addressing prevention and management of potential releases of oil and/or hazardous materials from pre- and post-construction should be presented to workers at the site and enforced. The plan should include but not be limited to, refueling of machinery, storage of fuels, and potential releases. MassDEP wishes to emphasize the importance of this specifically in proximity to Cold Water Fisheries and ORW.

BWSC CERO identified one RTN (2-12349-Pratts Junction Substation, Sterling), which is the one identified in the filing. This site had historical releases of mineral oil dielectric fluid (MODF) within the confines of the substation, reported to MassDEP in 1998. MODF-impacted soil was excavated, and an A-3 Response Action Outcome was filed in 2002. There are two Activity and Use Limitation areas within the electric substation. The Proponent stated that no subsurface work will be conducted in the Pratts Junction Substation for the Project. Therefore, there is limited potential impact to the Project from site conditions.

IV. Other Comments/Guidance

Greenhouse Gas (GHG) Emissions

The Proponent indicates that GHG emissions from the project will be below the applicable reporting threshold and that during the construction phase of the project, short-term localized air quality effects will be minimal. GHG impacts should be submitted in the Draft and Final EIR. MassDEP recommends distinguishing both short term (construction) and any long-term impacts from the proposed work.

Draft Section 61 Findings

The Proponent provides no mitigation for land alteration or wetland impacts beyond measures required by regulations associated with the Massachusetts Wetlands Protection Act and related stormwater requirements. MassDEP requests that the Proponent offer additional meaningful mitigation measures to offset the environmental impacts in project areas where impacts to wetlands and undisturbed forests cannot be avoided or minimized.

MassDEP staff are available for discussions as the project progresses. If you have any questions regarding this comment letter, please do not hesitate to contact Kathleen Fournier at (413) 755-2267.

Sincerely,

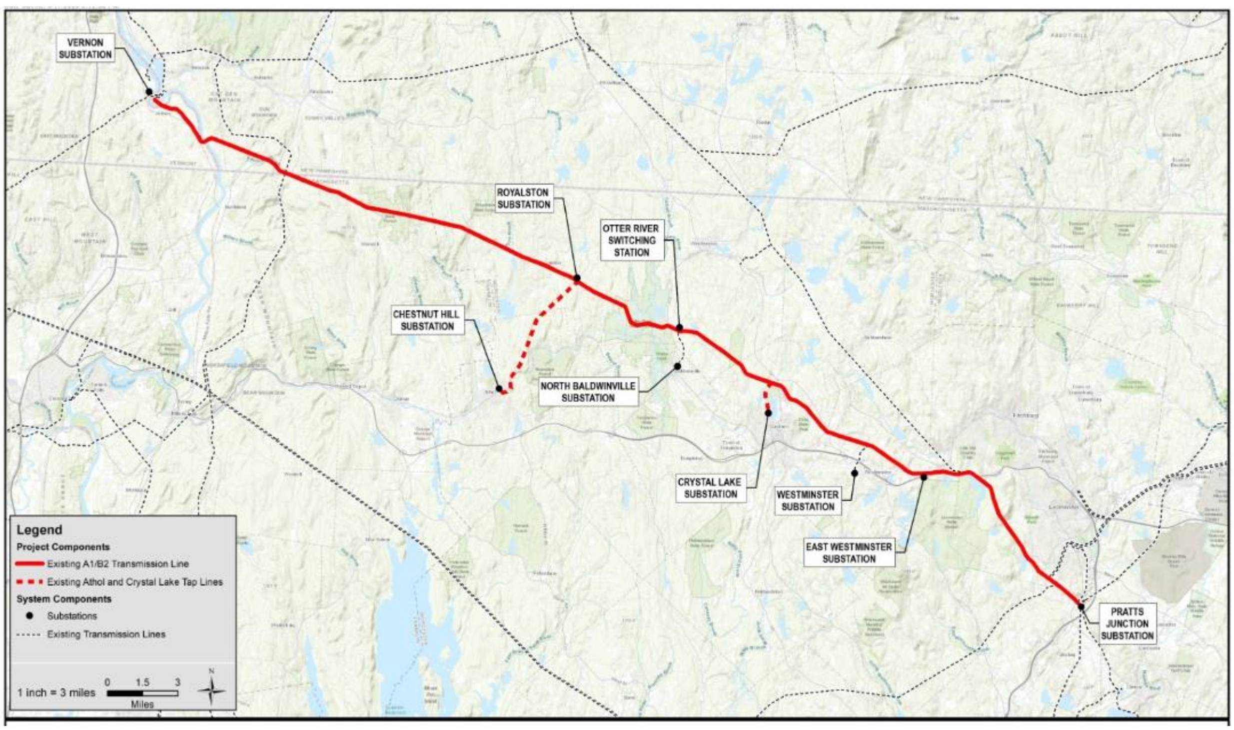
Catherine V. Skiba, P.G. for
Michael Gorski
Regional Director

cc: MEPA File

May 2023

New England Power Company d/b/a National Grid
A1/B2 Asset Refurbishment Project

Application to Support the Petition before the Energy Facilities Siting Board
EFSB 23-02, Attachment A



Warwick, Royalston, Athol, Winchendon, Gardner,
Westminster, Fitchburg, Leominster, & Sterling, Massachusetts

This document has been reviewed for Critical Energy Infrastructure Information (CEII)

nationalgrid

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Glossary

Acronym	Description
ACEC	Areas of Critical Environmental Concern
ACSS	Aluminum Conductor, Steel Supported
APR	Agricultural Preservation Restriction
BESS	Battery Energy Storage Systems
BMPs	Best Management Practices
BOS	Board of Selectmen
BVW	Bordering Vegetated Wetland
CE	Conservation Easement
CEII	Critical Energy Infrastructure Information
CELT	Capacity Energy Loads and Transmission
CMP	Conservation and Management Permit
CMR	Code of Massachusetts Regulations
CR	Conservation Restriction
CVP	Certified Vernal Pool
dBa	A-weighted decibels
DCR	Massachusetts Department of Conservation and Recreation
DER	Distributed Energy Resources
DEIR	Draft Environmental Impact Report
DGA	Designated Geographic Area
DPU	Department of Public Utilities
EEA	Executive Office of Energy and Environmental Affairs
EG-303NE	National Grid's ROW Access, Maintenance and Construction Best Management Practices
EHS	Extra High Strength
EIR	Environmental Impact Report
EMF	Electric and Magnetic Fields

Acronym	Description
EENF	Expanded Environmental Notification Form
EJ	Environmental Justice
Eversource	NSTAR Electric Company d/b/a Eversource Energy
FATV	Fitchburg Access Television
FCA	Forward Capacity Auction
GHG	Greenhouse Gas
gpm	Gallons Per Minute
G&W	Genesse &Wyoming
GWSA	Global Warming Solutions Act
Hz	Hertz
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IPAC	USFWS Information for Planning and Consultation
ISO-NE	Independent System Operator – New England
I-91	Interstate Route 91
I-190	Interstate Route 190
km	kilometer
kV	Kilovolt
MassDEP	Massachusetts Department of Environmental Protection
MassDOT	Massachusetts Department of Transportation
MassGIS	Massachusetts Geographic Information System
MBTA	Massachusetts Bay Transportation Authority
MECo	Massachusetts Electric Company d/b/a National Grid (also referred to as the Company)
MEPA	Massachusetts Environmental Policy Act
MESA	Massachusetts Endangered Species Act
mG	Milligauss
MHC	Massachusetts Historical Commission
MVA	Mega Volt Amp

Acronym	Description
MW	Megawatt
MWPA	Massachusetts Wetlands Protection Act
NEP	New England Power Company d/b/a National Grid (also referred to as the Company)
NERC	North American Electric Reliability Corporation
NESC	National Electrical Safety Code
NHD	USGS National Hydrography Data
NHESP	Natural Heritage and Endangered Species
NPCC	Northeast Power Coordinating Council
NRHP	National Register of Historic Places
NWA	Non-Wires Alternative
OATT	Open Access Transmission Tariff
OPGW	Optical Ground Wires
ORW	Outstanding Resource Waters
PAC	Planning Advisory Committee
PAR	Pan Am Railways
PAS	Pan Am Southern
PCN	Section 404 Pre-Construction Notification
PH	Priority Habitat
PNF	Project Notification Form
PSC	Public Service Commission
PV	Photovoltaic
P&W	Providence and Worcester Railroad
ROW	Right-of-Way
SCADA	Supervisory Control and Data Acquisition
SIS	System Impact Studies
Siting Board	Massachusetts Energy Facilities Siting Board
SWCA	SWCA Environmental Consultants

Acronym	Description
SWPPP	Stormwater Pollution Prevention Plan
TGP	Tennessee Gas Pipeline
TMLWP	Templeton Municipal Light and Water Plant
TMP	Traffic Management Plan
USGS	United States Geological Survey
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VELCO	Vermont Electric Power Company
WCE	Wildlife Conservation Easement
WCMA	Western and Central Massachusetts Area

1 PROJECT OVERVIEW

1.1 INTRODUCTION

New England Power Company d/b/a National Grid ("NEP" or the "Company") submits this application ("Application") to the Energy Facilities Siting Board (the "Siting Board") as Attachment A to its petition, filed pursuant to G.L. c. 164, § 69J ("Section 69J Petition"), seeking approval for the A1/B2 Asset Condition Refurbishment Project (the "Project"). The Project will be located within an existing electric transmission line right-of-way ("ROW") that extends from NEP's Vernon Substation #13 in Vernon, Vermont, and passes through portions of Vermont, New Hampshire, and central Massachusetts, before terminating at NEP's Pratts Junction Substation #225 in Sterling, Massachusetts.

This ROW is currently occupied by two 69 kilovolt ("kV") overhead transmission circuits known as the A1 and B2 transmission lines ("A1/B2 Lines"). These lines extend approximately 53.5 miles from Vernon Substation to Pratts Junction Substation; however, the length of the A1/B2 Lines in Massachusetts is approximately 47 miles through the municipalities of Warwick, Royalston, Winchendon, Gardner, Westminster, Fitchburg, Leominster, and Sterling. The A1/B2 Lines are supported primarily by approximately 575 steel, double circuit lattice tower structures that date back to 1909 when the A1/B2 Lines were first constructed.

The Project involves the removal of the existing double circuit towers and the rebuilding of the A1/B2 Lines (referred to as the "Existing Lines" and the "Rebuilt Lines") in Massachusetts. The Existing Lines must be rebuilt because they are approaching the end of their asset life, have a poor operating history and provide insufficient capacity to interconnect renewables and other green technology to the electric grid. The new towers will be weathering steel, double circuit, davit arm monopole structures, with an average height of 95 feet. The new structures will be constructed slightly offset from the centerline of the Existing Lines within the existing ROW. The Company will replace the existing 2/0 copper conductor with 795 MCM Aluminum Conductor, Steel Supported ("ACSS") conductor and the existing shield wire with two Optical Ground Wires[1] ("OPGWs"), which will increase the reliability and capacity of the Existing Lines and improve communication between stations. Although the Company initially plans to operate the Rebuilt Lines at 69 kV, the Rebuilt Lines will be designed to support future operation at 115 kV to provide flexibility in meeting future transmission system needs.

The Project also includes the reconstruction of two of the five tap lines associated with the A1/B2 Lines: the Athol Tap Lines and the Crystal Lake Tap Lines[2] (referred to as the "Existing Taps" and the "Rebuilt Taps") and the construction, reestablishment, and improvement of access routes. The Athol Taps are two parallel single circuit lines, each approximately six miles long, that pass through Royalston and connect the A1/B2 Lines with the Chestnut Hill Substation #702 in Athol. The Crystal Lake Taps are two parallel single circuit lines, each approximately 1.2 miles long, that connect the A1/B2 Lines with the Crystal Lake Substation #610 in Gardner.

[1] An optical ground wire or an optical fiber composite overhead ground wire is a type of cable that combines the functions of grounding and communications.

[2] The other tap lines that are not being rebuilt as part of the Project include the Westminster Tap Lines that connect the A1/B2 Lines to the Westminster Substation #602 in Westminster, the Templeton Tap Line, that connects the A1/B2 Lines to the North Baldwinville Substation (Templeton Municipal), and the East Westminster Tap Lines that connect the A1/B2 Lines to the Westminster Substation #609 in Westminster.

As with the Existing Lines, the Existing Taps have a poor operating history and have insufficient capacity to interconnect renewables to the electric grid. The Existing Taps are currently supported on wood pole single circuit structures and will be replaced generally with steel pole single circuit structures.[3] The Company will replace all 158 of the structures along the Tap Line ROWs. The Rebuilt Taps will also be reconductored with 795 MCM ACSS with two OPGWs and will operate at 69 kV, but will be designed to support future operation at 115 kV.

As discussed further in *Section 4*, the Company proposes construction of the Rebuilt Lines and Taps along the route of, and in the same ROWs as, the Existing Lines and Taps because this route is superior to any other potential route given the need to provide continued transmission service to the eight switching stations and substations between Vernon Substation and the Pratts Junction Substation. Constructing the Project along other routes would result in increased costs, schedule delays, and new and/or increased impacts to human and natural environments. Figure 1-1 depicts the location of the Existing Lines and Taps, which are also shown on the United States Geological Survey ("USGS") quadrangle base map in Appendix 5-1.

Contemporaneous with the filing of the Section 69J Petition, NEP filed a petition with the Department of Public Utilities ("DPU") requesting a determination that the Project is necessary and will serve the public convenience and be consistent with the public interest in accordance with G.L. c. 164, § 72 ("Section 72 Petition").

[3] The southernmost portion of the Athol Taps will be reconstructed on double circuit structures to reduce overall project impacts and enhance constructability.

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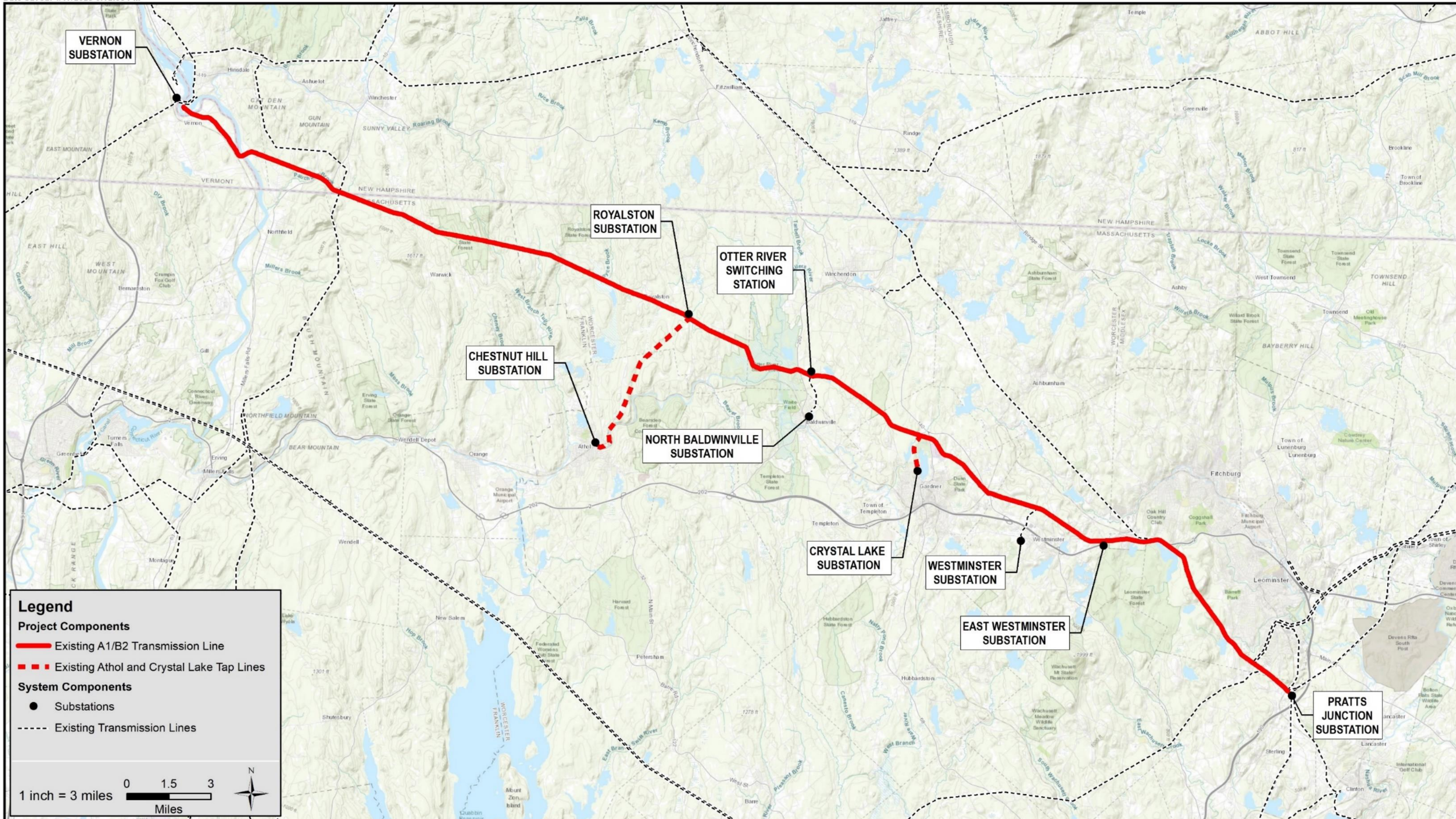


A1/B2 Asset Condition Refurbishment Project

nationalgrid
BSC GROUP

Figure 1-1

United States Geological Survey (USGS) Locus Map

1.2 OVERVIEW OF APPLICATION

The balance of *Section 1* presents an overview of the Project. The remaining sections of this Application provide detailed information and analysis to support the Project, specifically the need for the Rebuilt Lines (*Section 2*), a comparison of Project alternatives (*Section 3*), a description of the route evaluation process that was used to determine the optimal route for the Rebuilt Lines (*Section 4*), a detailed analysis of the Project's impacts on the natural and social environment, including mitigation of those impacts (*Section 5*), and an analysis of the Project's consistency with the health, environmental protection, resource use, and development policies of the Commonwealth of Massachusetts (*Section 6*).

1.3 PROJECT NEED

The Existing Lines, which were originally constructed in 1909, reconductored in the 1920s and reinsulated in 2004, are among the oldest transmission lines in New England and are supported by the original lattice structures. They are the sole transmission source for approximately 24,000 customers in twelve Massachusetts municipalities and must be replaced as they are approaching the end of their asset life and have intrinsic flaws in their structural configuration, which has resulted in poor reliability. The Existing Lines are among NEP's worst performing transmission lines with 35 outage events having occurred during the five-year period between 2017 and 2021, including two that resulted in extended customer outages. This poor performance is due in large part to the original structure design, which makes the Existing Lines particularly susceptible to lightning damage and avian interaction. The Company also has identified physical issues on a large number of structures on both the Existing Lines and Taps, contributing to the poor performance of the lines. In addition, the Existing Lines and Taps do not have sufficient thermal capacity to support the connection of proposed and future distributed energy resources ("DER") to the electric grid.[4] Lastly, the Independent System Operator – New England ("ISO-NE") found in its Western and Central Massachusetts 2029 Needs Assessment ("2029 Needs Assessment"), issued in May 2020, that even without proposed DER, equipment at multiple substations served by the Existing Lines would be subject to low voltage conditions under certain contingencies as early as June 1, 2022. Thus, the need for the Rebuilt Lines is imminent.

The Existing Lines and Taps must be replaced to allow NEP to continue to meet regional demands for a reliable supply of electricity and will support connection of increasing amounts of renewable energy in central and western Massachusetts, consistent with the Commonwealth's and region's carbon reduction targets. Accordingly, as discussed in *Section 2*, the Existing Lines and Taps must be replaced in the near term.

1.4 PROJECT ALTERNATIVES

In accordance with Siting Board precedent, NEP evaluated a series of Project alternatives for the potential to meet the identified need and to determine the approach that best balances reliability, cost, and environmental impact.

Section 3 summarizes the analyses used to identify and evaluate alternative means of meeting the identified need. These include: (1) a No-Build Alternative; (2) a Non-Wires Alternative ("NWA"); (3) a Critical Asset Repair Alternative; (4) a Repair and Reconductor Alternative; and (5) a Rebuild Alternative. After determining that rebuilding the Existing Lines and Taps was the only alternative that could meet all the identified needs, the Company assessed two transmission structure designs for the Rebuilt Lines - rebuilding

[4] DER are small-scale energy resources usually situated near sites of electricity use, such as solar photovoltaic ("PV") and battery energy storage systems ("BESS").

the Existing Lines to operate at 69 kV or rebuilding the Existing Lines to support future operation at 115 kV. The Company determined that the Project as proposed – rebuilding the Existing Lines to support future operation at 115 kV along the existing ROW – will most effectively provide a reliable energy supply with the least impact on the environment at the lowest reasonable cost, as well as support long term electric load growth.

1.5 THE PROJECT ROUTE

Section 4 of this Application describes the process by which NEP evaluated potential route alternatives to ensure no clearly superior route was overlooked. Route selection was heavily guided by the need to connect the two termini of the Existing Lines and Taps, as well as the eight substations between them. As an initial matter, the Company identified a geographic study area (the "Study Area") that encompassed possible route options for the Rebuilt Lines and Taps. The Study Area and the routing opportunities and constraints within it are described in *Section 4*. The Company also established criteria to identify, screen and evaluate potential overhead routes. NEP assessed potential routes with a focus on maximizing the use of existing linear corridors, limiting construction constraints, and minimizing the potential for natural and social environmental impacts. After evaluating a wide array of potential route corridors and options, NEP determined that all potential alternative routes for both the A1/B2 Lines and the Taps, as compared to the route along the Existing Lines and Taps ROWs (the "Project Route"), were clearly inferior in that they would be longer, have greater environmental impacts and more significant constructability issues and, therefore, would be more costly.

1.6 SUMMARY OF PROJECT SCHEDULE AND COST

Assuming receipt of all necessary permits and approvals, construction of the Project is expected to commence in May 2025; the Rebuilt Lines and Taps are expected to be energized as installed; and all Project-related activities, including removal of the Existing Lines and Taps, are expected to conclude in December 2029.

1.6.1 Project Schedule

A summary of the major Project elements and their corresponding target milestone dates is provided in Table 1-1.

Table 1-1: Anticipated Project Schedule

Project Component	Estimated Start Date	Estimated End Date
Access Route Construction, Reestablishment, and Improvements	May 2025	June 2029
Rebuild Existing Lines and Taps	September 2025	December 2029
Removal of Existing Lines and Taps	September 2025	December 2029
ROW Restoration Where Required	Spring 2026	Fall 2030

1.6.2 Project Cost

NEP estimates that the total cost of rebuilding the Existing Lines and Taps across all three states is approximately $347.3 million. This estimate is provided with an assumed accuracy level of –

25%/+50%. Based on line length alone, NEP estimates that approximately $304 million of this cost will be incurred in Massachusetts.

1.7 CONSTRUCTION OVERVIEW AND MINIMIZATION OF IMPACTS

Section 5 describes the methodology by which the Project will be constructed, assesses the potential for environmental impacts, and describes mitigation measures that will be implemented by the Company to minimize impacts of construction on the surrounding community.

Generally, there are eight phases of construction for an overhead transmission line project: (1) removal of vegetation and ROW mowing in advance of construction; (2) installation of soil erosion and sediment controls; (3) construction and improvements to access; (4) structure work pads and construction staging areas; (5) installation of foundations and transmission structures; (6) installation of overhead conductor and OPGW; (7) removal and disposal of existing transmission line components; and (8) restoration and stabilization of the ROW. Several phases of construction may be ongoing simultaneously in different sections of the route. The various construction activities occur as a progression of work activities along the ROW and each transmission structure location will be visited intermittently to complete each phase of construction.

Potential impacts from Project construction will include temporary traffic congestion, construction noise, and sediment generation. As discussed in *Section 5,* the Company has thoroughly assessed the potential for impacts to the environment and surrounding community as a result of the Project, and has avoided, minimized, or mitigated those impacts. The Project is simultaneously undergoing review pursuant to the Massachusetts Environmental Policy Act, GL c. 30, §§ 61 through 62L ("MEPA"). NEP submitted an Expanded Environmental Notification Form ("EENF") on September 12, 2022. On October 31, 2022, the Secretary of Energy and Environmental Affairs ("EEA") issued a Certificate on the EENF requiring the submittal of a Draft Environmental Impact Report ("DEIR"), which the Company plans to file in the summer of 2023.[5]

1.8 AGENCY AND COMMUNITY OUTREACH

NEP is committed to working with municipal officials, local businesses, residents, communities along the Project Route, and any interested stakeholders to provide proactive and transparent communication throughout the life of the Project. NEP's initial outreach efforts have been aimed at providing notification to abutting landowners of activities within the ROW and briefing local officials and other stakeholders on the need for the Project, providing details regarding the Project Route and Project schedule; and detailing the permitting and siting processes, including opportunities for public input. The Company will continue these efforts throughout the licensing and permitting process and will maintain a focused communications program during and after construction. This outreach program is designed to educate and engage the Project communities, foster public participation, and solicit feedback from stakeholders. Key elements of NEP's outreach program for the Project are described below.

Open House: NEP held a virtual Open House via Zoom on February 17, 2022, to introduce the Project. NEP mailed invitations to landowners along the Project Route and to municipal officials. The Open House provided the public an opportunity to speak with subject matter experts, ask questions, and share concerns about the Project. During the Open House, NEP provided a Project overview with a focus on the need, benefits, permitting process, location, design, schedule, and anticipated construction activities, as well as a

5 The EENF for the Project is provided as Appendix 6-1, while the Secretary's Certificate on the EENF is provided as Appendix 6-2.

summary of participation opportunities for all interested persons. A recording of the Open House is posted on the Company's Project website.

Per 301 Code of Massachusetts Regulations ("CMR") 11.05(4)(b), the Company sent advanced notification in the form of a completed "Environmental Justice Screening Form" via electronic mail on June 14, 2022, by BSC to all contacts on the Environmental Justice ("EJ") Reference List provided by the MEPA Office on February 23, 2022. NEP hosted a virtual meeting pursuant to MEPA guidelines on July 11, 2022. EJ community members on the provided EJ Reference List[6] were invited to attend, in addition to the abutters within EJ communities, to learn more about the Project and its anticipated impacts on EJ community areas as identified by MEPA. Invitations were published in local publications in English and Spanish. The presentation was delivered in English with live, simultaneous Spanish interpretation by an experienced, professional interpreter in a virtual breakout room. A recording of the virtual meeting was then translated with Spanish subtitles and posted to the Project website.

Door-to-Door: The Company has reached out in-person to landowners upon request and/or as needed to discuss ongoing field activities and future use of abutter properties, i.e., access and tree trimming. Targeted door-to-door outreach is planned pre-construction.

Website: NEP hosts a Project website, **www.newenglanda1b2.com**. The website provides basic Project information, maps, regular updates, a construction process animation video, links to public filings, and contact information. The website can be viewed in English and Spanish; however, content can be translated to other languages by submitting a request through a form on the website. The website will be maintained and updated for the duration of the Project.

Project Hotline: NEP has a dedicated toll-free number (**1-844-500-3536**) for the Project. The Project hotline number is included in all Project outreach materials, including, mailings, the website, and at all community events. NEP commits to responding promptly to all inquiries received via the Project hotline. Inquiries received through the hotline are typically answered within three business days.

Project Email: NEP has designated **info@newenglanda1b2.com** as its Project email address. The email address is included in all Project outreach materials, including fact sheets, mailings, the website, and at all community events. As with the hotline, NEP commits to responding promptly to all inquiries received via the Project email.

Multilingual Materials: All printed Project community outreach materials issued since June 2022 are available in English and Spanish. Since March 2023, community outreach materials include a QR code directing recipients to the request for translation form on the Project website.

Municipal and Stakeholder Briefings: NEP has met with municipal officials and other stakeholders in Athol, Gardner, Fitchburg, Leominster, Royalston, Sterling, Warwick, Westminster, and Winchendon. A list of outreach meetings with the municipalities, regulatory agencies and other officials is provided in Table 1-2 and Table 1-3.

[6] Provided by the MEPA office as part of the MEPA Public Involvement Protocol for Environmental Justice Populations on February 23, 2022. The EJ Reference List includes statewide contacts, federal tribes, indigenous organizations, and local communities.

Table 1-2: Agency Outreach and Consultations

Date	Activities and Milestones	Interaction Type/Description
March 3, 2021	Project briefing with Department of Conservation and Recreation ("DCR")	Virtual Meeting
April 7, 2021	Project Notification Form ("PNF"), permit application, and research design submission to MHC[7] by SWCA	Report Submission
May 2022	MA Natural Heritage and Endangered Species Program ("NHESP") Consultation Meetings and Information Requests (ongoing)	Virtual Meetings and Massachusetts Endangered Species Act ("MESA") Checklist Submission
July 6, 2022	Pre-Filing Meeting with Massachusetts Department of Environmental Protection ("MassDEP") WERO ("Western Regional Office") and CERO ("Central Regional Office")	Virtual Meeting
July 18, 2022	Consultation with MassDOT	Virtual Meeting
October 17, 2022	Consultation and briefing with DCR	Virtual Meeting focused on ROW access proposal
November 2, 2022	Pre-filing/consultation meeting with ACOE	Virtual Meeting
March 7, 2023[8]	Submission of MHC report, volume I and II by SWCA	Report Submission

Table 1-3: Community Outreach

Date	Activities and Milestones	Interaction Type/Description
September 1, 2020	One Page Notification of Field Activity (Vermont, New Hampshire, Massachusetts)	Mailing
May 1, 2021	One Page Upcoming Field Activity Expectations (Vermont, New Hampshire, Massachusetts)	Mailing
October 14, 2021	Municipal Project Overview: Virtual Presentation (Massachusetts towns)	Virtual Meeting
November 23, 2021	One Page Soil Boring Phase 1 Notification	Mailing
December 14, 2021	Open House (Massachusetts) Invitation (432 recipients)	Mailing
January 6, 2022	Open House (Massachusetts) Invitation Mailing: RESCHEDULED INFO (1)	Mailing
January 14, 2022	Open House (Massachusetts) Invitation Mailing: RESCHEDULED INFO (2)	Mailing
February 17, 2022	Open House: Massachusetts Virtual Presentation	Virtual Open House - Open to all Massachusetts towns along Project Route

[7] SWCA has submitted revised research designs and additional permits, such as state archaeologist permit and permit modification to include access road improvements since then, and MHC permit modification acceptance letter was received on April 8, 2022.
[8] Received an MHC report review letter and concurrence on March 31, 2023.

Date	Activities and Milestones	Interaction Type/Description
April 7, 2022	Joint Pre-Filling Meeting with MEPA Director and Executive Office of EEA EJ Office	Virtual Meeting
June 13, 2022	www.newenglanda1b2.com	Website Launch
June 14, 2022	MEPA EJ Screening Form	Electronic Mailing - Sent to EJ Reference List
June 15, 2022	Website Announcement Notification	Mailing – Included website link and Project contact info – to 300 foot abutters
July 1, 2022	EJ Engagement Public Meeting Invitation	Mailing - Sent to EJ Reference List and abutters in EJ Communities and posted in local online and print publications
July 11, 2022	EJ Community Virtual Meeting	Virtual Meeting
August 5, 2022	Field Activity Postcard	Mailing - Field activity notification - to 100 foot abutters
September 7, 2022	Project Information Letter and EENF Filing Announcement	Mailing - To 300 foot abutters
October 6, 2022	Notice of Remote MEPA Consultation and In-Person Site Visit	Electronic Mailing - Sent to EJ Reference List
January 18, 2023	Project Information and Activity Update	Mailing - To 500-foot abutters
February 21, 2023	Presentation to Royalston BOS	In-Person Meeting - Presented Project to BOS: Project need, design, location, permitting, schedule, construction activities
February 21, 2023	Presentation to Fitchburg City Council (Aired on Fitchburg Access Television ("FATV") and live via web link)	In-Person Meeting - Presented Project to City Council (aired on FATV): Project need, design, location, permitting, schedule, construction activities
March 13, 2023	Presentation to Westminster Select Board	In-Person Meeting - Presented Project to Select Board: Project need, design, location, permitting, schedule, construction activities
March 22, 2023	Presentation to Athol Board of Selectmen ("BOS")	In-Person Meeting - Presented Project to BOS: Project need, design, location, permitting, schedule, construction activities. Aired on local TV and radio stations.
March 23, 2023	Correspondence with Royalston Historic Commission	Virtual Meeting with Email Follow-up - Provided Project overview and responded to several questions, including the option to relocate Structure 262.

Date	Activities and Milestones	Interaction Type/Description
April 24, 2023	Presentation to Leominster City Council	In-Person Meeting

Construction Community Outreach Plan: NEP will execute a comprehensive construction community outreach plan to keep landowners, businesses, and municipal officials, including fire, police, and emergency personnel, updated on planned construction activities. NEP will notify abutting landowners and municipal officials of its planned construction start date and work schedule prior to commencing construction and will work closely with both groups to limit construction impacts. In addition to the Project website and hotline, this outreach plan will include:

- Targeted door-to-door outreach throughout construction to notify landowners of upcoming activities and to address any questions or concerns they may have. Translation services will be made available as requested.
- In-person pre-construction briefings with municipalities and other stakeholder groups.
- Regular email updates to municipal officials and any other stakeholders requesting this form of communication.
- Periodic communications with abutters and other stakeholders providing advance notice of scheduled construction activities. Written communications will be provided in English and Spanish.
- Meetings, emails, and phone calls with concerned landowners will be held on a case-by-case basis.
- Upon request, meetings with affected landowners prior to each major stage of construction.

1.9 CONCLUSION

NEP proposes to rebuild its A1/B2 Lines and the Athol and Crystal Lake Tap Lines with steel pole structures, conductor, and OPGW designed to operate at 115 kV. The Rebuilt Lines and Taps will address underlying issues associated with the Existing Lines and Taps and will enhance reliability, increase resilience, and allow for easier future maintenance. In addition, the upgraded infrastructure will enable the Company to connect proposed renewable energy projects to the electric grid. The Company seeks authority to construct the Project to fulfill its obligations to ensure the safe and reliable transmission of power to its customers with a minimum impact on the environment at the lowest possible cost.

As described above and as demonstrated throughout this Application, the Project also will "serve the public convenience and is consistent with the public interest," consistent with the requirements of Section 72. Given the operational history of the Existing Lines and Taps, the Project is needed to address system reliability requirements. Further, NEP extensively considered potential alternatives to, and the environmental impacts of, the Project and has avoided and minimized environmental impacts and proposed appropriate mitigation for those impacts. As such, the Project meets the standards applicable under Section 72 for authorization to construct and operate its transmission facilities.

For the reasons described in greater detail in this Application, NEP has demonstrated that the Project is consistent with Siting Board and DPU standards and precedent on need, alternatives, routing, and minimization of environmental impacts under G.L. c. 164, § 69J, and therefore should be approved.

2 PROJECT NEED

2.1 INTRODUCTION

The NEP transmission system is an integral part of the regional power system delivering electricity to customers throughout New England. To maintain the integrity of this system, NEP must ensure that adequate transmission capacity exists to meet existing and projected load requirements, and that reliability, safety, and environmental objectives are met.

NEP's Existing Lines were constructed in 1909 to bring hydropower generated in Vermont along the Connecticut River south to serve electric customers in central Massachusetts. As the region continued to develop, the A1/B2 Lines were tapped in several locations to serve the needs of regional electric customers. Today, the Existing Lines continue to bring hydropower to Massachusetts and provide electricity to twelve cities and towns in Massachusetts Electric Company's ("MECo") service territory and to customers of the Templeton Municipal Light and Water Plant ("TMLWP").

Recent analyses and studies demonstrate that these century-old transmission lines are no longer fit-for-purpose and need to be rebuilt. Specifically:

- The Existing Lines have a long history of poor performance related to the original design of their structures. Despite numerous attempts to address these issues, recent performance data demonstrate that the Existing Lines continue to be among the least reliable on NEP's transmission system. In the five years between 2017 and 2021, the two Existing Lines experienced a total of 35 outage events, including two that resulted in extended customer outages. During the same period, 85% of NEP's transmission lines experienced an average of one event or fewer annually, and only 6% experienced more than two events per year. The two lines collectively experienced six additional outage events in 2022, including one that resulted in an extended customer outage.
- A 2019 review of the condition of the Existing Lines found physical issues on 221 out of 575 existing structures in Massachusetts. The review also identified broader physical issues (e.g., insufficient shielding angles when compared to industry standard and close, tall trees along the ROW) that likely contribute to the poor performance of the Existing Lines.
- NEP studies issued in 2019, 2020, and 2022 demonstrate that the A1/B2 Lines have insufficient thermal capacity to interconnect proposed DER along the A1/B2 transmission corridor. As a result, multiple solar photovoltaic ("PV") and Battery Energy Storage Systems ("BESS") projects proposing to interconnect to these lines are on hold.
- ISO-NE's Western and Central Massachusetts 2029 Needs Assessment, issued in May 2020, found that even without the proposed DER, equipment at multiple substations along the A1/B2 corridor currently would be subject to low voltage conditions under certain N-1 and N-1-1 contingencies.[9]

In light of these many concerns, NEP proposes to replace the Existing Lines and Taps with Rebuilt Lines and Taps within existing ROWs in Massachusetts. The Rebuilt Lines and Taps will be designed with additional capacity to meet known and anticipated future requirements, including the interconnection of new DER, and increasing transfers of power over time to support electrification within the Commonwealth. The Project will also address the existing voltage concerns identified by ISO-NE and provide an upgraded

[9] Transmission planning studies typically assess the reliability of the transmission system under N-0 (all-facilities-in), N-1 (all-facilities-in, first contingency), and N-1-1 (first contingency, 30 minutes of allowable system adjustments, second contingency) conditions.

communications path between NEP's Pratts Junction and Vernon Substations by installing OPGW to allow for high-speed communication between the remote ends of the Rebuilt Lines. As further discussed in *Section 3*, the Rebuilt Lines and Taps will initially be operated at 69 kV but will be designed to allow for future operation at 115 kV, should this become necessary in the future.

Section 2.2 provides a description of the Existing Lines and Taps and their role in the regional transmission system. *Section 2.3* discusses the operating history and current condition of the Existing Lines and Taps and the need to replace these assets. *Section 2.4* describes NEP and ISO-NE planning studies that document the need for capacity and voltage upgrades to the Existing Lines and Taps to meet present and future requirements. *Section 2.5* describes an ongoing ISO-NE planning study that addresses potential long-term needs for additional transmission capacity across New England to support New England state climate and renewable energy policies. Finally, *Section 2.6* summarizes the need for the proposed Project.

2.2 DESCRIPTION OF THE EXISTING TRANSMISSION SYSTEM

NEP owns and operates two, double circuit 69 kV lines, designated A1 and B2, which extend approximately 53.5 miles from NEP's existing Vernon Substation in Vernon, Vermont through portions of Vermont, New Hampshire, and central Massachusetts, and terminate at NEP's Pratts Junction Substation in Sterling, Massachusetts. These lines are part of the interconnected New England transmission system, carrying network power flows and supplying distribution load-serving substations in Massachusetts and Vermont. The lines also connect DER resources in central and western Massachusetts and hydrogeneration facilities in Vermont to the transmission system.

2.2.1 Substations, Switching Stations, and Tap Lines

Multiple tap lines, switching stations, and substations are located along the route of the Existing Lines between the Vernon and Pratts Junction Substations. From north to south, these include:

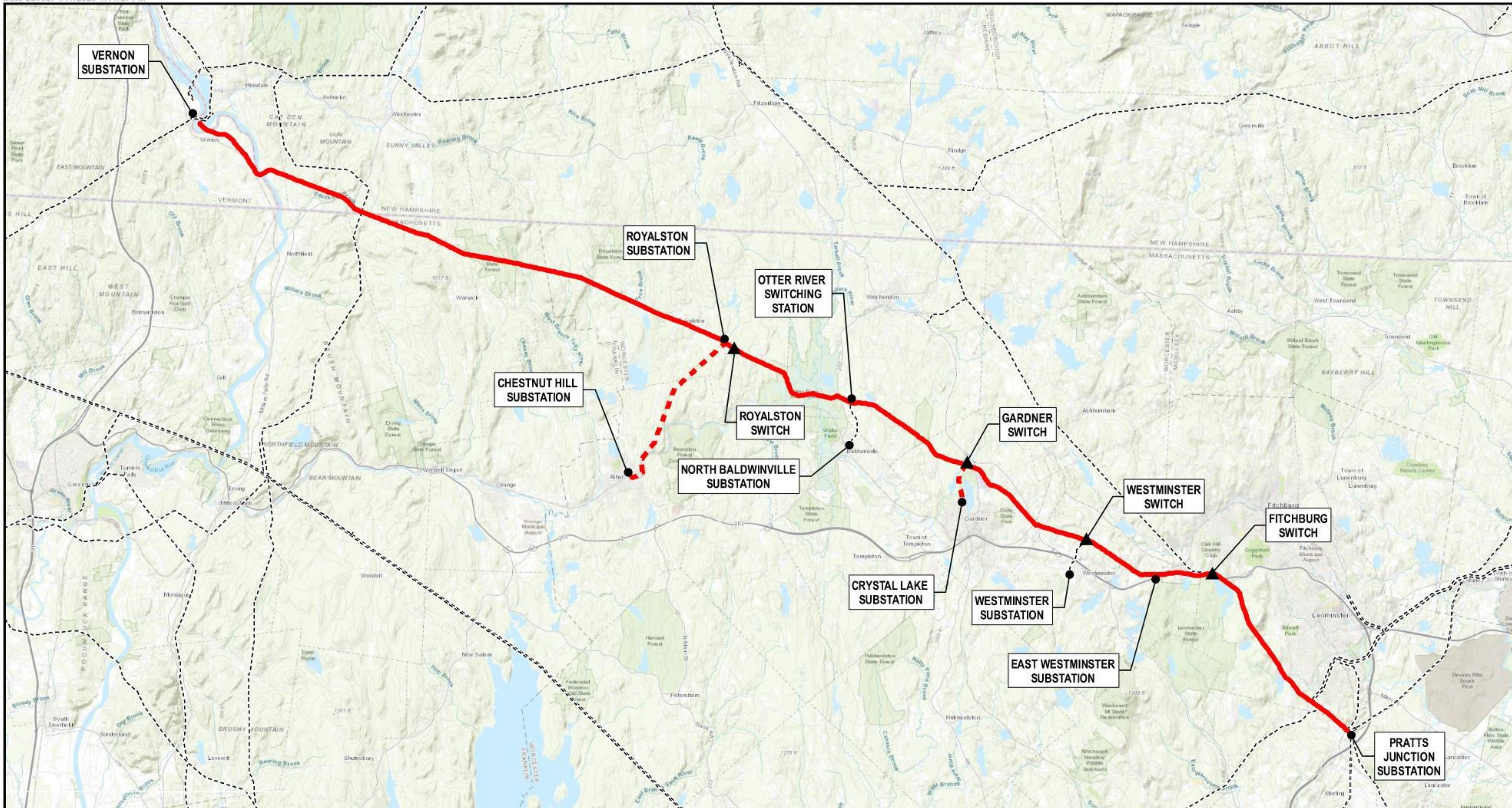
- **Royalston Substation**: NEP's Royalston Substation #701 in Royalston serves MECo customers in Royalston and Athol.
- **Athol Taps and Chestnut Hill Substation:** NEP's Athol Tap Lines #1 and #2 ("Athol Taps") extend for approximately 6.0 miles from the Royalston Switch just south of the Royalston Substation to NEP's Chestnut Hill Substation #702. The Chestnut Hill Substation serves MECo customers in Athol, Royalston, Warwick, Orange, New Salem, Petersham, and Phillipston.
- **Otter River Switching Station, North Baldwinville Taps, and North Baldwinville Substation**: NEP's North Baldwinville Taps extend approximately 1.5 miles from NEP's Otter River Switching Station in Winchendon to TMLWP's North Baldwinville Substation #682 in Templeton. The North Baldwinville Substation serves TMLWP customers in Templeton. The Otter River Switching Station does not directly serve customer load.
- **Crystal Lake Taps and Substation**: NEP's Crystal Lake Tap Lines #1 and #2 extend approximately 1.2 miles from the Gardner Switch to NEP's Crystal Lake Substation #610. The Crystal Lake Substation serves MECo customers in Gardner and Winchendon.
- **Westminster Taps and Substation:** NEP's Westminster Taps extend approximately 1.2 miles from a series of switches located in the ROW at the tap point to the Westminster Substation #602 in Westminster. The substation serves MECo customers in Westminster, Hubbardston, and Gardner.

- **East Westminster Substation:** NEP's East Westminster Substation #609 in Westminster interconnects with the Existing Lines via single span radial taps. The substation serves MECo customers in Westminster and Hubbardston.

Figure 2-1 shows the location of the Existing Lines and interconnected switchgear, substations and tap lines. A one-line diagram of the existing transmission system is provided as Figure 2-2[10].

[10] Figure 2-2 refers to the Crystal Lake Tap Lines as the Gardner Taps.

File Location: G:\GISPrj\8962066\Output\Maps\MXD\ReportMaps\RouteAnalysis\RouteAnalysis_PDFTemplates\A1B2_Fig2-1_ExistingLines_20230406.mxd
Date Saved: 4/17/2023 4:14:27 PM



A1/B2 Asset Condition Refurbishment Project

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Figure 2-1

Existing Lines and Interconnected Switchgear, Substations and Tap Lines.

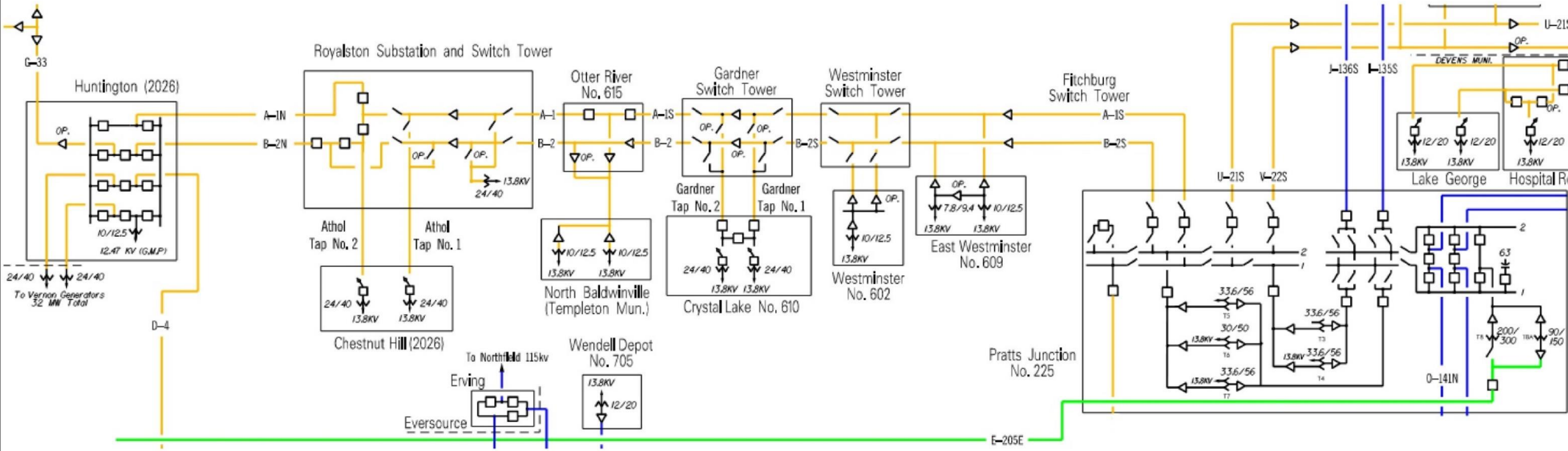

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Figure 2-2

One-line Diagram of the Existing Transmission System

2.2.2 Summer Peak Load

As shown in Table 2-1, approximately 24,000 electric customers in twelve Massachusetts cities and towns are served from substations connected to the Existing Lines. The 2022 summer peak load for the substations served from the Existing Lines is approximately 89.3 megawatts (MW). The Existing Lines are the only transmission supplies to these six substations.

Table 2-1: 2022 Summer Peak Load served from Existing A1/B2 Lines

Substation	Customers	Load (MW)	Towns Served
Royalston	463	0.9	Royalston Athol
Chestnut Hill	5208	21.5	Athol Royalston Warwick Orange New Salem Petersham Phillipston
North Baldwinville (TMLWP)	3600	13.0	Templeton
Crystal Lake	8010	28.2	Gardner Winchendon
Westminster	4055	12.7	Westminster Hubbardston Gardner
East Westminster	2727	13.0	Westminster Hubbardston

2.3 A1/B2 OPERATING HISTORY AND ASSET CONDITION

2.3.1 Description of the Existing Lines and Taps

NEP proposes to replace the Existing Lines, the Athol Taps, and the Crystal Lake Taps as part of the Project. The existing structures, conductors and shielding are briefly described below.

Within Massachusetts, the Existing Lines consist of a total of approximately 575 structures centered within the existing ROW extending from the Vermont/Massachusetts border to Pratts Junction Substation. The existing structures are steel, double circuit lattice towers approximately 50 to 60 feet in height above ground. The existing transmission conductor consists of 2/0 copper wire, protected primarily with 3 strand #4 copper clad steel shield wire. A representative cross-section of the Existing Lines is provided as Figure 2-3 and Appendix 5-3.

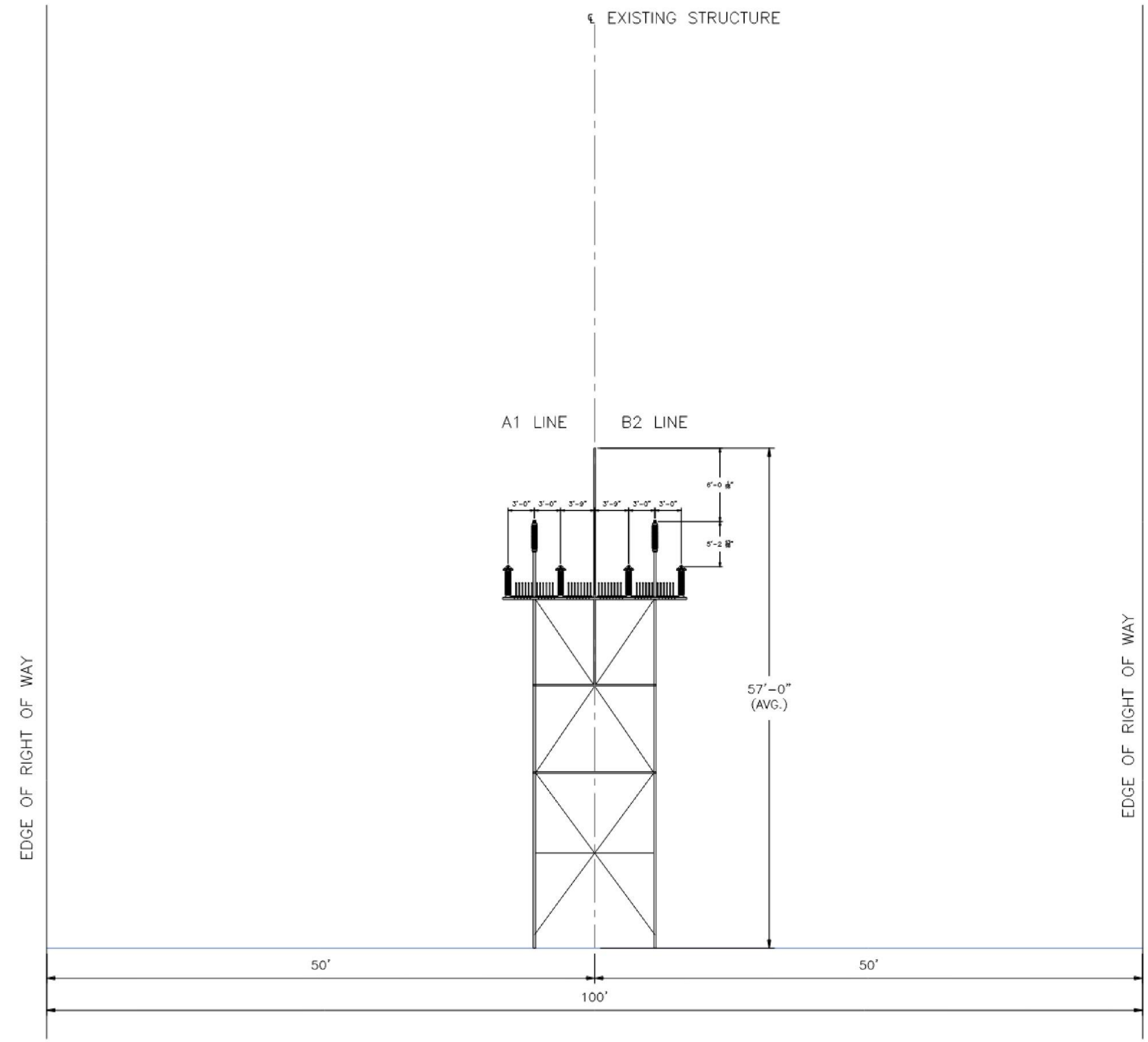

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Figure 2-3

A representative cross-section of the Existing Lines

The majority of the structures on the Existing Lines were installed when the A1/B2 Lines were originally energized. Over the years, the Existing Lines have been subject to several refurbishments, relocations, and modifications to ensure that safe and reliable service is maintained. The A1/B2 Lines were first reconductored in the early 1920's. During this project, a lightning mast was added to the original towers and a shield wire was installed to mitigate lightning-related outages. Subsequent projects on the Existing Lines to enhance reliability have included the installation of 88 kV insulators in the 1980's, selective installation of coupling wire in not less than two separate efforts to determine the effects on lightning performance and, most recently, the complete replacement of all existing post insulators on the existing structures with 115 kV post insulators. This insulator replacement project, completed in the early 2000's, also included the installation of insulator covers to minimize the potential for avian interaction, tower bridge mounted bird deterrents to prevent nesting, replacement of all clevis type insulators with ball and socket insulators and the removal of all underslung coupling wire as it had provided no tangible benefit to performance and was deteriorating. In the intervening years, the tower bridge bird deterrents and insulator covers have been consistently maintained in an effort to reduce avian related outage issues.

The Athol Tap Lines each extend for approximately 6.0 miles from the Royalston Switch to the Chestnut Hill Substation. The Athol Taps consist of a mix of wood single circuit H-Frame and Chair Frame structures approximately 34 to 70 feet in height above ground. The existing transmission conductor on both Athol Taps consists of 2/0 copper wire; the shield wires on both Athol Tap #1 and Athol Tap #2 are 3/8" Extra High Strength ("EHS") steel wire. A representative cross-section of the Athol Taps is provided as Figure 2-4 and in Appendix 5-3.

The Crystal Lake Tap Lines each extend for approximately 1.2 miles from the Gardner Switch to the Crystal Lake Substation. The Crystal Lake Taps consist of wood single circuit double-arm suspension structures approximately 39 to 48 feet in height above ground. The existing transmission conductor on the Crystal Lake Taps consists of 2/0 copper wire. The Crystal Lake Tap Lines do not have a shield wire. A representative cross-section of the Crystal Lake Taps is provided as Figure 2-5 and in Appendix 5-3.

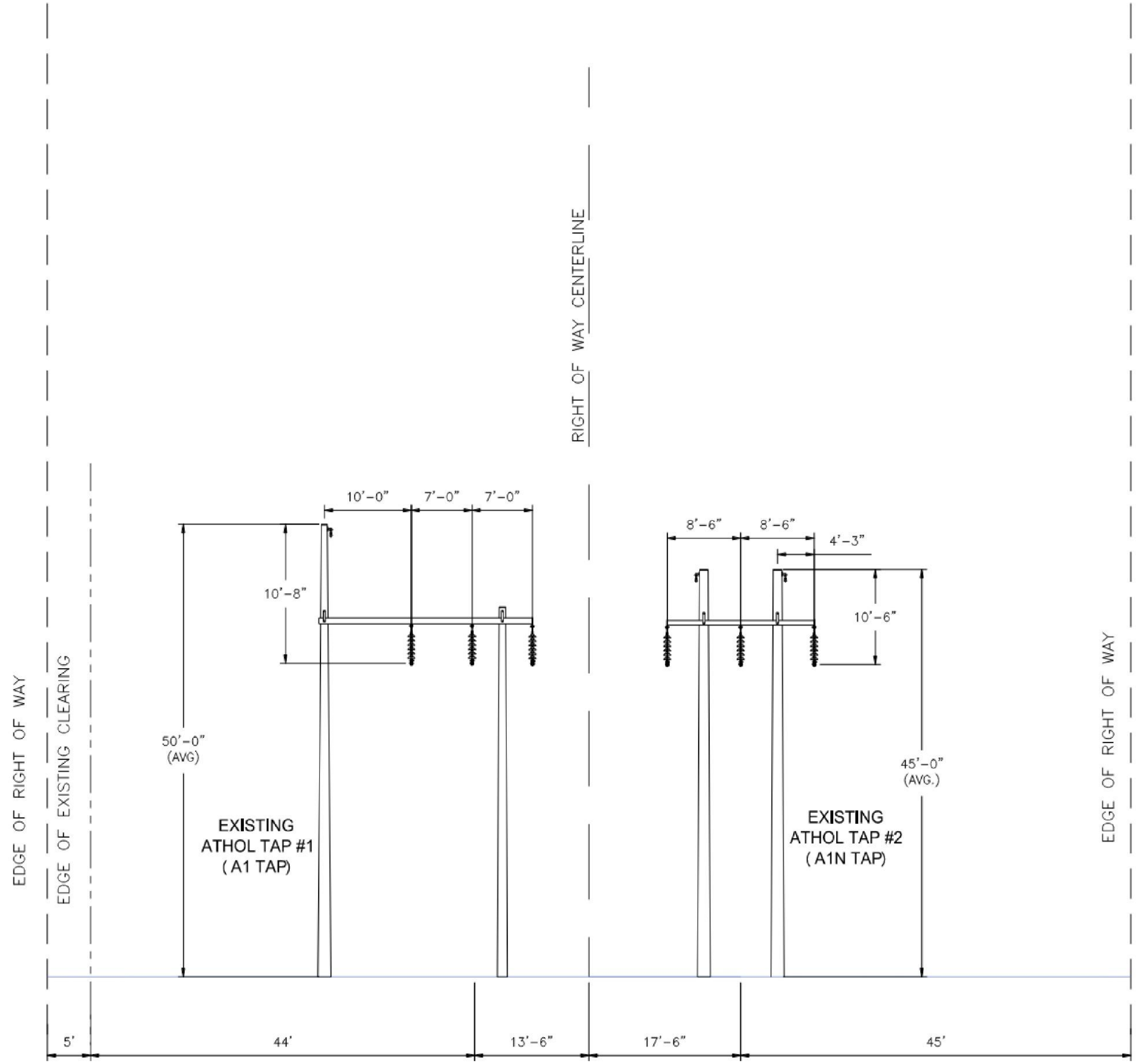

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Figure 2-4

A representative cross-section of the Athol Taps

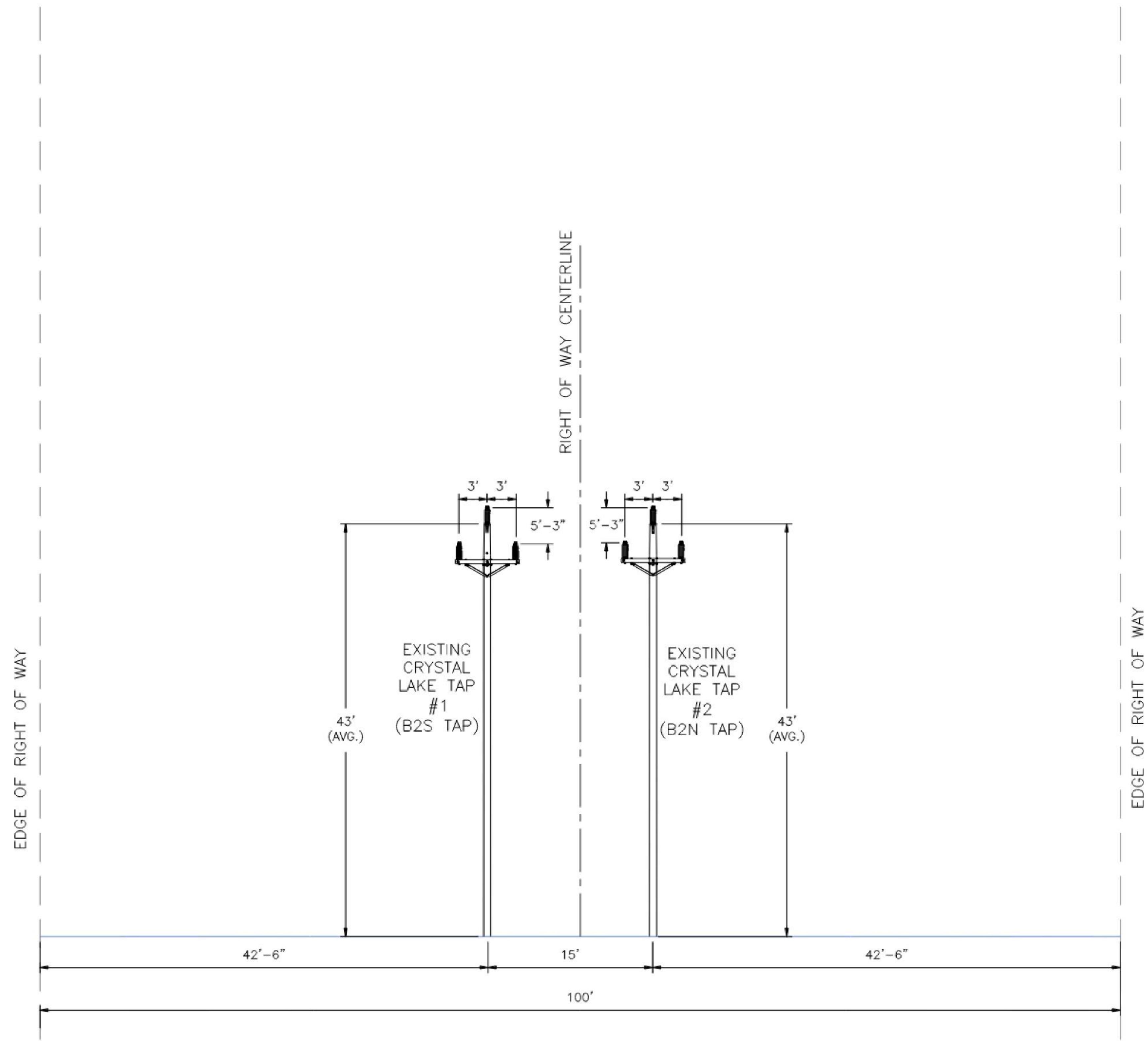

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Figure 2-5
A representative cross-section of the Crystal Lake Taps

2.3.2 Operating History

The Existing Lines historically have been among the least reliable lines on the NEP transmission system, consistently experiencing an unusually high rate of outages associated with lightning strikes, vegetation contacts, and thunderstorms. These issues persist today. As shown in Tables 2-2 and 2-3, the A1 Line experienced 22 trip-and-reclose or lock-out events[11] in the five years between 2017 and 2021; similarly, the B2 Line experienced 14 such events over the same period. In comparison, 85% of NEP's transmission lines experienced five or fewer events during this period, and only 6% experienced ten or more events. The A1 Line had the highest incident count of all 176 NEP lines during this period while the B2 Line ranked seventh.[12]

Table 2-2: A1 Line Outage History, 2017-2021

Circuit	Outage Date	Outage Duration (Minutes)	Cause	Weather
A1	3/18/21	215	Other	Light rain/Calm to light wind
A1	5/19/21	< 1	Unknown	Fair/Calm to light wind
A1	6/1/21	< 1	Other	Fair/Calm to light wind
A1	9/13/21	< 1	Lightning	Thunderstorms
A1	9/15/21	< 1	Lightning	Thunderstorms
A1	11/16/21	< 1	Unknown	Fair
A1	7/2/2020	2	Weather	Thunderstorms
A1	7/1/2020	< 1	Lightning	Thunderstorms
A1	7/1/2020	< 1	Unknown	Heavy rain/Calm to light wind
A1	6/28/2020	223	Weather	Thunderstorms
A1	5/15/2020	< 1	Weather	Thunderstorms
A1	10/16/2019 to 10/18/19	2368	Vegetation	Heavy rain/Severe wind
A1	10/11/2018	< 1	Unknown	Fog/Calm to light wind
A1	9/2/2018	334	Unknown	Fair/Calm to light wind
A1	8/17/2018	< 1	Lightning	Thunderstorms
A1	8/17/2018	< 1	Lightning	Thunderstorms
A1	7/17/2018	553	Weather	Thunderstorms
A1	6/18/2018	< 1	Vegetation	Thunderstorms
A1	12/12/2017	< 1	Unknown	Fair/Calm to light wind
A1	6/30/2017	< 1	Lightning	Thunderstorms
A1	6/4/2017	< 1	Unknown	Light rain/Mild wind
A1	1/1/2017	637	Unknown	Fair/Calm to light wind

[11] A trip-and-reclose event (also referred to as a momentary outage) is defined by NERC as an automatic outage with a duration of less than one minute that the transmission system can reclose (or return to service) without further intervention. A lock-out event (also referred to as a sustained outage) is an outage with a duration greater than a minute that typically requires corrective action along a circuit prior to re-energization.

[12] NEP annually ranks the performance of its transmission lines based on their importance to the transmission system and the frequency of incidents over a rolling five-year period. This ranking is used to identify transmission lines in urgent need of improvement to maintain customer reliability. The A1 Line was among the 20 worst performers in both 2019 (for the period 2014-2018) and 2020 (for the period 2015-2019).

Table 2-3: B2 Line Outage History, 2017-2021

Circuit	Outage Date	Outage Duration (Minutes)	Cause	Weather
B2	9/13/21	< 1	Lightning	Thunderstorms
B2	8/4/2020 to 8/5/20	1027	Vegetation	Heavy rain/Major Storm
B2	7/1/2020	< 1	Lightning	Thunderstorms
B2	1/30/2020	< 1	Unknown	Fair/Calm to light wind
B2	7/28/2019	< 1	Lightning	Thunderstorms
B2	7/10/2019	< 1	Unknown	Fair/Calm to light wind
B2	7/6/2019	< 1	Lightning	Thunderstorms
B2	2/25/2019	< 1	Weather	Freezing rain or sleet/Strong wind
B2	9/2/2018	< 1	Unknown	Fair/Calm to light wind
B2	8/17/2018	< 1	Lightning	Thunderstorms
B2	6/18/2018	< 1	Vegetation	Thunderstorms
B2	6/30/2017	< 1	Lightning	Thunderstorms
B2	3/2/2017	< 1	Weather	Fair/Calm to light wind
B2	2/25/2017	< 1	Weather	Thunderstorms

As shown in Tables 2-2 and 2-3, two of these transmission line outages resulted in extended customer outages, including a seventeen-hour outage on the B2 Line in 2020 affecting over 5,700 customers, and an approximately 3.5-hour outage on the A1 Line in 2021 affecting 829 customers. Five additional extended outages on the A1 Line – including one that lasted over 39 hours – left customers at increased risk in the event of an incident affecting the B2 Line. Momentary outages may also have significant impacts on customers with sensitive equipment that can be taken offline or damaged by momentary voltage fluctuations.

Table 2-4: Line Outage Counts by Cause, 2017-2021

Line	Cause					
	Lightning	Weather	Vegetation	Other	Unknown	Total
A1	5	4	2	2	8	21
B2	6	3	2	0	3	14
Total	11	7	4	2	11	35

Table 2-4 provides a summary of the causes of outages on the Existing Lines during the 2017-2021 period. As can be seen from Table 2-4, lightning strikes accounted for eleven events, while downed trees contributed to four. Another seven took place during storms but could not be tied definitively to either lightning strikes or vegetative interference. One event was associated with logging activities in proximity to the ROW, and another with avian interference.

In eleven cases, no cause could be definitively identified. NEP believes that at least some of these are associated with avian interference. It can be difficult to find physical evidence to support the hypothesis of avian interference as a cause of a specific incident, as the bird involved would be quickly removed by scavengers. However, the lattice tower structure design provides an attractive location for roosting and nesting activities that contribute to avian interference, and many of the recorded outages took place during calm, fair weather when other explanations are less likely. The configuration of the existing structures, with phases supported on insulators above a crossarm, lends itself to birds perching or nesting on the crossarm thereby placing themselves physically between conductors of different electrical phases. This condition can lead to a bird reducing the air insulation between those phases causing a flashover[13] and an outage. Several types of devices intended to deter avian roosting and nesting have been installed on the existing A1/B2 structures. While some types have produced measurable reductions of outages potentially attributable to avian activity, others have not, and operational experience has found the deterrent devices are easily broken or detached.

Preliminary data from NEP's Interruption and Disturbance System indicate that unusually high outage rates on the Existing Lines continued through calendar year 2022 and into 2023. As shown in Table 2-5, the A1 Line experienced four outage events in 2022, including one that resulted in an extended customer outage, and another tree related outage event in January 2023. The B2 Line experienced one outage event in 2022.

Table 2-5: Raw Outage Data, 2022-2/16/2023

Circuit	Outage Date	Outage Duration (Minutes)	Customers Out (Y/N)
A1	2/17/22	681	N
A1	3/7/22 to 3/8/22	1,108	Y
A1	8/14/22	>1	N
B2	8/26/2022	11	N
A1	11/2/22	<1	Y
A1	1/23/23	29	N

The sub-optimal performance of Existing Lines despite having been refurbished and modified indicates that the existing structure configuration and shielding angle are insufficient, regardless of the frequency of maintenance, to fully address both the lightning and avian interaction issues present since initial energization.

2.3.3 Asset Condition Study

In 2019, NEP conducted a review of the physical condition of the Existing Lines and Taps to identify any issues that might negatively affect the service reliability of the lines. This review included both a field inspection of accessible critical structures and drilled pier foundations and a desktop review of aerial photography for the full length of the lines and taps. The results of this review are provided in NEP's April 2019 *Inspection Report: A1/B2 Asset Condition Refurbishment* ("Inspection Report"), which is provided as Appendix 2-1. The Inspection Report identified numerous concerns with the physical condition of structures on the Existing Lines and Taps, including:

[13] A flashover is an electric short circuit made through the air between exposed conductors.

- Structural member buckling, light corrosion, and rusted hardware on lattice towers,
- Woodpecker damage on wood poles, and missing or damaged pole caps,
- Crossarm deterioration, and
- Flashed, damaged or leaning insulators.

In all, physical issues were identified on 221 out of the 575 existing structures inspected on the Existing Lines in Massachusetts. In addition, physical issues were identified on 139 out of the 201 existing structures on the Athol Taps, and 12 out of the 48 existing structures on the Crystal Lake Taps. A detailed analysis of structural issues on the Existing Lines and Taps can be found in Appendix 2-1.

Although the Inspection Report focused on the condition of individual structures, it also identified design and ROW issues that could contribute to the poor performance of the Existing Lines. In particular, the Inspection Report noted that:

- "Based on visual inspections, the shielding angle on the Existing Lines and the Athol Taps appears to be greater than the 30 degrees currently recommended in RUS Bulletin 1724E-200. This results in a higher probability of flashover of the insulation during lightning strikes and potential reliability issues during storms." Inspection Report at 3.
- "The entire ROW is characterized by very close and high trees." Inspection Report at 12.

These observations are consistent with, and predictive of, the types of events experienced on the Existing Lines. As shown in Table 2-4, lightning strikes account for almost one third of total line outages in the 2017-2021 period – and perhaps more, since some the outages attributed to "weather" may well be unidentified lightning strikes. The frequency of lightning-related outages reflects the insufficient shielding angle on the Existing Lines. Shielding angle is the angle between the vertical line drawn through the shield wire at the attachment point on the structure and a line between the shield wire and the outermost conductor. As noted above, present industry practice is to restrict shielding angle to 30 degrees or less. This allows the shield wire to intercept lightning strikes prior to the lightning hitting an energized conductor; this significantly reduces the potential for a flashover creating an outage. Circuits with a greater shielding angle are more likely to be directly struck by lightning causing a flashover. The lattice towers supporting the Existing Lines were originally built without shield wire. Lightning masts were installed on the existing structures after the original energization of the Existing Lines; however, the height of the lightning mast does not provide sufficient shielding angle to adequately protect the A1/B2 Lines. Replacement of the existing lighting masts with those tall enough to provide the appropriate shielding angle to the A1/B2 Lines would introduce structural deficiencies that cannot be mitigated by installing additional tower reinforcements or replacing existing structural elements. Therefore, this issue cannot be addressed without replacing the existing structures.

Similarly, the close proximity of tall trees along the ROW likely contributes to the high frequency of tree-related outages on the lines. In many areas, the abutting land just beyond the ROW is densely vegetated with tall-growing species that can easily exceed the height of the existing structures. When these trees fall or drop limbs during periods of high winds, they make contact with the existing conductors and cause either momentary or sustained outages. The configuration of the Existing Lines is generally horizontal, with the elevation of the conductors across the width of the ROW generally within 5.25 feet of each other. Additionally, the elevation of the existing conductor above grade is typically the minimum necessary to conform with the governing code. As a result, when a tall growing tree located outside the bounds of the ROW falls across the width of the ROW, there is a high probability that the vegetation will contact multiple phases and potentially both circuits supported by the existing structures. Indeed, the longest outage of the last five years, which extended from 11:26 p.m. on October 16, 2019, to 2:54 p.m. on October 18, 2019, was caused by tree damage that took down all three phases of the A1 Line in a hard-to-access flooded wetland.

2.3.4 Summary of Asset Condition

In summary, the Existing Lines are among the least reliable lines on the NEP transmission system, consistently experiencing an unusually high rate of outages associated with lightning strikes, vegetation contacts, thunderstorms, and probable avian interaction. This outage rate reflects both issues inherent in the existing structure design and the tall, dense vegetation that has sprung up along the A1/B2 ROW. As discussed in *Section 2.3.3,* the existing lattice tower structures were originally constructed without any form of lightning protection. Although lightning masts and shield wires have since been installed, the original structure design makes it impossible to create the shielding angles needed to properly protect the lines from lightning strikes. Similarly, as discussed in *Section 2.3.2*, lattice tower structures provide attractive sites for bird roosting and nesting, which increases the probability of avian interference. Further, the dense and tall vegetation along many parts of the ROW likely contributes to the frequency with which downed trees and dropped limbs interrupt power flow on the Existing Lines.

NEP's 2019 Inspection Report also has identified damage to many structures on the Existing Lines. While these could be repaired on a structure-by-structure basis, such repairs would not by themselves address existing design issues.

As can be seen in Table 2-4, the majority of outages on the Existing Lines are associated with storm conditions. These outages are likely to continue – perhaps exacerbated by an increase in storm frequency and intensity due to climate change – until their underlying causes are addressed. Consequently, there is a need to address the condition of the Existing Lines in order to improve their performance and increase reliability of service to electric customers.

2.4 NEED FOR ADDITIONAL CAPACITY AND VOLTAGE SUPPORT

In addition to the reliability needs identified in *Section 2.3*, there are documented needs for additional transmission resources along the A1/B2 corridor to facilitate the interconnection of DER and to address existing voltage issues at substations along the route of the A1/B2 Lines. Specifically, NEP has identified a need for both additional transmission capacity and voltage support to interconnect proposed solar PV and BESS projects along the A1/B2 corridor. As discussed in more detail in *Section 2.4.1* below, multiple proposed solar PV and BESS projects are on hold until the Existing Lines are upgraded. The proposed Project would provide the additional transmission capacity and voltage support needed along the A1/B2 corridor to provide for the interconnection of proposed and future DER.

ISO-NE also has identified a time-sensitive need to address the potential for low voltage conditions at substations along the A1/B2 corridor, even without additional load or DER projects. The proposed Project would address this time-sensitive need. ISO-NE's findings are addressed in *Section 2.4.2*, below.

2.4.1 NEP Western Massachusetts Cluster Studies

In recent years, developers have proposed over 550 MW of DER projects that would interconnect at more than 30 National Grid substations in central and western Massachusetts, including five substations along the A1/B2 transmission corridor. NEP conducted a series of system impact studies ("SIS") to determine whether the interconnection of these projects would result in a significant adverse impact on the reliability, stability and operating characteristics of the New England bulk power transmission system and the National

Grid transmission system. These SIS consisted of thermal, voltage, stability, and short-circuit analyses for three successive groups of proposed DER projects, known as Groups 1, 2 and 3. This series of studies is known collectively as the "Western Massachusetts Cluster Studies".

The three Western Massachusetts Cluster Studies are provided as Appendices 2-2, 2-3, and 2-4[14], respectively. Details of NEP's modelling methodology, assumptions and results can be found in these three Appendices. The Western Massachusetts Cluster Study results are summarized below.

Group 1 Cluster Study: In November 2019, NEP issued the "Transmission System Impact Study Report for Group 1 of Distributed Energy Resource (DER) Additions in Western Massachusetts" ("Group 1 Cluster Study"), which is provided as Appendix 2-2. The Group 1 Cluster Study considered 320 MW of proposed DER projects, including approximately 40 MW of projects that would interconnect at NEP's Chestnut Hill, Crystal Lake, Westminster, and East Westminster Substations, shown in Table 2-6. The study found that all proposed Group 1 projects along the Existing Lines could interconnect without transmission system upgrades.

Table 2-6: Group 1 DER by Substation (A1/B2 Line Only)

Substation	Total MW
Chestnut Hill	8.94
Crystal Lake	16.936
Westminster	4.877
East Westminster	9.96

Group 2 Cluster Study Results: In May 2020, NEP issued its "Transmission System Impact Study Results for Group 2 of Distributed Energy Resources (DER) Additions in Western Massachusetts" ("Group 2 Cluster Study"), which examined the impact of interconnecting an additional 391 MW of DER in central and western Massachusetts. As shown in Table 2-7, approximately 50 MW of Group 2 proposed to interconnect at substations along the A1/B2 Lines, in addition to the 40 MW of projects approved to interconnect for Group 1.

Table 2-7: Group 2 DER by Substation (A1/B2 Line Only)

Substation	Total MW
Chestnut Hill	1.35
Crystal Lake	30.57
East Westminster	10.251
Royalston	4.99

The Group 2 Cluster Study found that the Group 2 DER projects would cause all sections of the Existing Lines to overload under N-0 (all-facilities-in), N-1 (all-facilities-in, first contingency), or N-1-1 (first contingency, 30 minutes of allowable system adjustments, second contingency) contingencies. These overloads are summarized in Table 2.8.

[14] The 2029 Needs Assessment has been redacted for the public record in order to avoid disclosure of Critical Energy Infrastructure Information ("CEII"). An unredacted copy has been provided to the Siting Board under seal and subject to a Motion for Protective Treatment and will be provided to eligible parties who have executed CEII Non-Disclosure Agreements.

Table 2-8: Group 2 Cluster Study: Thermal Results

Element ID	Element	Contingencies Resulting in Overloads
B-2	Pratts Junction to East Westminster	N-0, N-1, N-1-1
B-2	Crystal Lake to Vernon	N-1, N-1-1
B-2	East Westminster to Crystal Lake	N-1-1
A-1	Otter River to Royalston	N-1, N-1-1
A-1	Remainder of Main Line	N-1-1

NEP determined that these potential thermal overloads could be addressed by reconductoring the Existing Lines at a higher capacity.[15] Until this work was complete, the approximately 50 MW of Group 2 DER projects located along the A1/B2 transmission corridor would not be permitted to interconnect to the transmission system. These DER projects subsequently withdrew from the ISO-NE interconnection queue and were either abandoned or resubmitted for evaluation as part of the Group 3 Cluster Study.

Group 3 Cluster Study: In June 2022, NEP issued its "Transmission System Impact Study Results for Group 3 of Distributed Energy Resources (DER) Additions in Western Massachusetts" ("Group 3 Cluster Study"), which is provided as Appendix 2-4. This study assessed the transmission system impact of interconnecting DER projects that were proposed since the Group 2 Cluster Study was issued, including three projects totaling 20.5 MW that would interconnect along the A1/B2 transmission corridor. As shown in Table 2-9, these new DER projects include one BESS and two combined BESS/solar PV projects.

Table 2-9: Group 3 DER by Substation (A1/B2 Line Only)

Substation	Technology	Total MW
Crystal Lake	BESS	8
East Westminster	PV + BESS	4.99
Royalston	PV + BESS	7.5

The Group 3 Cluster Study found that the interconnection of these projects would result in violations of thermal reliability criteria for the Existing Lines. Specifically, the study identified thermal overloads on the B2 Line under N-0, N-1, and N-1-1 contingencies, and on the A1 Line under N-1 and N-1-1 contingencies. These overloads are summarized in Table 2.10.

Table 2-10: Group 3 Cluster Study: Thermal Results

Element ID	Element	Contingencies Resulting in Overloads
B-2	Pratts Junction to East Westminster	N-0, N-1, N-1-1
B-2	East Westminster to Westminster	N-0, N-1, N-1-1
B-2	Westminster to Crystal Lake	N-0, N-1, N-1-1
A-1	Otter River to Royalston	N-1, N-1-1
A-1S	Pratts Junction to East Westminster	N-1

[15] The Group 2 Cluster Study also found that Group 2 projects triggered high voltage issues all along the A-1/B-2 69 kV lines at all load levels, for several different N-1 and N-1-1 contingency combinations. These voltage issues could be addressed by the installation of dynamic reactive compensation devices at the Otter River Switching Station.

The Group 3 Cluster Study (at 46) notes that the overloads on the Existing Lines "will be eliminated by an asset condition project already scheduled for the A1/B2 Lines which involves the complete rebuild of the lines using 795 ACSS conductor", together with upgrades to NEP's Vernon Substation in Vernon, Vermont. The referenced asset condition project is the rebuild of the Existing Lines proposed in this proceeding; a petition for approval of the Vernon Substation project is currently pending with the Vermont Public Service Commission ("PSC") in Case No. 22-5303. Until this work is complete, the three pending Group 3 DER projects located along the A1/B2 transmission corridor will not be permitted to interconnect with the transmission system.[16]

In summary, both the Group 2 and Group 3 Cluster Studies identified the potential for thermal overloads on the Existing Lines following the addition of proposed DER at substations along the two lines. The proposed DER projects – and any future projects proposed along the A1/B2 transmission corridor – cannot move forward until the Existing Lines have been replaced with higher capacity transmission lines. Consequently, there is an existing and ongoing need for additional transmission capacity along the A1/B2 corridor to support the interconnection of proposed and future DER projects.

2.4.2 ISO-NE Western and Central Massachusetts (WCMA) 2029 Needs Assessment

In administering the regional system planning process, ISO-NE conducts periodic needs assessments on a system-wide or specific-area bases, as appropriate. These needs assessments are designed to identify future system needs on the regional transmission system, or within a subarea of the system.

- As stated earlier, ISO-NE most recently studied the Existing Lines in its 2029 Needs Assessment, issued in May 2020. A copy of the 2029 Needs Assessment is provided as Appendix 2-5[17]. The 2029 Needs Assessment considered the following:
- Future load conditions as presented in the 2019 Capacity Energy Loads and Transmission ("CELT") Report;
- Reliability over a range of generation patterns and transfer levels;
- Resource changes in the western and central Massachusetts study area based on Forward Capacity Auction ("FCA") 13 results;[18]
- Retirement of resources in the western and central Massachusetts study area through FCA 14; and,
- All applicable North American Electric Reliability Corporation ("NERC"), Northeast Power Coordinating Council ("NPCC") and ISO-NE transmission planning reliability standards.

The analysis did not address requirements for interconnection of proposed DER. Rather, the study evaluated the reliability of the transmission system serving the western and central Massachusetts study area for the projected system conditions in 2029. The system was tested under N-0, N-1, and N-1-1 conditions for a

[16] The Group 3 Cluster Study also identified low and high voltage issues along the A1/B2 corridor that would be triggered by interconnection of the Group 3 DER. These voltage issues will be addressed by the addition of breakers at NEP's Royalston Substation. The Royalston breaker additions are currently in the design phase; NEP anticipates that the project will be completed before the proposed Project can be placed in service.
[17] The 2029 Needs Assessment has been redacted for the public record in order to avoid disclosure of Critical Energy Infrastructure Information ("CEII"). An unredacted copy has been provided to the Siting Board under seal and subject to a Motion for Protective Treatment and will be provided to eligible parties who have executed CEII Non-Disclosure Agreements.

[18] Vineyard Wind, Revolution Wind, and New England Clean Energy Connect had financially binding contracts and were included in the 2029 Needs Assessment. However, the A1/B2 Rebuild Project, which at that time was in the "Concept" stage of ISO-NE's planning process, was not assumed in service.

number of possible operating scenarios with respect to generating unit unavailability conditions and import levels from external areas. The following analyses were performed:

- Thermal Analysis studies to determine the level of steady-state power flows on transmission circuits under base case conditions and following contingency events.
- Voltage Analysis studies to determine steady-state voltage levels and performance under base case conditions and following contingency events.
- Short Circuit Analysis studies to determine the ability of substation equipment to withstand and interrupt fault current.

The 2029 Needs Assessment identified voltage violations at the East Westminster, Westminster, Crystal Lake, North Baldwinville (TMLWP), and Royalston Substations, as well as the Otter River Switching Station. These voltage violations were determined to be time sensitive.[19] No thermal issues were identified.

In September 2021, NEP presented the Project to the ISO-NE Planning Advisory Committee ("PAC"). Subsequently, ISO-NE reran its thermal and voltage analyses with the Project in service and issued an addendum to the 2029 Needs Assessment ("Addendum") summarizing its findings. The Addendum is provided as Appendix 2-6. The Addendum reports that, with the addition of the Project, voltage violations were no longer observed along the A1/B2 corridor. ISO-NE concluded that, since there are no criteria violations observed in the Addendum analysis, there was no need to conduct a 2029 Solutions Study.

In short, ISO-NE has identified the potential for voltage violations along the A1/B2 corridor under 2029 peak load conditions and has determined that these voltage violations are time-sensitive. It also has determined that the Project would resolve these voltage violations. Thus, there is an existing need for additional transmission resources to address voltage violations along the A1/B2 corridor under N-1 and N-1-1 conditions. This need can be met by the Project.

2.5 LONG TERM CONSIDERATIONS: ISO-NE 2050 STUDY

ISO-NE, in consultation with the New England States Committee on Energy, has launched an ongoing study of the transmission system impacts associated with meeting existing renewable energy, clean energy, greenhouse gas ("GHG") reduction and net-zero carbon policies in Massachusetts, Connecticut, Maine, Rhode Island, and Vermont through 2050 ("2050 Transmission Study"). This work, although preliminary, points to a long-term need for additional capacity across the New England transmission system to support long term electric load growth driven by these regional commitments.

Key assumptions and preliminary findings of the 2050 Transmission Study are set forth in a September 2022 presentation by Robert Ethier, Vice President of System Planning at ISO-NE, to the New England Electric Restructuring Roundtable ("Ethier Presentation"), provided as Appendix 2-7. The Ethier Presentation anticipates several paradigms shifts in New England's demand for electricity by 2050. In particular, the 2050 Transmission Study assumes that electricity consumption in New England will more than double by 2050 due to electrification of heating and transportation, with the peak demand for power shifting from summer to winter. By 2050, winter evening peak demand will be in the range of 51 to 57 gigawatts (GW). In addition, the future resource mix will shift dramatically away from natural gas toward renewables. The Ethier Presentation notes that, as of September 2022, off-shore and on-shore wind

[19] Transmission needs identified in a Needs Assessment are deemed time-sensitive if they have a year of need within three years of the completion of the Needs Assessment.

accounted for 58% of ISO-NE's interconnection queue; solar provided an additional 14%, battery storage a further 25%, and natural gas only 3%.

The Ethier Presentation reports that significant new investments in transmission may be needed to reliably serve load under these conditions. ISO-NE's modeling projects that a winter peak demand level of 57 GW would overload more than 4,000 miles, or more than half, of New England's transmission lines. At a somewhat lower winter peak of 51 GW, approximately 2,500 miles of lines would be overloaded.

In a December 13, 2022, update to the PAC, provided as Appendix 2-8, ISO-NE outlined some initial lessons learned from its early work on potential solutions to long-term transmission system needs. One of these lessons is that the full use of existing overhead transmission ROWs may be sufficient to address many load-serving concerns in 2035, 2040, and 2050. The presentation notes that the capacity of existing transmission lines may be increased by (1) reconductoring existing lines to increase current-carrying capacity; (2) replacing single conductors with double-bundled conductors; (3) rebuilding existing lines to accommodate the weight of larger conductors; and (4) upgrading lines to a higher operating voltage.

In summary, ISO-NE's 2050 Transmission Study points to the need for a significant investment in electric transmission resources over the next 25 years to meet existing renewable energy, clean energy, GHG reduction and net-zero carbon policies in New England states. Potential solutions (i.e., the specific upgrades that may be required) will be sensitive to the size and location of future generating resources and to the distribution of load. One potentially effective approach to creating this additional capacity is to increase the capacity of existing transmission lines by reconductoring them and/or operating them at a higher voltage.

NEP notes that the 2050 Transmission Study does not yet recommend specific transmission system upgrades, and that any future recommendations would necessarily be sensitive to assumptions about the geographical distribution of both future generator interconnections and future load growth. However, it provides useful context for the comparison of project alternatives. This matter is discussed further in *Section 3*.

2.6 CONCLUSION

The Existing A1/B2 Lines were built in 1909 to bring Vermont hydropower south to serve Massachusetts electric customers. Today, they continue to bring hydropower to Massachusetts, and also serve as the sole transmission source for electric customers in twelve Massachusetts cities and towns.

A review of the Existing Lines' and Taps' recent operating history, asset condition and transmission planning studies demonstrate that these more than century-old transmission lines are no longer fit-for-purpose and need to be replaced. A review of the Existing Lines recent operating history, asset condition and transmission planning studies demonstrate that these more than century-old transmission lines are no longer fit-for-purpose and need to be replaced. In particular:

- The Existing Lines and Taps are among the least reliable lines on the NEP transmission system, consistently experiencing an unusually high rate of outages associated with lightning strikes, downed trees, thunderstorms, and probable avian interactions. The existing structures have been modified several times over their asset life in an effort to improve reliability as it relates to both lightning and avian interaction issues. These efforts have not enhanced reliability to an acceptable level. This is due to the inherent constraints of the existing structures with their narrow conductor phase to phase spacing, prime construction for bird nesting/roosting, and insufficient structural capacity to support an extended lightning mast. Additionally, the tall, dense vegetation in close proximity to the ROW exposes the lines to tree falls and dropped limbs.

- The Existing Lines and Taps have insufficient thermal capacity to interconnect proposed DER along the A1/B2 transmission corridor. As a result, multiple proposed solar PV and BESS projects are currently on hold, and any future projects to connect renewables and other green technology to this part of the transmission system must be deferred until upgrades have been completed.
- Even at existing load levels, equipment at multiple substations along the Existing Lines and Taps would be subject to low voltage conditions under certain N-1 and N-1-1 contingencies.

The Project will address all of these issues, and additionally will provide an upgraded communications path between NEP's Pratts Junction and Vernon Substations. Therefore, in accordance with Siting Board standards, the Project is needed to improve system reliability and to provide additional thermal capacity and voltage support to meet existing and future needs, including the interconnection of DER.

3 PROJECT ALTERNATIVES

3.1 INTRODUCTION

This section discusses the various Project alternatives that NEP identified and evaluated for their potential to address the resource needs identified in *Section 2*. Recent analyses and studies demonstrate that these century-old transmission lines are no longer fit-for-purpose and need to be rebuilt. Specifically:

- The Existing Lines and Taps are among the least reliable lines on the NEP transmission system, consistently experiencing an unusually high rate of outages associated with lightning strikes, downed trees, thunderstorms, and probable avian interactions. The existing structures have been modified several times over their asset life in an effort to improve reliability as it relates to both lightning and avian interaction issues. These efforts have not enhanced reliability to an acceptable level. This is due to the inherent constraints of the existing structures with their narrow conductor phase to phase spacing, prime construction for bird nesting/roosting, and insufficient structural capacity to support an extended lightning mast. Additionally, the tall, dense vegetation in close proximity to the ROW exposes the lines to tree falls and dropped limbs.
- The Existing Lines and Taps have insufficient thermal capacity to interconnect proposed DER along the A1/B2 transmission corridor. As a result, multiple proposed solar PV and BESS projects are currently on hold, and any future projects to connect renewables and other green technology to this part of the transmission system must be deferred until upgrades have been completed.
- Even at existing load levels, equipment at multiple substations along the Existing Lines and Taps would be subject to low voltage conditions under certain N-1 and N-1-1 contingencies.

The sections below describe the Project alternatives considered, including a No-Build Alternative (*Section 3.2*); Non-Wires Alternatives (*Section 3.3*); a Critical Asset Repair Alternative (*Section 3.4*); a Repair and Reconductor Alternative (*Section 3.5*); and a Rebuild Alternative (*Section 3.6*). Of these, only the Rebuild Alternative addresses the full range of needs identified in *Section 2*.

In addition, the Company considered two transmission structure designs for the Rebuilt Lines: one that complies with NEP's 115 kV design standards, and a second that complies with NEP's 69 kV design standards. *Section 3.7* compares these two structure designs with respect to transmission system reliability, environmental impacts, and project cost. This comparison also considers the ability of the two designs to support long term electric load growth driven by regional commitments to address climate change through electrification and a deeper integration of renewable resources. These analyses demonstrate that the replacement of the Existing Lines with overhead lines built within the existing ROW to 115 kV specifications is the superior approach in terms of its ability to meet the identified need at the lowest reasonable cost, with the fewest environmental impacts, and with a high degree of reliability.

3.2 NO-BUILD ALTERNATIVE

Under the No-Build Alternative, the Existing Lines would remain in place in their current condition, and NEP would take no steps to address performance issues, voltage issues, or the need for additional capacity on the Existing Lines.

As discussed above, the Existing Lines are experiencing poor performance, have insufficient thermal capacity to interconnect proposed DER projects, and are subject to low voltage conditions under certain N-1 and N-1-1 contingencies at existing load levels. In short, they are no longer fit-for-purpose. The No-Build

Alternative would not address any of these issues. Because the No-Build Alternative would not meet the identified need, it was eliminated from further consideration.

3.3 NON-WIRES ALTERNATIVES

Non-wire alternatives ("NWAs") use some combination of energy efficiency and demand response programs, new distributed generation, and new energy storage facilities as alternative means of deferring or addressing the underlying need for a transmission or distribution project. NWAs generally are most feasible when the underlying need for a Project is driven by increasing load levels, so that the load reductions provided by the NWA allow an increasing number of electric customers to be served with the existing transmission and distribution infrastructure.

In this instance, however, the underlying Project need is driven in large part by the design of the Existing Lines, which are among the least reliable on NEP's transmission system. The implementation of an NWA would not address either the inherent structure constraints that predispose the Existing Lines to outages from lightning strikes and avian interference, or the proximity of tall, dense vegetation that exposes the lines to tree falls and dropped limbs. In addition, as discussed in *Section 2.4.1*, the Existing Lines do not have sufficient transmission capacity to interconnect proposed solar PV and BESS projects. These types of NWAs therefore are not alternatives to the proposed Project, but rather are dependent on it. For these reasons, NEP determined that NWAs would not meet the identified resource need and eliminated them from further consideration.

3.4 CRITICAL ASSET REPAIR ALTERNATIVE

The Critical Asset Repair Alternative, as outlined in the Project EENF, is a targeted structure repair program that would address the most pressing concerns identified in the 2019 Inspection Report. The existing structures, conductor and shield wires would remain in place; ROW and access improvements would be limited to what is required to complete the structure repair work. Actions to address most of the needs identified in *Section 2* would be deferred until a later date.

A targeted repair program like the Critical Asset Repair Alternative can be a low-cost, low-impact strategy for extending the life of transmission lines that are otherwise fit-for-service. However, it is not appropriate for the Existing Lines. A targeted repair program would leave existing structures in place, and therefore would not address the underlying reliability issues associated with the poor shielding angle of the existing circuits and the propensity for avian related outages driven by the structure geometry. Additionally, it would not provide the additional capacity needed to interconnect proposed and future solar PV and BESS projects and would not address existing voltage issues. At best, the Critical Asset Repair Alternative would extend the life of individual structures without providing either improved reliability or increased capacity. Because this alternative does not meet the identified need, it was dismissed from further consideration.

3.5 RECONDUCTORING AND REPAIR OF THE EXISTING LINES

The Reconductoring and Repair Alternative would address the needs identified in *Section 2* to the extent possible without wholesale replacement of the existing structures. Key components of this alternative include:

- Repairing individual structures to address buckling, corrosion, woodpecker damage, deteriorated crossarms, insulator damage, and other physical damage identified in the 2019 Inspection Report,
- Replacing the existing 2/0 Copper conductor on both the A1 and B2 Lines with a higher capacity conductor and replacing structures as needed to support the new conductor,

- Replacing the existing shield wire with 7 #9 Alumoweld wire,[20]
- Installing voltage support measures as needed to support the interconnection of proposed DER, and
- Vegetation management, upgrading existing access, and creating new access as required to construct and maintain the reconductored lines.

Reconductoring and repairing the Existing Lines would provide the additional capacity needed to interconnect proposed DER and would address some of the issues identified in the 2019 Inspection Report. However, to the extent that the original structures are retained rather than replaced, this alternative would be unlikely to reduce the incidence of line outages associated with lightning strikes, downed trees, thunderstorms, and avian interference. In addition, because OPGW would not be installed, the benefits of high-speed communications between substations would not be realized.

Preliminary analysis indicated that in order to install a new, higher capacity conductor on the Existing Lines, approximately 25% of the existing tangent structures would need to be replaced to provide the appropriate conductor clearance to ground and another 10% would need to be replaced to provide adequate structural capacity. In addition, all of the existing dead-end structures would require replacement as the existing structures are assumed to have insufficient structural capacity to support the increased loading imparted to them by the new conductor. However, the reliability improvements associated with this alternative would be limited because these individual replacement structures would need to remain relatively physically consistent with the existing towers and the remaining structures would remain unimproved.

In short, if the existing structures are repaired rather than replaced, both existing electric customers and the proposed solar PV and BESS projects would continue to experience line outages at a much higher than average rate for the foreseeable future. Because this alternative does not address the key structure design issues associated with the poor reliability of the Existing Lines, it was dismissed from further consideration.

3.6 LINE REBUILD (PROJECT)

Under the Rebuild Alternative, NEP would rebuild the Existing Lines and Taps[21] within existing ROWs, completely replacing the existing structures, conductor, and shield wire. Key components of this alternative include:

- Installing new double circuit, davit arm, monopole structures along the ROW between the Vernon and Pratts Junction Substations and subsequently removing the existing double circuit lattice structures,
- Replacing the existing 2/0 Copper conductor on both the Existing Lines with 795 ACSS “Drake” conductor,
- Replacing existing shield wire with OPGW, and
- Vegetation management, upgrading existing access, and creating new access as required to construct and maintain the Rebuilt Lines.

[20] OPGW would not be used for this alternative as there is a high probability that the introduction of OPGW to the existing shield wire bayonets would result in the need to replace a substantial number of structures due to the change in loading imparted to the structure at the attachment point.
[21] This section focuses on the Existing Lines, but key design components of the Rebuild Alternative also apply to the Taps.

Rebuilding the Existing Lines on new double circuit, davit arm, monopole structures would address all the needs identified in *Section 2*. As discussed below, the new monopoles would have a shielding angle of approximately 15 degrees, as compared to approximately 40 degrees for the existing structures; they would also elevate conductors well above their current height and would reduce opportunities for bird nesting. Taken together, these design changes would significantly reduce the frequency of outages on the Existing Lines. Upgraded access would improve NEP's ability to quickly repair damage to the lines when it does occur.

Replacing the existing copper conductor with 795 ACSS "Drake" conductor provides the additional thermal capacity needed both to interconnect currently proposed DER and to support projected electric load growth without the need for additional line upgrades in the foreseeable future. As discussed above, the Project also addresses the voltage issues identified in ISO-NE's 2029 Needs Assessment. Replacing the existing shield wire with OPGW allows for high-speed communication between substations along the Rebuilt Lines, which can be used to support protective relaying schemes and expansion of National Grid's private fiber network, which provides communications to support voice, land mobile radio, Supervisory Control and Data Acquisition ("SCADA"), online monitoring cyber and physical security, and other potential future uses. Additionally, the OPGW will allow for further networking between National Grid assets along the Deerfield River to the south and the Vermont Electric Power Company ("VELCO") system to the north.

Because the Rebuild Alternative is the only alternative that improves performance by addressing all of the underlying causes and provides the additional thermal capacity and voltage support required to interconnect proposed DER and support future load growth, NEP selected it and dismissed other alternatives from further consideration. As discussed in *Section 3.7*, NEP then turned to the question of whether a 69 kV structure design or a 115 kV structure design would best meet the identified need while minimizing cost and environmental impacts and providing for the long-term reliability of the electric transmission system.

3.7 STRUCTURE DESIGN ALTERNATIVES

NEP considered two transmission structure design alternatives: one that complies with NEP's 115 kV design standards ("115 kV Design"), and a second that complies with NEP's 69 kV design standards ("69 kV Design"). Both structure designs are able to support NEP's proposed 795 ACSS "Drake" conductors and can be contained within NEP's existing A1/B2 ROW. In addition, as discussed in *Section 3.7.1* below, both designs elevate the new conductors above the existing structures so that old and new conductors can be operated simultaneously during construction. However, the 115 kV Design provides additional insulation and, more importantly, the ability to operate at 115 kV in the future if conditions warrant, the benefits of which are discussed below in *Section 3.7.3*.

3.7.1 Construction Outage Constraints

As discussed in *Section 2.2*, the Existing Lines connect the Vernon and Pratts Junction Substations and deliver electricity to substations serving 24,000 electric customers in twelve Massachusetts cities and towns. Further, as evidenced by the Cluster Studies, spare capacity on the Existing Lines is extremely limited. If one of the two lines were taken out of service during periods of high demand, the remaining line would be loaded at or very near its thermal capacity.

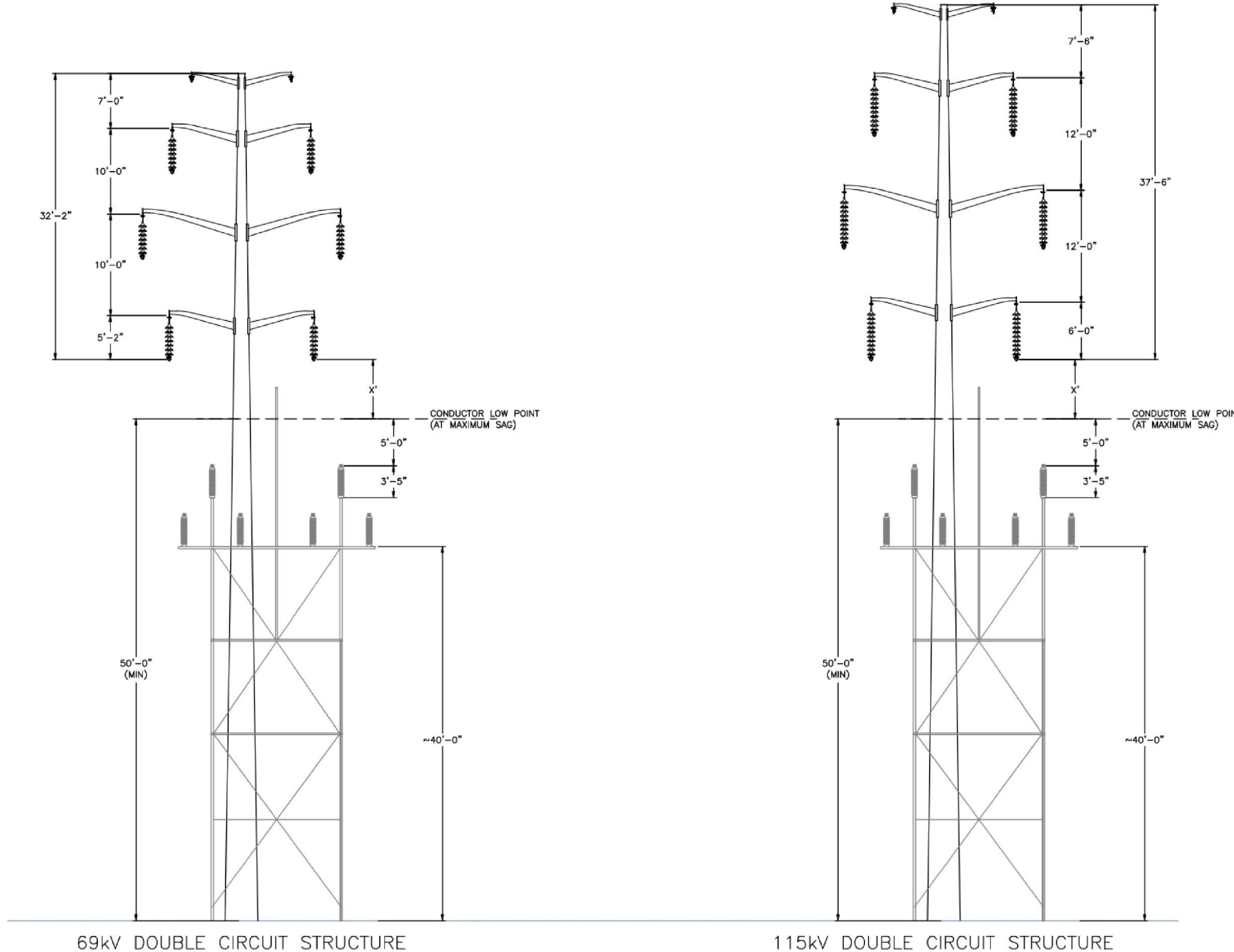
These factors, taken together, limit the availability of line outages during construction.[22] In particular, simultaneous outages on both lines are unlikely to be available except, perhaps, during short periods in the spring and fall. Accordingly, construction will progress through a series of alternating single-line outages, with NEP retaining the ability to restore and re-energize the out-of-service circuit within 48 hours at any point during the construction process.

Constructing the Project this way requires a design that maintains the appropriate clearances, not just only with respect to the new conductors on the Rebuilt Lines and underlying features such as the ground, roads, waterways and crossing distribution circuits, but also between both the new and existing conductors and the existing lattice tower structures. By designing the project in this manner, one circuit can be taken out of service, existing wire transferred to the new structures, and new wire installed while the adjacent circuit remains energized. To meet this need, NEP has designed the Project to allow for the transfer of the existing 2/0 copper conductor to the new steel pole structures, with selective removal of the insulators and lightning masts on the existing structures to provide the appropriate clearance to structures of another line as outlined in DPU's regulations on Installation and Maintenance of Electric Transmission Lines (in 220 CMR 125.23, Table 10). The same clearance requirements were also evaluated for the proposed 795 MCM ACSS "Drake" conductor to the existing structures. In practice, this means that the conductors transferred to the new monopole structures must remain a minimum of four feet from the existing lattice tower structures, under all operating conditions, as shown in Figure 3-1.

3.7.2 69 kV and 115 kV Designs

Figure 3-1 depicts typical 69 kV and 115 kV structure designs for the Project and their relationship to the existing lattice tower structures. The 69 kV and 115 kV Designs both use double circuit, vertically configured, davit arm, monopole structures with a lowest conductor attachment point at an elevation such that the appropriate clearance is maintained between the conductor (both existing and proposed) and the existing structures supporting the Existing Lines to facilitate re-energization as needed during construction. However, as seen in Figure 3-1, each insulator string on the 69 kV structure carries seven insulators, while the 115 kV insulators strings carry ten insulators. The additional spacing required to accommodate the longer insulator strings and larger required phase-to-phase clearance results in an approximately 5.5-foot increase in structure height for the 115 kV Design.

[22] Line outages during construction typically would involve removing a line from service between two consecutive substations (e.g., between the Royalston and Otter River Substations), rather than along the entire ROW.



A1/B2 Asset Condition Refurbishment Project

nationalgrid
BSC GROUP

Figure 3-1
Typical 69kV and 115kV Structure Design

3.7.3 Reliability Comparison

The 69 kV and 115 kV Designs both address the design issues associated with the poor performance record of the Existing Lines. In particular, the replacement structures under either design would have an approximately 15 degree shielding angle, consistent with the current industry practice of limiting the shielding angle to 30 degrees or less. In contrast, the existing towers have an approximately 40 degree shielding angle, which contributes to the Existing Lines' poor storm performance. Similarly, the higher elevation of the conductors on the Rebuilt Lines will reduce the probability of faults resulting from off-ROW vegetation striking the energized lines. In addition, the change in structure configuration from horizontal lattice towers to vertical monopole structures will reduce the potential for avian-related outages. Birds are prone to use the bridge of the existing lattice towers to construct nests, which results in greater opportunity for avian interaction to create momentary outages on the circuits. Overall, either design should result in significant improvements in line performance.

Nonetheless, use of the 115 kV Design standard would provide both near-term and longer-term transmission system reliability benefits. In the short term, the increased insulation and phase spacing associated with the 115 kV Design would further improve lightning performance, and the additional structure height, while limited, may further reduce the probability of off-ROW vegetation striking the energized conductor.

In the longer term, the 115 kV Design would allow the Rebuilt Lines to be operated at 115 kV in the future without further costly transmission line upgrades. Operation at 115 kV provides several advantages over 69 kV operation. First, it provides 66% more capacity on a transmission line for a given conductor size. As a result, more DER and/or electric load can be added at the substations supplied by the A1/B2 Lines without overloading them or undertaking a reconductoring project. Table 3-1 shows the higher thermal ratings that could be achieved by operating the proposed 795 ACSS conductor at 115 kV rather than at 69 kV.

Table 3-1: Thermal Ratings of Proposed 795 ACSS conductor at 69 kV and 115 kV

Overhead Line Conductor	Thermal Ratings when Operated at 69 kV	Thermal Ratings when Operated at 115 kV
795 ACSS	218 MVA (Summer Normal/Long Term Emergency)	366 MVA (Summer Normal/Long Term Emergency)

Additionally, 115 kV operation provides superior voltage regulation due to the lower impedance of 115 kV on a per Mega Volt-Amp ("MVA") basis. In practice, this helps avoid the need for additional transmission switching stations, capacitor banks, reactors, or dynamic voltage control devices to support new load or DER.

Finally, future operation of the lines at 115 kV would facilitate interconnection with nearby transmission facilities and networks that currently operate at 115 kV. For example, VELCO's 115 kV Vernon Station is located approximately one mile away from the NEP's 69 kV Vernon Substation. Creating a connection between the two substations is not currently feasible because they operate at different voltages but would become much more feasible if the Existing Lines were operated at 115 kV. Similarly, 115 kV operation of the lines would also allow NEP to provide 115 kV service to TMLWP, which has requested such service in the past and whose tap line is already designed to accommodate 115 kV operation.

3.7.4 Environmental Comparison

Section 5 provides a detailed analysis of the environmental impacts of the Project using the 115 kV Design. Briefly, those impacts include temporary and permanent impacts to wetlands and water resources, impacts associated with vegetation management and removal, access improvements, visual impacts associated with the proposed increase in structure heights, construction noise and traffic impacts. *Section 5* also summarizes the measures that NEP has taken during Project design and engineering to reduce and mitigate these impacts.

NEP anticipates that use of the 69 kV Design would not significantly reduce any of these impacts. The minor reduction in structure height would be unlikely to change either the number of structures installed or their location. The same construction techniques would be used, and, as a result, construction-related impacts, including vegetative clearing, access improvements, wetlands and water resource impacts, and construction noise and traffic, would be similar or identical. Visual impacts would be marginally reduced based on the 5.5-foot difference in structure height. Magnetic fields at any given load level would marginally increase for the same reason.

Finally, the use of the 115 kV Design for the Project obviates the possible need for a future project within the ROW to upgrade the lines to 115 kV at a later date. A future upgrade to 115 kV from 69 kV-designed structures would require that all structures be replaced, as the structures would not have the appropriate phase-to-phase separation to allow for insulation or operation at 115 kV. This would also require a re-mobilization and significant redundant construction efforts, which would place a repeat burden on the abutters along this ROW, as well as create negative environmental impacts. On balance, NEP considers the 115 kV Design to be preferable to the 69 kV Design from the perspective of environmental impacts.

3.7.5 Cost Comparison

As noted in *Section 1*, the estimated cost of the Project, including the replacement of the Athol and Crystal Lake Taps, is approximately $375 million. NEP has not developed a cost estimate for the Project using the 69 kV Design. However, because the number and location of structures, and the anticipated construction techniques would be the same for both designs, most of the cost difference would be associated with changes in materials costs, including:

- Cost of steel: Approximately six feet of pole length, or roughly $8,400[23] per dead-end structure and approximately $5,450 per suspension structure.
- Cost of insulator discs: Eighteen fewer insulator discs, or approximately $320 per suspension structure and thirty-six fewer disc insulators, or approximately $640 per dead-end structure.

Taken together, these material cost savings would amount to approximately $5.02 million, or less than 1.5% of the estimated cost of the Project. However, should the need arise to operate the Existing Lines at 115 kV in the future, not only would the material, labor, and equipment costs associated with the structure replacements be incurred again, but the costs associated with engineering, permitting and construction would be incurred as well. Specifically, construction matting in sensitive areas, as well as associated mitigation costs, would be required where permanent access is not being constructed.

[23] These per unit costs do not include sales tax, stores handling, contingency, escalation, cash on delivery, allowance for funds used during construction, and administrative and general costs.

3.7.6 Summary

The 115 kV and 69 kV structure designs would both use double circuit, davit arm, monopole structures to support new 795 ACSS "Drake" conductor and OPGW installed between the Vernon and Pratts Junction Substations. The primary physical difference between the two designs is the length of the insulator string and phase spacing at the top of each monopole structure. As shown in Figure 3-1, insulator strings on the 115 kV structures would carry ten insulator discs, while the 69 kV strings would carry only seven insulators. Additional vertical spacing between the davit arms of the 115 kV structures increases the average height of each structure by approximately 5.5 feet, from 90 feet to 95 feet above grade. In the short term, the additional insulation and phase spacing will provide increased resilience to lightning and tree-related events. In the longer term, they make it possible to operate the Rebuilt Lines at 115 kV when required, providing increased thermal capacity and improved voltage regulation.

As discussed above, the environmental impacts of the Project would be similar regardless of the structure design, with the marginally increased visibility of the 115 kV structures offset by a marginal decrease in magnetic field levels. The increased cost of the 115 kV Design is also low relative to the overall cost of the Project. This additional cost essentially secures the ability to maximize the use of the A1/B2 corridor by operating the lines at 115 kV in the future.

In short, constructing the Project to 115 kV Design standards will not significantly increase the estimated cost of the Project, and will allow NEP to adapt its transmission network to future demands without undertaking costly upgrades that result in further impacts at a later date. NEP believes that this is a prudent decision, particularly in light of the initial findings of ISO-NE's ongoing 2050 Transmission Study. As discussed in *Section 2.5*, the 2050 Transmission Study highlights the need for additional transmission capacity across New England to accommodate the electrification of heating and transportation systems and the large-scale integration of on-shore and off-shore wind, solar, and storage resources. The 115 kV Design provides NEP with the flexibility to convert the A1/B2 circuits to 115 kV in the future if needed to support large-scale electrification and interconnection of renewable energy sources throughout the Commonwealth. It also provides NEP with the ability to integrate the lines into the larger 115 kV transmission system when necessary, and to provide 115 kV service to its customers in the future, without a costly upgrade project. For these reasons, NEP selected the 115 kV Design for its new monopole transmission structures.

3.8 CONCLUSION

As described in *Sections 3.2 through 3.6*, above, five alternative concepts were initially considered to meet the identified resource need. The No-Build, Non-Wires and Critical Asset Replacement Alternatives were rejected because they would neither address the asset condition and reliability issues of the Existing Lines, nor provide additional capacity to interconnect proposed DER or meet the future projected demand on the transmission system resulting from the electrification of the energy system required to meet the Commonwealth's decarbonization goals. The Reconductoring and Repair Alternative also was rejected because it would not improve the reliability of the Existing Lines. NEP therefore determined that the needs identified in *Section 2* could only be met by replacing both the existing structures and the existing conductor. In *Section 3.7*, NEP compared the cost, environmental impact, and reliability benefits associated with the use of a 69 kV structure design and a 115 kV structure design and concluded that the additional capacity and flexibility provided by the 115 kV Design outweighed the minor additional costs and visual impacts. Consequently, NEP concluded that the replacement of the Existing Lines in the existing ROW, using a 115 kV structure design, would best address the identified needs at a low cost while minimizing environmental impact.

4 ROUTE SELECTION PROCESS

As discussed in previous sections, NEP proposes to replace the Existing Lines and Taps with Rebuilt Lines and Taps within their existing ROWs in Massachusetts. The Rebuilt Lines will address asset condition concerns and allow for future operation at 115 kV, should this become necessary to address future system requirements.

Consistent with the Siting Board's standards and the requirements of G.L.c.164, § 69J, this section describes the process by which NEP evaluated potential route alternatives[24] to ensure no clearly superior route was overlooked. NEP's review of potential route alternatives was informed by the need to maintain over 100 years of reliable service to electric customers in twelve Massachusetts cities and towns both during and after construction. As discussed in *Sections 2* and *3*, these towns are dependent on the A1/B2 Lines for electric service. Thus, any feasible alternative route must continue to serve the existing substations along the A1/B2 corridor. Due to these constraints, routes with significant geographic diversity would not meet the Project need. However, NEP did evaluate potential route alternatives to ensure the Project best balanced considerations of reliability, and minimization of environmental impacts and costs. When compared to other potential routing opportunities, the Existing Lines and Tap Line corridors offered clear advantages and, as such, are presented as the single route option for the Project ("Project Route").

4.1 OVERVIEW OF SITING METHODOLOGY

The objective of NEP's routing evaluation was to identify technically feasible route alternatives that would maintain system function, minimize impacts to the natural and social environments, and minimize construction and operation costs.

The route evaluation began with NEP defining a study area centered on the existing A1/B2 ROW[25] and developing a general set of route evaluation criteria. NEP then identified a wide variety of potential overhead routes using the most recent available mapping, databases, and aerial photography, focusing on identifying existing linear corridors located within or adjacent to the A1/B2 transmission corridor and the Athol and Crystal Lake Tap Lines. These potential route options included existing electric transmission, railroad, natural gas pipeline, and highway and roadway corridors.

NEP then screened these linear corridors against the route selection criteria to assess whether any would be a potentially superior route to the existing A1/B2 and Tap Line ROWs. Routes were initially screened out if they were found to be clearly inferior to the Project because they could not maintain system function and operability. Following the initial screening, NEP continued to focus on maximizing the use of existing linear corridors while minimizing construction constraints, costs, and environmental impacts. As a result of this iterative process, NEP determined that no candidate routes were equal or superior to the Project Route, which maintains the A1/B2 and Tap Lines in their existing ROWs. As such, NEP is not proposing to construct the Project on any route other than along the existing A1/B2 and Tap Line corridors.

[24] "Alternatives" include full route alternatives and partial route variations, which may only be applicable to specific segments of the A1/B2 and Tap Line corridors.

[25] "ROW" and "corridor" are both used to identify land currently owned/operated and managed by NEP for transmission and sub-transmission assets. These terms will be used interchangeably throughout this section.

4.2 DEFINITION OF STUDY AREA

NEP began the route evaluation by establishing a study area surrounding NEP's existing A1/B2 ROW between the Pratts Junction Substation in Massachusetts and the Vernon Substation in Vermont (the "Study Area"). In order to ensure that the full range of options were considered, and that a clearly superior route alternative was not overlooked, NEP broadly defined the Study Area to include land within the following boundaries as shown in Figure 4-1:

- NEP's E205 and D4 transmission ROWs (to the south of the existing A1/B2 ROW).
- NEP's I135/J136, NSTAR Electric Company dba Eversource Energy's ("Eversource") 379, NEP's G33, and NEP's K137W/L138W collocated with Eversource's 314/343 transmission ROWs (to the north and south-east of the existing A1/B2 ROW).

Expanding outward from the A1/B2 ROW, the 784 square mile Study Area is bounded by the first overhead transmission corridors that do not present reasonable options to supply power to the existing substations served by the A1/B2 and Tap Lines: (1) Royalston Substation in Royalston, (2) Chestnut Hill Substation in Athol, (3) Otter River Switching Station in Winchendon, (4) North Baldwinville Substation in Templeton, (5) Crystal Lake Substation in Gardner, (6) Westminster Substation and East Westminster Substation in Westminster, and (7) Pratts Junction Substation in Sterling.

In general, the Study Area contains municipalities in Worcester, Middlesex, and Franklin Counties of which Worcester County contains the most densely developed population areas, including Fitchburg and Leominster. The majority of the Study Area consists of exempt properties,[26] residential areas, and open lands interspersed with pockets of forest, mixed use, commercial, industrial, transportation corridors, and agricultural lands. Additionally, within the Study Area, a few municipalities own, maintain, and operate municipal light plants[27] that provide electric services to their customers, including Ashburnham Municipal Light, TMLWP, and Sterling Municipal Light Department.

[26] Exempt Property are properties that qualify from exemption from taxation under various provisions of the law and include public land and facilities, hospitals, schools, churches, and cultural institutions, G.L. c. 59 §5.
[27] Municipal light plants are community-owned utilities that are exempt from many of the state's regulatory requirements.

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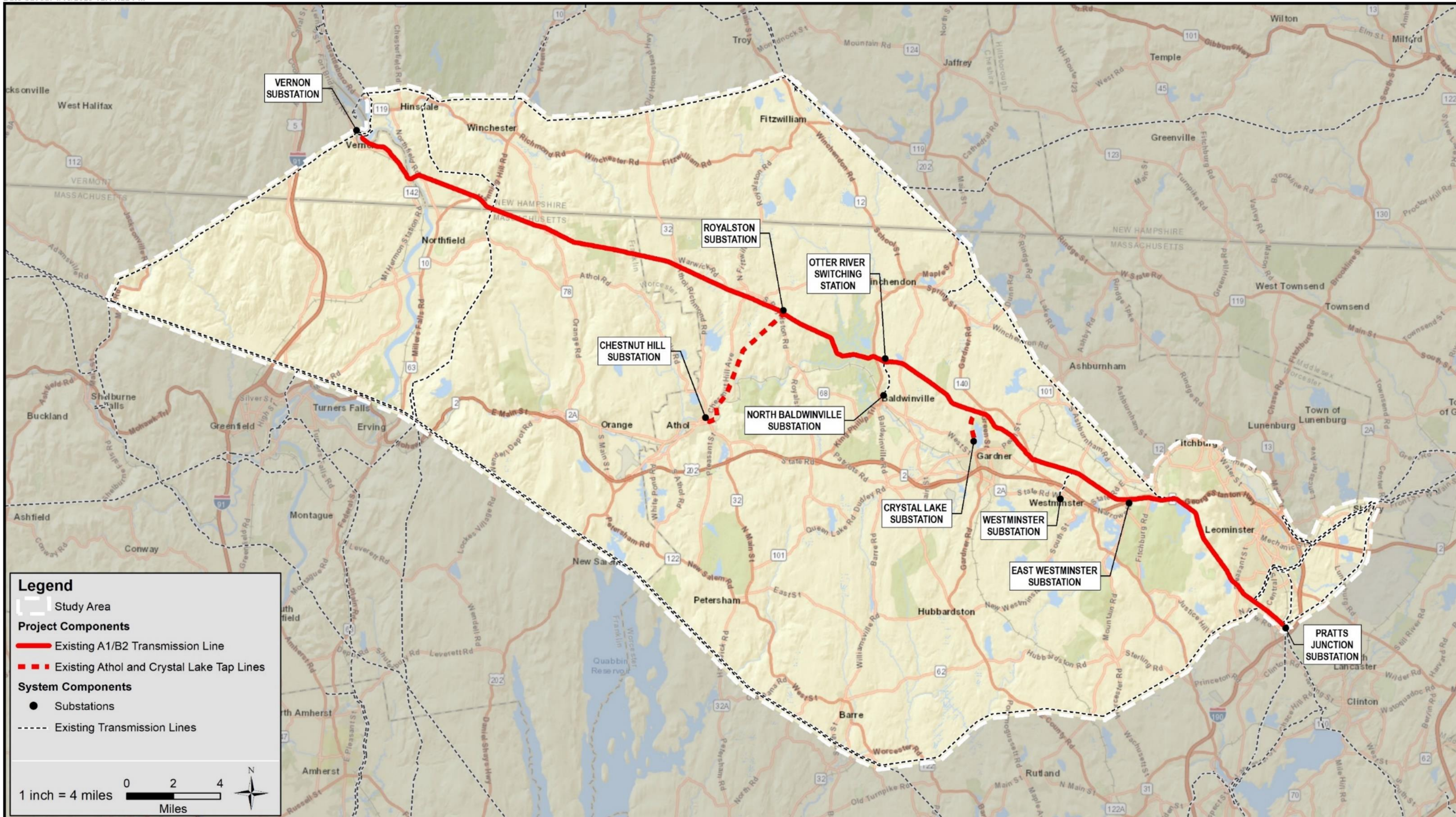

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Figure 4-1

Routing Study Area

4.3 ESTABLISHMENT OF ROUTE EVALUATION CRITERIA

An initial step in NEP's analysis was to establish general criteria to identify potential overhead and underground routes. An important consideration is the corridor requirements to construct an overhead line, including vertical and horizontal clearance codes, depths and setbacks from other active utilities, service to intermediate substations, and final connections to substations. Based on these operational considerations and additional construction and environmental considerations, NEP established the following general criteria:

1. **Maintain system function, operability, and reliability.** Because the Project is proposed to address existing asset condition concerns and future system requirements, NEP's primary routing consideration was the need to maintain reliable delivery of electricity to customers in twelve Massachusetts cities and towns and intermediate and final connection substations serviced by the A1/B2 and Tap Lines. The Existing Lines are the sole transmission supply to the substations listed in *Section 4.2*. In addition, comparable or superior routes must allow general accessibility for future maintenance or repair. Access to all locations along an overhead route is typically not required; however, all structure locations must be reachable from some appropriate access point. NEP accordingly sought routes that would minimize access restrictions.

2. **Maximize the use of existing linear corridors.** Because the Project can be accommodated within existing ROWs, established linear corridors (e.g., transmission line, highway, railroad, and pipeline corridors) were prioritized in the route evaluation. Where sufficient space is available, collocation along existing linear corridors already encumbered by infrastructure minimizes conflicts with local, state, and federal land use plans and policies; minimizes the need to acquire land or land rights; and decreases environmental impacts significantly as compared to the establishment of a new corridor. Utilizing existing transmission line ROWs, in particular, offers the benefit of an established network of access routes and lands already encumbered with utility easements without the need to expand or create a new ROW. These attributes of existing linear corridors also have a positive impact on project cost and schedule.

3. **Minimize impacts to environmental resources.** NEP sought to identify route alternatives that would minimize impacts to environmental resources such as land use, wetlands and wildlife, rare species habitats, historical/archaeological resources, and other designated resources.

4. **Minimize cost.** NEP sought to identify route alternatives that would avoid costly remediation or construction requirements or, alternatively, would provide some opportunity for securing cost reductions.

5. **Limit construction constraints.** In evaluating potential route options within the Study Area, NEP gave preference to route alternatives that would minimize constructability constraints and limitations. For example, road/highway crossings or working within other utility corridors (e.g., railroad corridors) can result in access restrictions, workspace constraints, safety concerns, traffic disruptions, and restrictive work hours, all of which impact project cost and schedule.

6. **Minimize impacts to densely developed areas.** The placement of transmission facilities in densely developed areas typically creates additional complexity both during initial construction and when maintenance or replacement is required. The potential for construction and maintenance work-hour restrictions, limited access availability, and the need for additional ROW and/or temporary workspace are more prevalent in densely populated areas. Therefore, NEP sought to identify route

alternatives that would, to the extent practicable, minimize impacts to densely developed areas and the social environment.

4.4 POTENTIAL ROUTE OPTIONS

Using the route evaluation criteria, NEP mapped existing linear corridors within the Study Area that could be used to develop routes that would maintain system function and operation without the need to create a new ROW. NEP focused on the use of existing utility and transportation corridors in proximity to the A1/B2 and Tap Line corridors. Numerous linear corridors were identified through a macro-review of USGS topographic maps, Geographic Information System ("GIS") data, and aerial imagery within the Study Area. Theoretically, these corridors could be utilized to develop potential routes, including those associated with electric transmission lines, natural gas pipelines, railroads, and highways and major roadways. The existing corridors identified in the Study Area are summarized below and depicted in Figure 4-2.

4.4.1. Electric Transmission Line Corridors

Ten existing overhead electric transmission line corridors were identified in the Study Area as shown in Figure 4-3. In addition to the A1/B2 and Tap Line ROWs, NEP owns and operates the majority of ROWs 1, 3, 4, 7, 9, and 10, and Eversource owns and operates the majority of ROWs 2, 5, and 6. ROW 8 consists of collocated NEP and Eversource assets.

The existing transmission line corridors identified in the Study Area are described below and shown on Figure 4-3. A detailed overview of existing transmission ROWs within the Study Area is provided in Table A in Appendix 4-1.

- **ROW 1:** This is an approximately 130-to-175-foot-wide transmission ROW that runs 32.6 miles NW/SE through the eastern corner of the Study Area.
- **ROW 2:** This is an approximately 100-to-275-foot-wide ROW that runs 19.5 miles E/W through the northern corner of the Study Area in New Hampshire.
- **ROW 3:** This is an approximately 100-to-275-foot-wide transmission ROW that runs 59.1 miles SW/W through the eastern corner of the Study Area.
- **ROW 4:** This is an approximately 75-to-350-foot-wide transmission ROW that runs 13.1 miles SW through the north-western corner of the Study Area.
- **ROW 5:** This is an approximately 115-to-315-foot-wide transmission ROW that runs 19.2 miles N/S through the north-western corner of the Study Area.
- **ROW 6:** This is an approximately 125-to-150-foot-wide transmission ROW that runs 1.4 miles N/S towards south-western corner of the Study Area.
- **ROW 7:** This is an approximately 115-to-315-foot-wide transmission ROW that runs 2.5 miles N/S through the north-western corner of Study Area in New Hampshire and Vermont.
- **ROW 8:** This is an approximately 75-to-250-foot-wide transmission ROW that runs 7 miles NE/SW through the eastern corner of the Study Area.
- **ROW 9:** This is an approximately 75-to-130-foot-wide transmission ROW that runs 18.3 miles NE/SW through the eastern corner of the Study Area.
- **ROW 10:** This is an approximately 130-to-185-foot-wide transmission ROW that runs 3 miles N/S through the eastern corner of the Study Area.

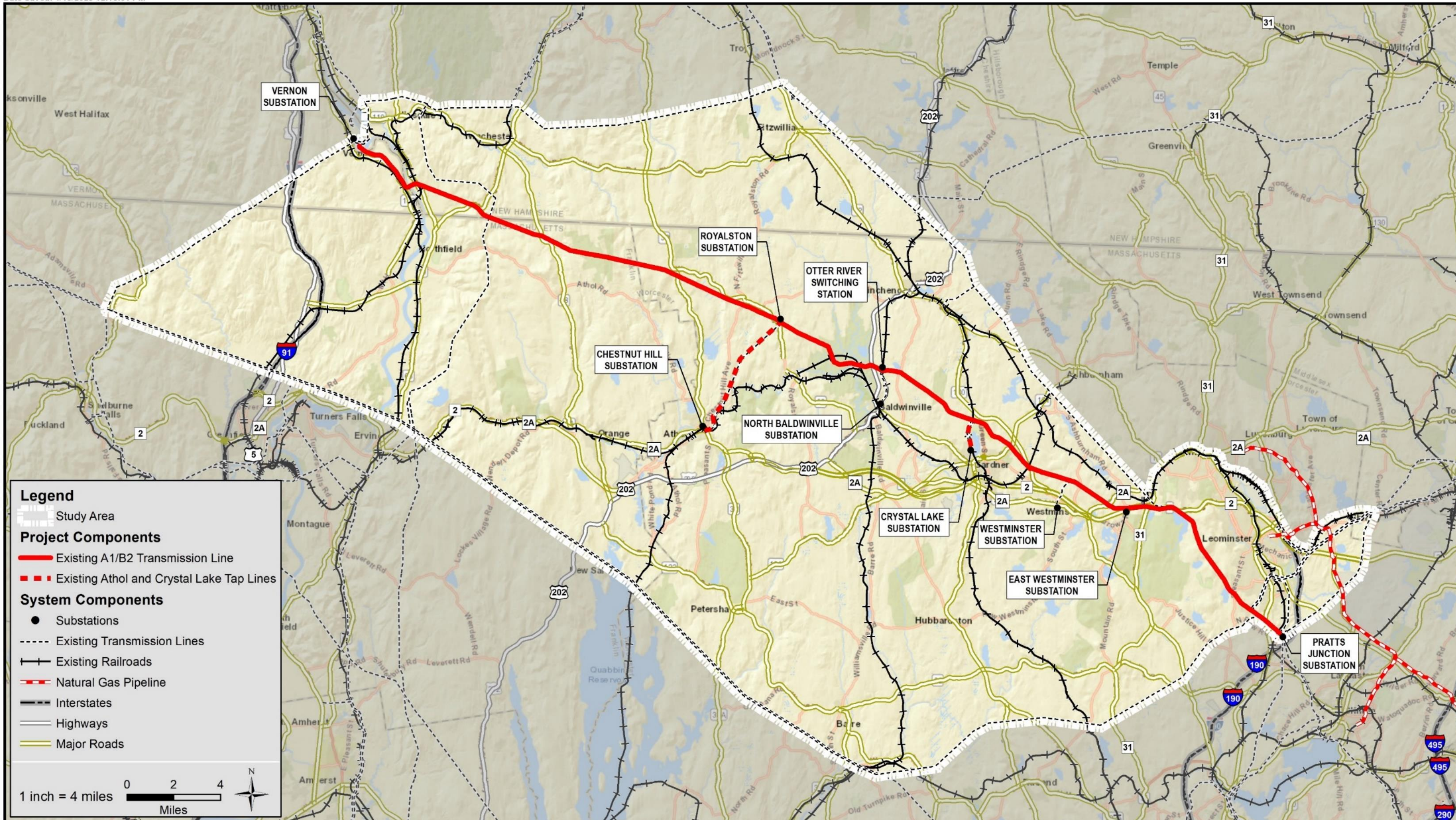

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Figure 4-2

Potential Route Options within the Study Area

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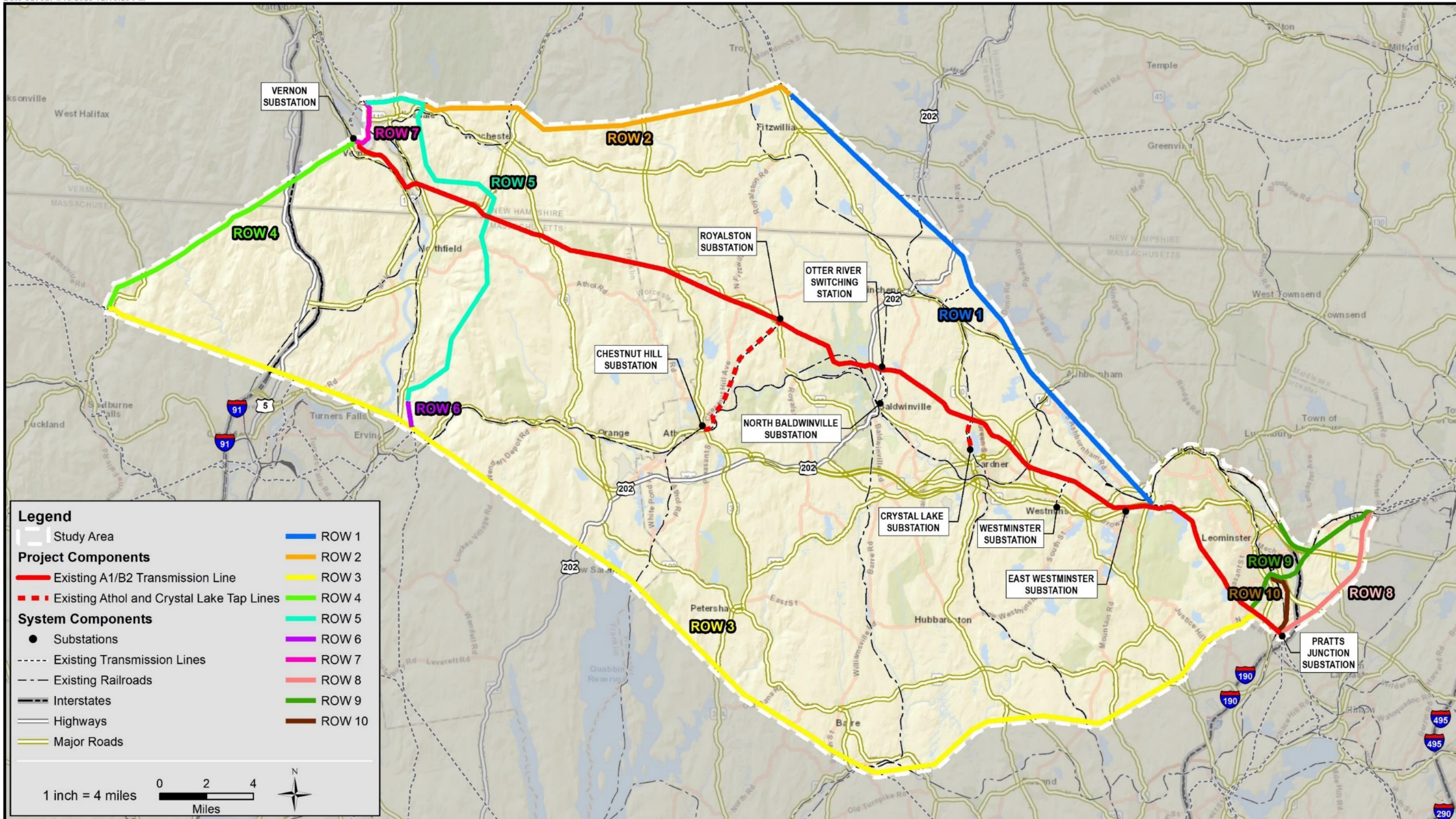

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Figure 4-3
Electric Transmission Line Corridors

4.4.2. Municipal Utility Corridors

No viable municipal utility corridors were identified within the Study Area.

4.4.3. Railroad Corridors

Several railroad corridors run north-south and east-west through the Study Area as shown in Figure 4-4. Of the existing railroad corridors identified, two run east-west in proximity to the A1/B2 corridor:

- The Boston and Maine Railroad – Massachusetts Bay Transportation Authority ("MBTA") Fitchburg rail line runs east-west through the Study Area in the vicinity of the Pratts Junction Substation in Sterling, Massachusetts.
- The Patriot Corridor runs approximately 45 miles east-west through the north-central half of the Study Area. Portions of the corridor are located in the vicinity of the Wendell Depot Substation #705, the Chestnut Hill Substation, North Baldwinville Substation, Ashburnham Substation #610, Flagg Pond Substation #4, and Prospect Street Substation #219.

A detailed overview of the rail corridors within the Study Area is provided in Table B in Appendix 4-1.

4.4.4. Highway and Major Roadway Corridors

Several major highways and roadway corridors run north-south and east-west through the Study Area as shown in Figure 4-5. Of the existing roadway and highway corridors identified, the following run proximate to the A1/B2 corridor in an east-west direction, or the Taps in a north-south direction:

- State Route 2 – State Route 2 generally runs east-west through the Study Area, but well to the north of the Pratts Junction Substation.
- State Route 68 – State Route 68 generally runs east-west through the towns of Gardner, and Royalston.
- State Route 2A – State Route 2A weaves around its parent State Route 2, and generally runs east-west through the Study Area, but well to the north of the Pratts Junction Substation.
- State Route 140 – State Route 140 is located in the central portion of the Study Area and runs east-west through the towns of Leominster, Westminster, Gardner, and Winchendon.
- State Route 32 - State Route 32 generally runs proximate to Athol Tap corridor in a north-south direction through the towns of Petersham, Athol, and Royalston before crossing into New Hampshire.

A detailed overview of the highway and roadway corridors within the Study Area is provided in Table C in Appendix 4-1.

4.4.5. Local Roadway Network

There are numerous local roadway networks throughout the municipalities located within the Study Area. Some roadway networks are concentrated in dense, urban areas such as the cities of Leominster and Fitchburg, while some are more rural, including those crossing through the towns of Warwick and Royalston. The local roadway networks across the Study Area are typically paved, but also consist of gravel and dirt roadways, especially in the most rural settings.

4.4.6. Natural Gas Pipeline Corridors

One natural gas pipeline, the Tennessee Gas Pipeline ("TGP") was identified within the eastern corner of the Study Area, as shown in Figure 4-6. The TGP corridor runs through the town of Lancaster and terminates in Lunenburg.

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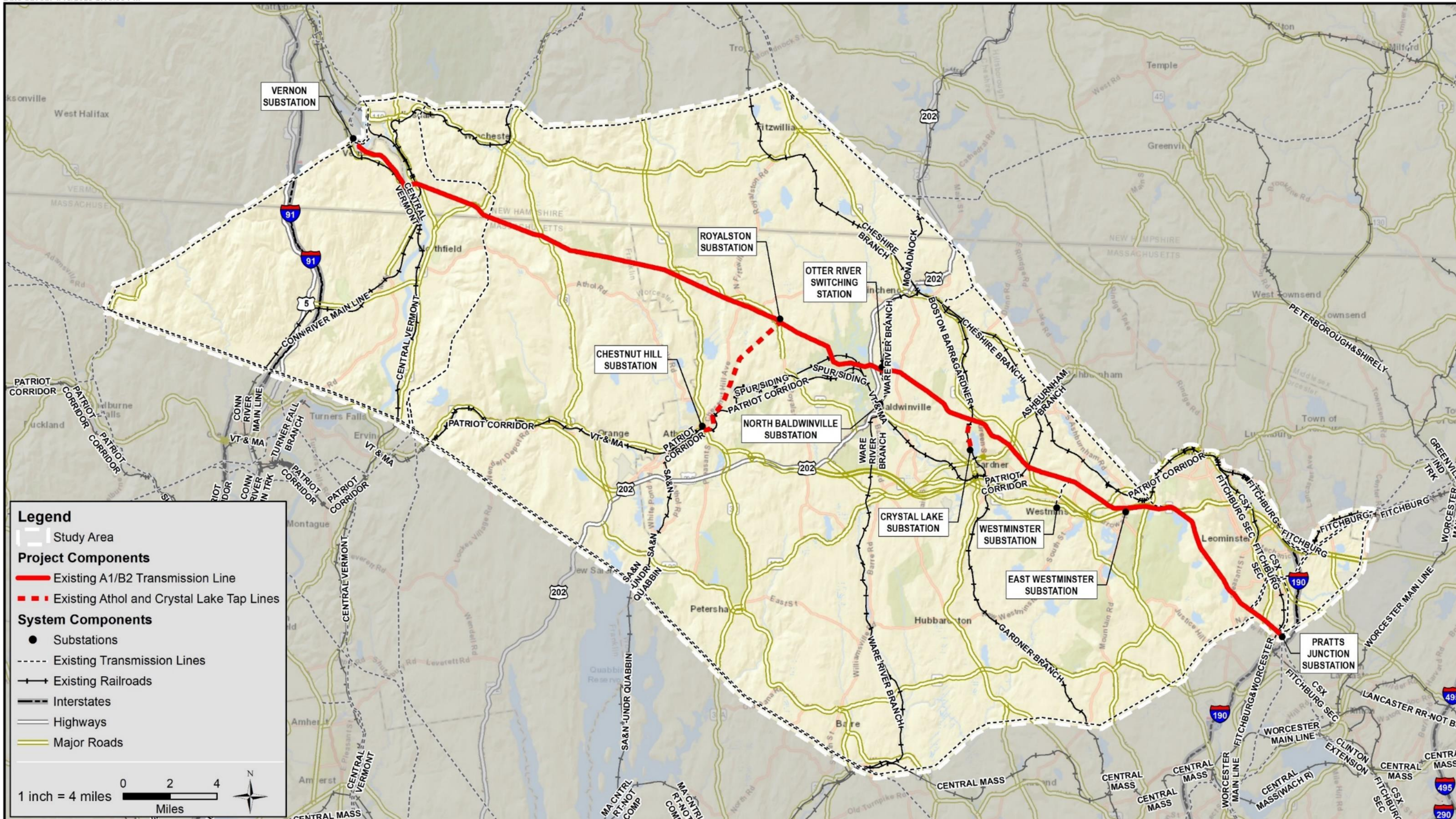

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Figure 4-4
Railroad Corridors

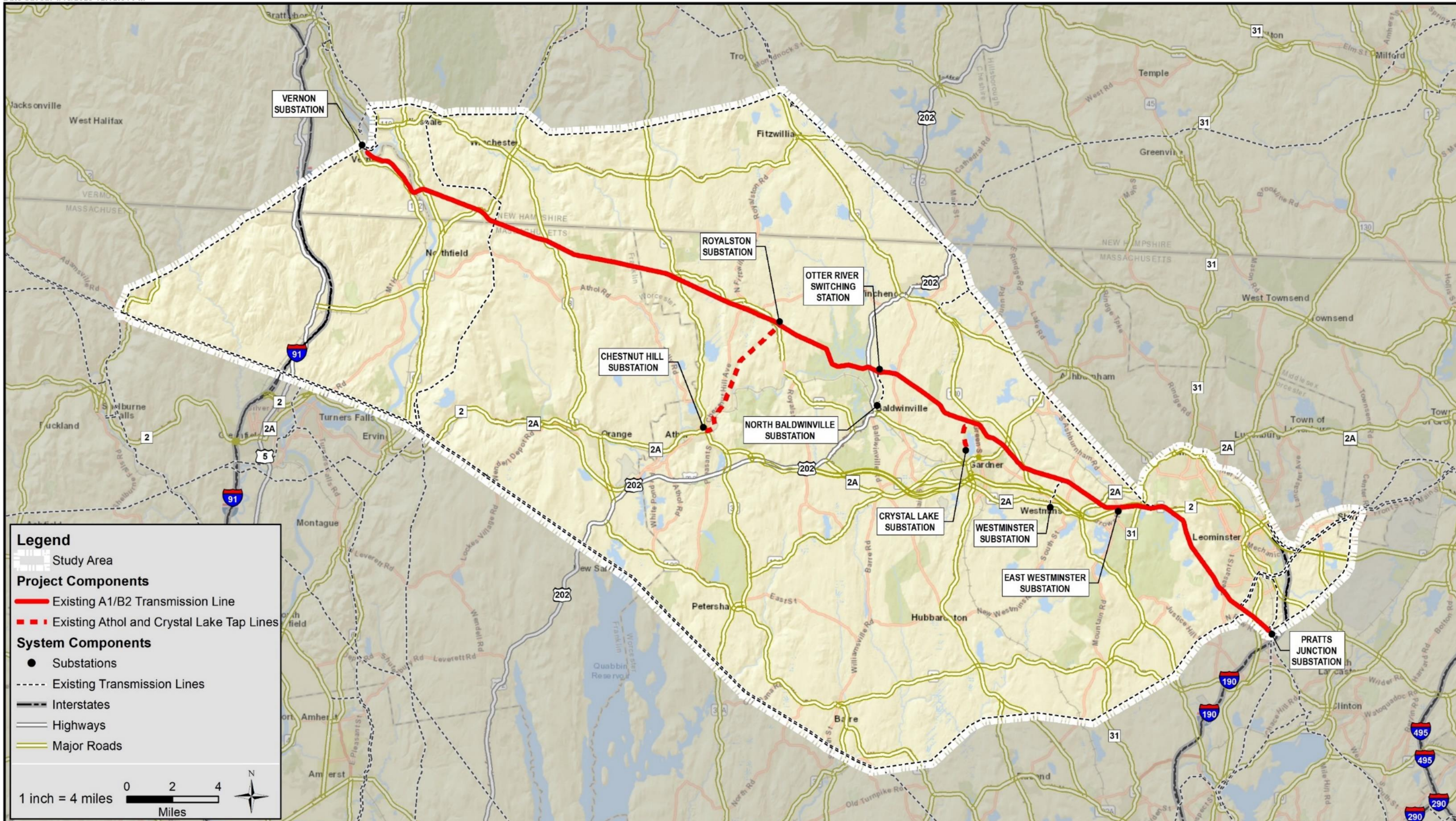

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Figure 4-5
Highway and Major Roadway Corridors

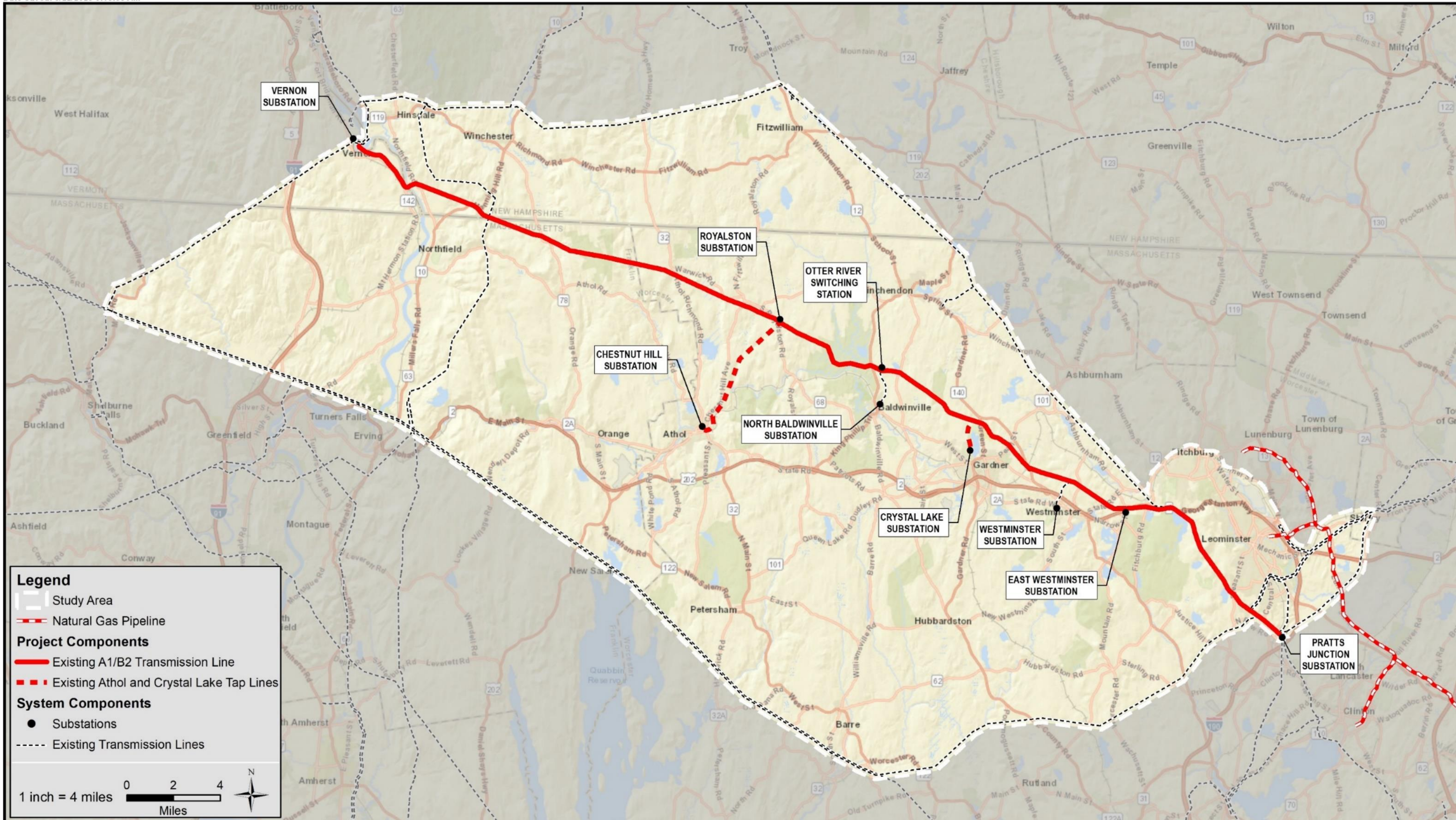

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Figure 4-6
Natural Gas Pipeline Corridors

4.5 IDENTIFICATION AND SCREENING OF POTENTIAL ROUTE OPTIONS

NEP applied the route evaluation criteria to identify existing linear corridors that could serve as a potentially superior route alternative for some or all of the Project. All corridors evaluated in the initial screening process are shown in Figure 4-2.

4.5.1. Initial Screening: Maintaining System Function, Operability, and Reliability

NEP's initial screening of existing linear corridors focused on identifying corridors that could provide system function and service to the twelve communities served by the Existing Lines, as well as allow for general accessibility for future maintenance or repair. Corridors that did not share the generally southeast-to-northwest orientation of the Existing Lines, or provide access to an intermediate substation, were eliminated during this screening. Table 4-1 summarizes the linear corridors that provide no practical connection to the substations currently served by the Existing Lines and Tap Lines. Please refer to Tables D, E, F, and G in Appendix 4-1 for a detailed summary of the corridors eliminated from further consideration.

Table 4-1: Corridors Eliminated from Further Consideration

Linear Corridor	Linear Corridor Name or Identifier
Electric Transmission Corridors	• ROW 1, ROW 2, ROW 3, ROW 4, ROW 6, ROW 8, ROW 9, ROW 10 • ROW 5 and ROW 7 were also eliminated as any potential alternatives as they are confined to Vermont
Railroad Corridors	• Massachusetts Department of Transportation ("MassDOT") Connecticut River Line • The portion of the Boston and Maine Railroad - Patriot Corridor located southwest of the Chestnut Hill Substation • Central Vermont Railway • The southern portion of the Providence and Worcester Railroad ("P&W")/Genesse &Wyoming ("G&W") - Gardner Branch P&W/ Pan Am Railways ("PAR") • Boston and Maine Railroad - MBTA Fitchburg • CSX - Fitchburg Secondary, and local lines
Highway and Major Roadway Corridors	• Interstate Route 190 ("I-190") • Interstate Route 91 ("I-91") • State Route 2A west of the Chestnut Hill Substation • State Route 2 west of the Chestnut Hill Substation • State Route 31 • State Route 5 • All other major roadways run perpendicular to the A1/B2 ROW and Tap Line ROWs and/or are far removed from the Existing Lines
Natural Gas Pipeline Corridors	• Tennessee Gas Pipeline

4.5.2. Secondary Screening

Following the initial route screening, NEP reviewed the remaining linear corridors (depicted in Figure 4-7) and determined feasible route alternatives were not available for the A1/B2 transmission corridor in its entirety.

However, as part of the secondary screening, NEP further evaluated potential route variations with a focus on minimizing engineering, construction, and future operating constraints, as well as potential natural and social/developed environmental constraints. Of the linear corridors remaining for consideration, potential route variations consisted of railroad, highway, major roadways, and the local roadway network.

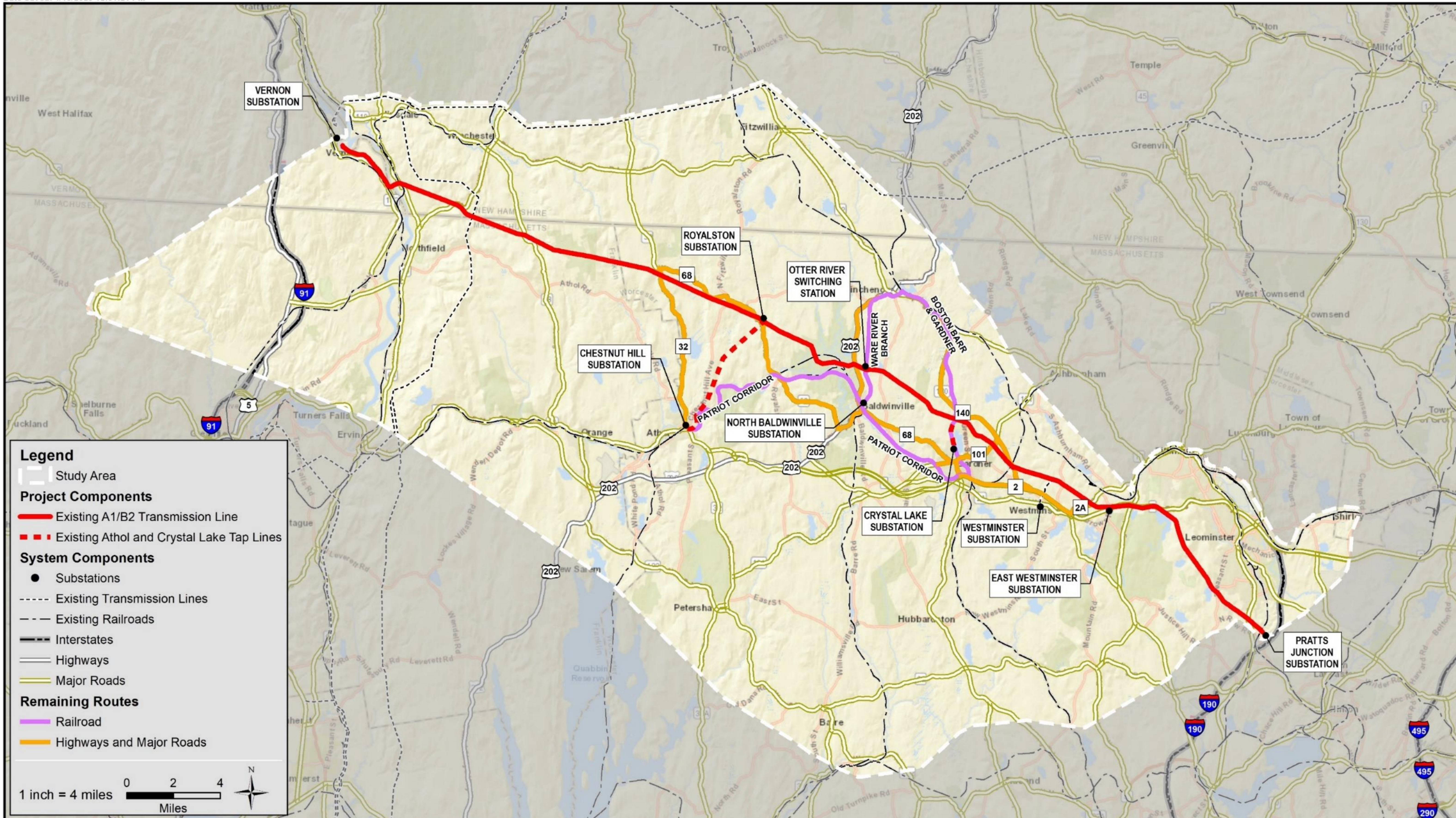

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Figure 4-7

Linear Corridors Remaining after Initial Screening

The majority of the potential route variations identified presented alternatives to the portion of the A1/B2 corridor located between the East Westminster Taps and the Royalston Substation and/or Athol Tap Lines. In addition, State Route 32, a segment of U.S. Highway Route 202, a segment of the Boston and Maine Railroad/Patriot corridor, and a segment of the P&W/G&W - Gardner Branch Railroad corridor presented alternatives to the Tap corridors. These potential route variations for the A1/B2 and Taps corridors are summarized in Table 4-2.

Table 4-2: Potential Route Variations Reviewed During Secondary Screening

Project Component	Corridor Type	Potential Route Variation	Location
A1/B2 Corridor	Major Highway and Roadway Combination	State Route 140 and U.S. Highway Route 202	• Between Westminster Substation in Westminster and Otter River Switching Station in Winchendon.
	Major Roadway and Railroad Combination	State Route 68, Patriot Corridor and U.S. Highway Route 202	• Between Royalston Substation in Royalston and State Route 32, West Royalston. • Between North Baldwinville Substation in North Baldwinville and Royalston Substation in Royalston. • Between Otter River Switching Station in Winchendon and Royalston Substation in Royalston.
	Major Highway and Roadways and Railroad Combination	Combination of State Route 2/2A, State Route 68, U.S. Highway Route 202, State Route 101, State Route 140, and Patriot Corridor/ Ware River Branch	• Between the East Westminster Substation in Westminster and Crystal Lake Substation in Gardner. • Between Westminster Substation in Westminster and Otter River Switching Station in Winchendon. • Between East Westminster Substation in Westminster and Royalston Substation in Royalston. • Between Otter River Switching Station in Winchendon and Royalston Substation in Royalston.
Crystal Lake Tap Line Corridor	Major Highway and Railroad Combination	Combination of State Route 2/2A, State Route 101, Patriot Corridor, and the Boston Barre & Gardner Branch	• Between East Westminster Substation, in Westminster and Crystal Lake Substation in Gardner.
	Railroad	Boston Barre & Gardner Branch	• Between Crystal Lake Substation in Gardner and Otter River Switching Station in Winchendon.
Athol Tap Line Corridor	Major Roadway	State Route 32	• Between Chestnut Hill Substation in Athol and State Route 68, West Royalston.
	Railroad	Patriot Corridor	• Between North Baldwinville Substation in North Baldwinville and Chestnut Hill Substation in Athol.

These potential variations were measured against the route evaluation criteria to ensure no superior route alternatives were overlooked. While all potential route variations would involve utilizing existing linear corridors to the maximum extent feasible, installation of a new overhead line along railroads, highways, and major roadways would require obtaining new property rights, and encroaching upon open space and residential properties in some locations.

In addition, installation of a new overhead line along railroad, highways, and major roadways presents significant construction and maintenance constraints, and associated cost. Collocating a transmission line along a railroad corridor or highway corridor may be possible; however, a project proponent must demonstrate to the applicable transportation agency that there is no feasible alternative to collocating with these facilities, which is not the case here. In addition, working within other utility corridors (e.g., railroad corridors) and road/highway crossings would result in access restrictions, workspace constraints, safety concerns, traffic disruptions, and restrictive work hours during both initial construction and long-term maintenance and operations activities. Furthermore, locating new overhead transmission lines along major highways, roadways, and railroads would result in new visual, traffic, and environmental impacts to communities and natural systems.

For the reasons summarized above, given the availability of the existing A1/B2 and Tap Line corridors, the remaining railroad, highway, and major roadway corridors were eliminated from further consideration. The secondary screening results and the primary justification for eliminating each potential route variation are summarized in Table 4-3.

Table 4-3: Status of Remaining Potential Route Variations after Secondary Screening

Potential Route Variation	Status
U.S. Highway Route 202	• Rights/Agreements would be required from MassDOT to occupy the U.S. Highway Route 202 corridor, which are not likely to be acquired due to the availability of the existing A1/B2 and Tap Line corridors. • Significant construction and improvement efforts would be required to create the general accessibility[28] necessary for construction and future maintenance of the relocated lines.
State Route 2/2A	• Rights/Agreements would be required from MassDOT to occupy the State Route 2 corridor, which are not likely to be acquired due to the availability of the existing A1/B2 corridor. • Significant construction and improvement efforts would be required to create the general accessibility necessary for construction and future maintenance of the relocated lines.
State Route 32	• Significant construction and improvement efforts would be required to create the general accessibility necessary for construction and future maintenance of the relocated lines. • Additional easement rights and/or land acquisition would be necessary along the ROW.
State Route 68	• Significant construction and improvement efforts would be required to create the general accessibility necessary for construction and future maintenance of the relocated lines. • Additional easement rights and/or land acquisition would be necessary along the ROW.
Portion of Boston and Maine Railroad/Patriot Corridor/ Ware River Branch/ Pan Am Southern ("PAS")	• Easement rights would be required from rail owners to collocate facilities along railroad ROW. • Restrictions on working near an active rail line would impact maintenance costs and emergency response. • Land acquisition and construction restrictions associated with working near active rail line would increase costs.

[28] Accessibility includes access and work envelopes required to construct, operate, and maintain the Rebuilt Lines and Taps.

Potential Route Variation	Status
Portion of P&W/G&W - Gardner Branch P&W/ PAR	• Easement rights would be required from rail owners to collocate facilities along railroad ROW. • Restrictions on working near an active rail line would impact maintenance costs and emergency response. • Land acquisition and construction restrictions associated with working near active rail line would increase costs.
State Route 101	• Significant construction and improvement efforts would be required to create the general accessibility necessary for construction and future maintenance of the relocated lines. • Additional easement rights and/or land acquisition would be necessary along the ROW.
State Route 140	• The existing roadway corridor extends north from the point of intersection on the mainline resulting in a long and circuitous route. • Additional easement rights and/or land acquisition would be necessary along the ROW.

In addition, while local roadways may provide route options that present reasonable connections to the substations served by the Existing Lines and Taps, these corridors were dismissed from further consideration because the installation of new overhead lines would require obtaining new property rights, encroaching on open space and residential properties, and potentially requiring the release of conservation lands in Royalston and Orange via the Article 97 land disposition process through the Legislature of the Commonwealth. Since the Project presents an option that would maintain the Rebuilt Lines within existing and established ROWs, the local roadway network does not offer superior route alternatives and has been removed from further consideration.

4.5.3 Summary and Proposed Project Route

NEP evaluated existing linear corridors within an extensive Study Area centered on the existing A1/B2 ROW to ensure that no clearly superior route alternatives to the Existing Lines and Taps corridors were overlooked. Using the route evaluation criteria, NEP screened potential linear corridors and eliminated local roadway networks, highways, railroads, and other overhead transmission line corridors because the Existing Lines and Taps corridors are clearly superior and best balance considerations of reliability and minimization of environmental impacts and cost. Therefore, the Existing Lines and Taps corridors are proposed as the Project Route (Figure 4-8). Specifically, the Project Route provides the following benefits:

- The Project Route provides a direct route between the Vernon Substation and the Pratts Junction Substation and rebuilding the Existing Lines and Taps within their existing ROWs maintains system function and service to the twelve communities they currently serve. Although several route options could be delineated using existing linear corridors within the Study Area, none would be shorter, less costly, or have less overall impact to the human and natural environments while still maintaining existing function.
- The Existing Lines have been situated along the proposed Project Route for over a century, and the Tap Lines are also well established and maintained NEP assets. As such, the existing A1/B2 and Tap Line ROWs have been historically accessed and maintained for the purpose of NEP's operations. Maintaining system operability and reliability has included vegetation maintenance, placing temporary construction mat crossings within existing wetland systems crossing the ROW,

and accessing and performing repairs where assets are located within EJ Communities. While access route improvements will be necessary as part of the Project, utilizing the existing A1/B2 and Tap Line ROWs also offers the benefit of an established network of access routes and lands already encumbered for this use.

- The Project Route does not require the acquisition of new or expansion of existing transmission line ROW, although construction of the Project will require acquisition of access easements from two private landowners.

4.6. CONCLUSION

NEP's process for selecting the Project Route for the proposed Rebuilt Lines and Tap Lines addresses the Siting Board's standards applicable to jurisdictional energy facilities in an objective and comprehensive fashion. NEP approached the process by identifying existing linear corridors within a broad routing Study Area to fulfill a review of potential route alternatives. Providing significant consideration to the unique scope of the Project and the significant length, cost, and reliability concerns, the route evaluation relied heavily on NEP's responsibility to ensure that no clearly superior route was overlooked. As a result of the in-depth screening process, no candidate routes were found to meet the route evaluation criteria and/or provide benefits comparable to rebuilding the Existing Lines and Tap Lines within their existing ROWs, the Project Route.

While it is feasible to construct the Project using alternative routes consisting of existing linear corridors, this would result in increased costs, schedule delays, and new and/or increased impacts to human and natural environments. Developing a Noticed Alternative Route over 54 miles would require a significant expenditure of funds and would unnecessarily raise concerns among abutters along inferior routes where NEP has no intention of constructing the Project. Thus, NEP determined that designating a Noticed Alternative Route was not warranted under these circumstances.

A more detailed examination of the Project Route is presented in *Section 5* of this Analysis.

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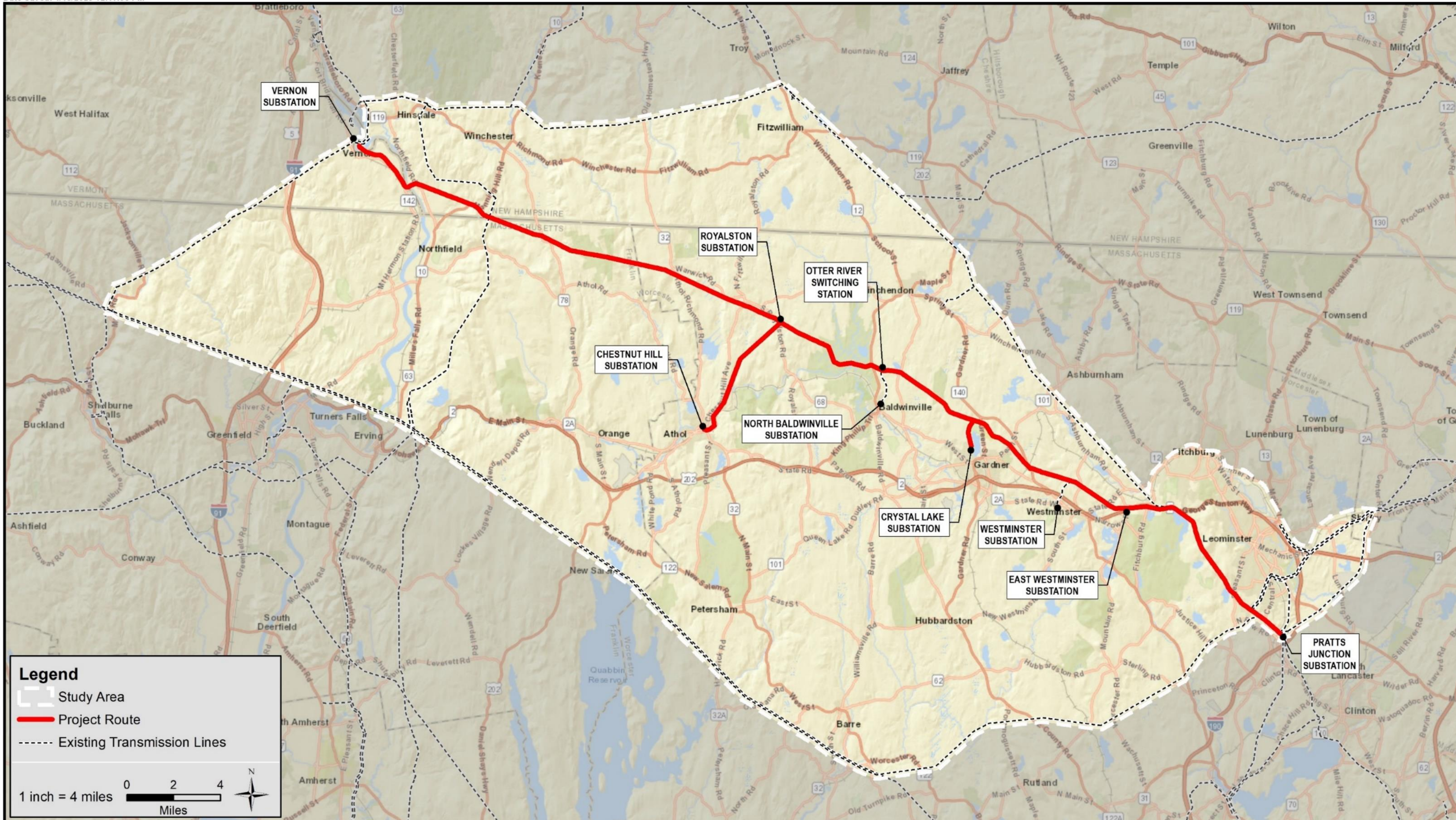

A1/B2 Asset Condition Refurbishment Project

nationalgrid
BSC GROUP

Figure 4-8
Project Route

5 PROJECT IMPACTS ANALYSIS

5.1 INTRODUCTION

This section provides a detailed analysis of the Project's impacts on the natural and social environment. To assess these potential environmental impacts and mitigation, NEP evaluated a series of natural and social environment criteria including land use, protected land and open space, historical/archaeological sites, tree removal, wetlands and water crossings, rare species habitat, public water supplies, visual, noise, traffic, and electric and magnetic fields ("EMF").

The potential impacts of the Project are both construction-related (temporary) impacts and siting and operation-related (permanent) impacts. Examples of potential temporary construction-related impacts include the temporary placement of construction matting in wetlands for access and work area, ground disturbance associated with structure installation and removal, traffic impacts at roadway crossings, and short-term construction noise associated with the operation of heavy equipment. Examples of permanent impacts include fill, tree and vegetation removal, and visual impacts.

A description of the Project Route is provided in *Section 5.2*. Related maps and figures are found in Appendices 5-1 and 5-3 of this Analysis. *Section 5.3* provides an overview of NEP's construction methodology and impact avoidance and minimization measures.

Project impacts to the natural and social environment, as well as proposed mitigation measures, are discussed in *Section 5.4*. Finally, a summary of the analysis and conclusion are provided in *Section 5.6*.

5.2 DESCRIPTION OF THE PROJECT ROUTE

5.2.1. Project Route

NEP proposes to replace the Existing Lines and Taps with Rebuilt Lines and Taps within existing ROWs in Massachusetts. The Project Route is illustrated in the Map Book in Appendix 5-1, typical ROW cross-sections are included in Appendix 5-3 and typical A1/B2 and Tap structure details are shown in Figure 3-1. The Existing Lines and Taps will be replaced in Sterling, Leominster, Gardner, Fitchburg, Westminster, Winchendon, Athol, Royalston, and Warwick, Massachusetts.

The Existing Lines and Taps are situated entirely within existing ROWs comprised of NEP easements or land owned in fee. The existing A1/B2 ROW encompasses approximately 47 miles of the Project Route and is, on average, 100 feet in width. The Athol Taps intersect the existing A1/B2 ROW in Athol, and the Crystal Lake Taps intersect in Gardner. The Athol Taps ROW comprises approximately six miles of the Project Route and is, on average, 125 feet wide. The remaining 1.2 miles of the Project Route are comprised of the Crystal Lake Taps ROW, which is generally 100 feet wide. Table 5-1 provides a breakdown of each of the Project Route components and their respective lengths and ROW widths.

Table 5-1: Project Route Components: Approximate ROW Widths and Mileage

Project Route Component	Existing ROW Width (ft)	Average Maintained ROW Width (ft)	Approximate Mileage (rounded to tenth)
Existing A1/B2 Line ROW	Varied Width: 100 to 450 ft[29] Average Width: 100 ft	Varied Width: 80-100 ft Average Existing Width: 85 ft Proposed Width: 100 ft	47
Existing Athol Tap Lines ROW	125 ft	Varied Width: 105-125 ft Average Existing Width: 115 ft Proposed Width: 125 ft	6
Existing Crystal Lake Tap Lines ROW	100 ft	Varied Width: 85-90 ft Average Existing Width: 85 ft Proposed Width: 100 ft	1.2
Total			**54.2 miles**

The Rebuilt Lines and Taps will generally be constructed on davit arm monopole steel weathering structures ranging in height from approximately 90 feet to 121 feet above ground (i.e., average 100 feet above ground). The A1/B2 structures will be double circuited, while the majority of the Tap structures will be single circuited. However, due to easement and terrain constraints, double circuit monopoles will be constructed in select locations on the Athol Taps.

With the exception of the Crystal Lake Taps and a few select suspension structures on the Existing Lines, the majority of the proposed suspension structures will be direct embedded. Dead-end structures along the Rebuilt Lines will be supported by concrete caisson foundations. The proposed caisson foundations are larger than the existing footprint of the concrete footers supporting the lattice towers, as well as the footprint of existing wood pole structures. Alternative foundation types such as helical piles, steel vibratory caisson foundations or micro pile foundations may be utilized if warranted by site conditions or other factors.

The Crystal Lake Taps will be constructed with a vertical davit arm configuration that allows for parallel single circuit structures without the need to expand the ROW to mitigate for potential vegetation related issues. Due to the asymmetrical structure load, concrete caisson foundations are required.

Route Maps

Project Route maps supporting the evaluation of Project impacts are provided in 11-inch by 17-inch format in Appendix 5-1.

Land Use Maps

The Land Use Maps, also provided in Appendix 5-1, illustrate land uses within the Project ROWs and an area of 300 feet measured from the edges of the Project Route. Land uses include mixed use, exempt property,[30]residential, commercial, agricultural, forest, industrial, water, recreational, transportation and other uses, as described in *Section 5.4.1*. The land use information was obtained from the Massachusetts

[29] The existing maintained width of the A1/B2 transmission corridor is generally 100 feet. However, in Sterling and Leominster, the A1/B2 Lines are collocated with a number of other transmission and distribution lines including the 69 kV U21 and V22 Lines, 115 kV I135S and J136S Lines, and the 230 kV E205E Line , therefore the corridor is wider to accommodate the additional circuits in these locations.
[30] Exempt Property are properties that qualify from exemption from taxation under various provisions of the law and include public land and facilities, hospitals, schools, churches, and cultural institutions, G.L. c. 59 §5.

Geographic Information System ("MassGIS") website. Land use mapping from MassGIS is based on 2022 aerial photography, and illustrates existing physical conditions identified by aerial photographs rather than zoning districts. A discussion of applicable zoning information and districts as they pertain to land use is provided for the Project Route in the sections below.

Environmental Resources Maps

The Environmental Resources Maps provided in Appendix 5-1 illustrate the natural and social environmental resources within the Project Route. Environmental resources include open space/recreational land, historic/archaeological sites, wetlands and water crossings, vernal pools (certified and potential), rare species habitat, and Outstanding Resource Waters ("ORW"). A detailed description of the environmental resources is presented in *Section 5.4*.

Environmental Justice Maps

The EJ Maps provided in Appendix 5-1 illustrate the 2020 EJ block groups, based upon demographic socioeconomic indicators developed by EEA within the 1-mile and 5-mile buffer to the ROW. The EJ maps include demographic data for the residents of each U.S. Census block group within the 1-mile and 5-mile radius of the Project Route including Minority, Income, Minority and Income, Minority and English Isolation, and Minority, Income and English Isolation. A summary of the EJ populations in the vicinity of the Project Route is provided in *Section 5.4.13*.

5.3 CONSTRUCTION METHODS

NEP has long established policies and procedures for minimizing construction related disturbances throughout all phases of construction. NEP and its contractors will follow these procedures for construction of the Project. These policies and procedures include National Grid's ROW Access, Maintenance and Construction Best Management Practices ("BMPs") EG-303NE ("National Grid's BMPs"), provided as Appendix 5-2.

This Section describes the general construction methods anticipated for the Project.

5.3.1. Overhead Transmission Line Construction Sequence

Conventional overhead electric transmission line construction techniques will be used to construct the Rebuilt Lines and Taps. The work will be completed in a progression of activities that will generally proceed as follows:

1. Removal of vegetation and ROW mowing in advance of construction.
2. Installation of soil erosion and sediment controls.
3. Construction of access routes and access route improvements.
4. Construction of work pads and staging areas.
5. Installation of foundations and structures.
6. Installation of conductor, OPGW, and shield wire.
7. Removal and disposal of existing transmission line components.
8. Restoration and stabilization of the ROW.

The following subsections describe the sequence of construction activities that will be used for the installation of the Rebuilt Lines and Taps. In addition to these activities, this section also addresses construction-related issues such as traffic, work hours, equipment, environmental compliance and monitoring, safety and public health considerations, and vegetation maintenance.

Tree Removal, ROW Mowing and Removal of Vegetation in Advance of Construction

Within the Project ROWs, mowing or other vegetation management is required prior to the start of construction to provide access to the proposed structure locations, to facilitate safe vehicular and equipment passage, and to provide safe work sites for personnel. Mowing will be completed by mechanical means. Small trees and shrubs will be mowed as necessary with the intent of preserving root systems to the extent practical. Where the Project Route crosses streams and brooks, any necessary vegetation mowing along the stream bank will be minimized to the extent practicable to reduce disturbance of soils and the potential for construction-related erosion.

Tree removal and trimming is also necessary to maintain required clearances between vegetation and the transmission line structures and conductors for reliable operation of the transmission facilities. The wood from trees removed within the ROWs will be offered to individual landowners, donated to a community wood bank, chipped and removed from the site or applied to upland areas. In certain environmentally sensitive areas, such as wetland resource areas and buffer zones, it may be necessary and desirable to leave felled trees and/or snags to decompose in place.

Temporary laydown areas will be established along the ROW to serve as locations to load timber, temporarily stage a wood-chipper, and park tree removal vehicles and equipment. Generally, trees to be removed will be cut close to the ground, leaving the stumps and roots in place, which will reduce soil disturbance and erosion. In locations where grading is required for accessibility and structure installation, stumps will be removed.

Installation of Soil Erosion and Sediment Controls

Following vegetation removal activities, erosion, and sediment control devices such as straw bales, straw wattles, siltation fencing, compost socks, and/or chip bales will be installed in accordance with National Grid's BMPs and approved plans and permit requirements. Installation of erosion and sediment controls may occur concurrently with installation of work pads, pulling pads, and/or access route construction. The installation of these erosion and sediment control devices will be supervised by NEP contractors and reviewed by NEP Construction Supervisors and/or designated environmental monitors. Erosion and sediment controls will be installed between the work site and environmentally sensitive areas such as wetlands, streams, drainage courses, roads, and adjacent properties when work activities will disturb soil and result in the potential for soil erosion and sedimentation. Erosion and sediment control devices will function to mitigate construction-related soil erosion and sedimentation and will also serve as a physical boundary to delineate resource areas and to contain construction activities within approved areas. NEP contractors, supervisors, and environmental monitors will regularly monitor installed controls.

In addition to those locations described above, erosion and sediment control devices will be installed along the perimeter of identified wetland resource areas prior to the onset of soil disturbance activities to ensure that stockpiles and other disturbed soil areas are confined and do not result in downslope sedimentation of wetland resources. Where structures requiring concrete foundations are located near wetlands, sedimentation controls will be installed to prevent transport of materials to these downgradient resource areas.

Construction and Improvement of Access

In preparation for construction, NEP will establish the physical access required to construct, inspect, and maintain the Rebuilt Lines and Taps through improvement of existing or historic accessways, temporary placement of construction mats, and construction of new access where necessary. Existing and proposed access routes are shown on the Environmental Resources Maps in Appendix 5-1.

In order to minimize construction impacts, NEP plans to move construction equipment on the existing ROWs to the maximum extent practicable, and to make use of existing access wherever feasible. However, in many cases, historic access ways will require significant improvement to meet the access requirements for the Project, ranging from a light resurfacing with clean gravel to full reestablishment, including mowing, grading, and addition of stone. Stabilized construction entrances will also need to be installed or refreshed where the ROWs cross public roadways.

In addition, new on- and off-ROW access will be needed for construction, inspection and maintenance of the Rebuilt Lines and Taps. New access routes have been designed to avoid or minimize disturbance to wetland resources to the extent feasible, to follow the existing contours of the land as closely as possible, and where practicable, to avoid severe slopes. Access way travel widths are generally 12 to 16 feet, but the constructed footprint may be wider in some locations to accommodate grading and stormwater BMPs, such as swales, stone check dams, water bars, or other similar measures.

Where access to structures cannot be obtained on the ROW due to challenging terrain or avoidance of environmentally sensitive areas, select off-ROW access alignments are proposed. The majority of these off-ROW access routes have been historically utilized for access to the Existing Lines and Taps, but improvements will be required for construction. NEP also plans to construct two new access ways to avoid future operation-related impacts to an extensive wetland system and state highway traffic. While off-ROW access will be designed in coordination with the property owners, most will be constructed of gravel, construction mats, or a combination thereof depending on site-specific conditions.

Where upland access is not available, access across wetlands and streams will be accomplished by the temporary placement of construction mats. The use of construction mats allows for heavy equipment access within wetland areas, minimizes the need to remove vegetation beneath the access way, and helps to reduce the degree of soil disturbance, soil compaction, and rutting in soft wetland soils. Construction mats most often used by NEP are wooden timbers bolted together typically into 4-foot by 16-foot sections. Typically, construction mats are installed on top of the existing vegetation; however, in some instances cutting or mowing woody vegetation may be required. Construction mats will be removed following completion of construction, and areas will be restored to reestablish pre-existing topography and hydrology, as necessary.

Access construction and improvements will be carried out in compliance with the conditions and approvals of the appropriate federal, state, and local regulatory agencies. Dust suppression measures, such as the use of water trucks to spray access surfaces, will be implemented as required to minimize fugitive dust from construction vehicle travel along the ROW. Crushed stone aprons/tracking pads will be used at all access entrances to public roadways as needed to minimize the migration of soils off-site from construction equipment. Additionally, stormwater BMPs will be installed as necessary as part of the access construction and improvement phase of the Project. These BMPs will reduce adverse impacts from stormwater flows, maintain the longevity of the access routes, and reduce overall maintenance needs.

Construction of Work Pads, Pulling Pads, and Staging/Laydown Areas

Work pads will be constructed to provide a safe and level work area for construction equipment to undertake foundation work and structure assembly, and to provide adequate space for the live line construction associated with the Project. Mowing of low growing woody vegetation and brush, and grading, may be necessary to create a work pad of approximately 160 feet by 80 to 100 feet at each proposed structure location. The work pads may be slightly smaller or larger depending on terrain, equipment, and overall site conditions at each structure location. Upland work pads will be constructed by grading and/or adding gravel or crushed stone to provide a stabilized work surface. Within agricultural areas and wetlands, work pads will consist of temporary construction matting placed on top of existing vegetation where feasible. Once construction is complete, some work pad locations (e.g., those located in environmentally sensitive areas, such as Riverfront Area, floodplain, and potentially rare species habitat) will be stabilized with topsoil and seeded to allow vegetation to re-establish.

Construction of wire stringing and pulling sites will be required at angle points in the Rebuilt Lines and at dead-end structures to provide a level workspace for equipment and personnel. Upland stringing and pulling sites may require mowing and grading to create a level work surface. Sites in agricultural and sensitive resource areas, such as wetlands and rare species habitat, will consist of construction matting placed on top of vegetation, where feasible. These temporary wire stringing and pulling sites will be stabilized and allowed to revegetate.

Temporary storage areas, staging areas, and laydown areas will also be needed to support construction. NEP and/or their designated contractor(s) will be responsible for selecting these areas and making arrangements with property owners for use of the land during construction. Selected staging areas and contractor laydown areas will typically be previously developed properties, where environmental resources can be avoided.

Installation of Foundations and Structures

Rebuilding the Existing Lines and Taps requires replacing steel and wood pole structures, including monopole, H-Frame and Chair Frame structures, with engineered weathering steel monopole structures to support the Rebuilt Lines and Taps. Monopole structures will be directly embedded into the ground or set upon reinforced concrete caisson foundations. Alternative foundation types such as helical piles, steel vibratory caisson foundations or micro pile foundations may be utilized, if warranted by site conditions or other factors.

Structures supported by concrete caisson foundations will result in approximately 79 square feet of fill (approximately 10 feet in diameter). Structures installed through direct embedment will result in approximately 28 square feet of fill (approximately 72 inches in diameter). Excavation will be performed using augers or rock drills, and depending on field conditions, backhoes, and excavators.

For direct embedment structures, a corrugated metal pipe will be placed vertically into the hole and backfilled. The annular space between the pole and the steel casing will then be backfilled with crushed stone. Caissons will be constructed by drilling a vertical shaft, installing a steel reinforced bar cage, placing anchor bolts clusters, pouring concrete, and backfilling as needed. The poles will be field assembled and lifted by cranes, then placed on the anchor bolts and into the embedded corrugated metal pipe.

Excavated material will be temporarily stockpiled next to the excavation; however, this material will not be placed directly into wetland resource areas. If a stockpile is in close proximity to wetlands, the excavated material will be enclosed by staked straw bales or other sediment controls. Additional controls, such as watertight spin off boxes or geotextile filter fabric, may be used for saturated stockpile management in work areas in wetlands (e.g., construction mat platforms) where sediment-laden runoff would pose an issue for the surrounding wetland. Excess excavated soil will be spread over upland areas outside of any applicable wetland buffer zones or other wetland resource areas or removed from the site in accordance with NEP's policies and procedures. Dewatering may be required during the foundation installation. Groundwater pumped from an excavation would be discharged to an upland area if there is adequate vegetation to function as a filter medium. Where conditions are not adequate for infiltration, water would be pumped into a sediment filter bag within a straw bale/silt fence corral (basin) located within an upland area. The basin and all accumulated sediment would be removed following dewatering operations and the area would be restored, as needed. Rock that is encountered during foundation excavation will generally be removed by means of drilling with rock coring augers rather than a standard soil auger. This method allows the same drill rig to be used and maintains a constant diameter hole. However, in some cases, rock hammering and excavation may be used to break up the rock. No blasting is currently anticipated for the Project.

Installation of Conductor and OPGW

Following the construction of transmission line structures, insulators will be installed on the structures. The insulators isolate the energized power conductors from the structure. OPGW and power conductors will then be installed using stringing blocks and wire stringing equipment. The wire stringing equipment is used to pull the conductors from a wire reel on the ground through stringing blocks attached to the structures to achieve the desired sag and tension condition. During the stringing operation, temporary guard structures or boom trucks will be placed at road and highway crossings, and at crossings of existing utility lines. These guard structures, and similar practices, are used to ensure public safety and uninterrupted operation of other utilities by keeping the wire away from other utility wires and clear of the traveled way.

Helicopter work is not anticipated at this time, but may be considered depending on the work methods proposed by the construction vendors. In the event helicopters are used, NEP would develop project-specific health and safety plans and hazard analyses in coordination with its contractor(s). NEP would notify municipal officials, fire, and police departments, and affected landowners, particularly those with livestock, in advance of any helicopter work.

Removal and Disposal of Existing Transmission Line Components

After the Rebuilt Lines and Taps have been placed into service, the existing structures will be removed. The majority of the existing structures are comprised of steel lattice towers. To facilitate their removal, a hydraulic shear will be used to cut and remove the steel lattice towers supporting the Existing Lines, and the steel will be salvaged. Conductors and insulators will also be salvaged and any equipment and debris that cannot be recycled will be transported to an appropriate off-site disposal facility. Handling of such materials will be performed in compliance with applicable laws and regulations and in accordance with NEP policy.

Wood pole structures will be removed in their entirety unless the complete removal of the pole will create an adverse impact to environmentally sensitive areas. The resulting hole will be backfilled and thoroughly tamped to minimize settling, then capped with native topsoil and allowed to revegetate. NEP will transport used wood poles to the nearest ROW street crossing that is accessible by truck for subsequent pick up. Treated wood poles will be transported for disposal at a licensed landfill or incinerator. All cross-arms, braces, and other hardware shall be removed from site and disposed of properly.

Restoration and Stabilization of the ROW

Restoration efforts, including removal of construction debris, final grading, and stabilization of disturbed soil, will be completed following construction. All disturbed areas around structure work pads and other graded locations will either be stabilized with a gravel surface or vegetated. Erosion control blankets, or similar, may be used to stabilize the soils in accordance with applicable regulations.

Temporary sediment control devices will be removed following the stabilization of disturbed areas. Existing stone walls and fences will be restored in accordance with property owner agreements and applicable local ordinances. Where authorized by property owners, permanent gates and access roadblocks will be installed at key locations to restrict access onto the ROW by unauthorized persons or vehicles. Regulated environmental resource areas temporarily or permanently disturbed by construction will be restored or replicated in accordance with applicable permit conditions.

5.3.2. Construction Traffic

Intermittent construction-related traffic will occur over the entire construction period. Construction equipment will typically gain access to the Project Route from public roadways crossing the ROW in various locations. Because each of the construction tasks will occur at different times and locations over the course of construction, traffic will be intermittent at these entry roadways. Traffic will consist of vehicle types ranging from pick-up trucks to heavy construction equipment.

NEP's contractors will coordinate closely with state transportation authorities to develop acceptable traffic management plans for work within state highway layouts. NEP will coordinate with local authorities for work on local streets and roads. At locations where construction equipment must be staged in a public way, the contractors will follow a pre-approved work zone traffic control plan. Further traffic information is provided in *Section 5.4.10*. NEP will notify affected landowners in advance of any use of off-ROW access and will work on a case-by-case basis with any abutting landowners that express concern.

5.3.3. Construction Work Hours

Construction activities and related deliveries will be limited to 7:00 a.m. to 7:00 p.m. on weekdays and 8:00 a.m. to 5:00 p.m. on Saturdays, with no construction on Sundays or state/federal holidays. Some work tasks such as concrete pours and transmission line stringing, once started, must be continued through to completion, and may go beyond normal work hours. Construction hours will be developed in consultation with the municipalities of Athol, Westminster, Fitchburg, Leominster, Royalston, Warwick, Gardner, Sterling, and Winchendon, the MassDOT, and the MBTA.

None of the municipalities have specific limits on construction work hours; instead, they determine work hours on a case-by-case basis. NEP will work closely with each of the municipalities to negotiate mutually agreeable work hours. In addition, during construction, NEP will assign a community outreach representative to keep abutting property owners and municipal officials informed about the Project as it progresses along the ROW through each community.

5.3.4. Environmental Compliance and Monitoring

NEP will retain the services of environmental compliance monitors to observe civil construction activities, including the installation and maintenance of soil erosion and sediment control BMPs, on a routine basis to ensure compliance with all federal, state, and local permit commitments. The environmental monitors will be experienced in soil erosion and sediment control techniques and will have an understanding of wetland resources to be protected.

In addition, NEP will require that its construction contractors designate a construction supervisor or equivalent to be responsible for coordinating with the environmental monitor and for regular inspections and compliance with permit requirements. This person, or the team involved, will be responsible for providing appropriate training and direction to the other members of the construction crew regarding work methods as they relate to permit compliance and construction mitigation commitments. Additionally, construction personnel will undergo pre-construction training on appropriate environmental protection and compliance obligations prior to the start of construction of the Project. Training topics will include environmental, stormwater management, cultural resources, and safety considerations. Daily tailboard meetings will occur including a review of the day's environmental requirements and considerations. Regular construction progress meetings will be held to reinforce contractor awareness of these mitigation measures, and training will be provided to new crew members as they join the work force.

NEP will develop and maintain a Stormwater Pollution Prevention Plan ("SWPPP") and Soil Erosion and Sediment Control Plan for the Project. The SWPPP will identify controls to be implemented to avoid and minimize the potential for erosion and sedimentation from soil disturbance during construction. The SWPPP will include a construction personnel contact list, a description of the proposed work, stormwater controls and spill prevention measures, and inspection practices to be implemented for the management of construction-related storm water discharges from the Project. The SWPPP will be adhered to by the contractors during all phases of Project construction in accordance with the general conditions prescribed in the Project's U.S. Environmental Protection Agency ("USEPA") Stormwater Construction General Permit.

As necessary, deficiencies of erosion and sediment control measures and other permit compliance matters will be immediately brought to the attention of the contractor's construction supervisor for implementation of corrective measures. A copy of the Final Decision issued by the Siting Board, and copies of all other permits and approvals, will be provided to and reviewed by NEP project managers and construction supervisors in advance of construction. These documents will also be provided to the contractor's project manager and construction supervisor prior to construction. Contractors are required, through their contracts with NEP, to understand and comply with Siting Board conditions or requirements and any other applicable Project permits and approvals. NEP also requires contractors to keep copies of these documents on site and available to all personnel during construction. These documents and applicable conditions will also be reviewed during the construction kick-off meeting in the field between NEP representatives and contractor personnel.

5.3.5. Safety and Public Health Considerations

NEP will construct and maintain the proposed Project so that the health and safety of the public is protected. This will be accomplished through adherence to all federal, state, and local regulations, and industry standards and guidelines established for protection of the public. Practices that will be used during construction will include, but not be limited to, establishing traffic control plans for construction traffic on busy streets to maintain safe driving conditions, restricting public access to potentially hazardous work areas, and using temporary guard structures at road and electric line crossings to prevent accidental contact with the conductor during installation.

Prior to construction, NEP will ensure all contractors are familiar with and understand NEP's detailed public safety measures. All safety measures will conform to NEP's Safety Procedures and Work Area Protection Manual. Site-specific measures in this document include traffic control, excavation protection, exclusionary fencing, warning signs/devices, safety and orientation training for all crew members, and general housekeeping.

Following construction, all transmission structures will be clearly marked with warning signs to alert the public to potential hazards if climbed or entered. Throughout the Project design and implementation sequence, NEP will evaluate locations that may require the installation of signs, and/or other types of barriers (e.g., large stones) at access points from public roads.

5.4 ENVIRONMENTAL IMPACT ANALYSIS

This section describes the existing conditions along the Project Route, presents an analysis of potential impacts to specific resources as a result of Project construction, and describes the measures NEP proposes to undertake to avoid, minimize, and mitigate such impacts.

Categories of potential impacts considered include land use, protected lands and open space, historic and archaeological resources, tree removal, wetlands and water resources, rare species habitat, noise, visual, traffic and transportation, electric and magnetic fields, climate change, and EJ considerations. Data on natural and social environmental resources were compiled for the Project Route using field collected data and most recently available MassGIS data and mapping.

5.4.1. Land Use and Sensitive Receptors

The Project Route is located entirely within existing ROW corridors held in fee or easement by NEP. With the exception of the establishment of two new, off-ROW access ways, Project construction is contained within existing NEP ROWs and along historically utilized access routes. There are no anticipated permanent changes to abutting land uses associated with construction of the Project along the Project Route. Additional easements are only needed for the two new off-ROW access ways and no other property acquisitions are necessary. However, NEP has evaluated land uses within the Project ROWs, as well as adjacent lands within 300 feet, to identify potential impacts to abutting stakeholders during construction.

To identify land uses along the route, MassGIS land use data layers were overlaid onto aerial photographs, field investigations were completed to confirm existing conditions, and Project-specific land use categories and maps were created by combining MassGIS data with information collected in the field. As listed in Table 5-2, land uses along the Project Route are predominantly Exempt Properties and residential areas, interspersed with vacant, and industrial uses. Land use types along the Project Route are also shown in the Map Book in Appendix 5-1.

Table 5-2: Land Uses Within the Project ROWs and 300-foot Buffer to ROW

Land Use Type	Project Route (Acres)	
	Within Existing ROWs	300-foot Buffer to Existing ROWs
Agricultural/ Horticultural	2	19
Commercial	3	29.5
Exempt Property	395	1552

Land Use Type	Project Route (Acres)	
	Within Existing ROWs	**300-foot Buffer to Existing ROWs**
Forest Property[31]	32	195
Industrial	80	184
Mixed Use	66	198
Recreational Property[32]	1	8
Residential	139	719
Vacant[33]	85	416
Transportation	19	117
Unknown	2	13
Water	3	27
Total	**829**	**3,479**

As shown in Table 5-2, the primary land use on the Project ROWs and within 300 feet consists of approximately 1,947 acres of Exempt Property. Exempt Property associated with the Project includes land owned primarily by municipalities and DCR. Municipal lands include conservation land such as Bailey Brook Conservation Area in the City of Gardner, Minnie French Conservation Area in the Town of Athol, Nashua Valley, Elm Street and Hill Street Conservation Area in the City of Leominster, and Shenk Farm Conservation Area in the Town of Westminster. DCR properties include the Royalston State Forest, Warwick State Forest, Leominster State Forest, and Otter River State Forest. In addition, the U.S. Fish and Wildlife Service ("USFWS") has Exempt Property in the municipalities of Athol, Royalston, and Westminster. Mount Wachusett Community College property is within a half mile of the ROW, and the parking lot of the college is within 300 feet of the ROW in the City of Gardner.

Secondarily, approximately 139 acres and 719 acres of land on Project ROWs and within 300 feet are classified as residential land use, respectively. Single-family and multi-family residential development is predominantly located in Gardner and Leominster. Along the Project Route, single-family residential development occurs primarily at existing roadway crossings such as Pearl Street and Chapel Street in Gardner; North Common Road, Town Farm Road, Bartherick Road, near Willard Road, and Turnpike Road in Westminster; Pleasant Street, Samoset Drive, and Willard Street in Leominster; and near Legate Hill Road in Sterling near Pratts Junction Substation. Multi-family residential development occurs primarily at existing roadway crossings such as Pleasant Street in Leominster, and Turnpike Road, Willard Road, Newcomb Road, Town Farm Road, and Oakmont Avenue in Westminster.

[31] Forest lands are lands designated under Chapter 61 ("Forest Tax Program") and Christmas trees as per property type classification codes prepared by the Bureau of Local Assessment revised April 2019. Source - Bureau of Local Assessment. (2019, April). Property Type Classification Codes - Massachusetts. PROPERTY TYPE CLASSIFICATION CODES. Retrieved April 4, 2023, from https://www.mass.gov/doc/property-type-classification-codes-non-arms-length-codes-and-sales-report-spreadsheet/download

[32] All property designated under Chapter 61B including productive woodland, golfing, hiking – trail or paths, etc. Source - Bureau of Local Assessment. (2019, April). Property Type Classification Codes - Massachusetts. PROPERTY TYPE CLASSIFICATION CODES. Retrieved April 4, 2023, from https://www.mass.gov/doc/property-type-classification-codes-non-arms-length-codes-and-sales-report-spreadsheet/download

[33] According to G.L. c. 59 §2A, vacant land includes developable land, potentially developable land, undeveloped land, and agricultural/horticultural land not included in Chapter 61A. Source - Bureau of Local Assessment. (2019, April). Property Type Classification Codes - Massachusetts. PROPERTY TYPE CLASSIFICATION CODES. Retrieved April 4, 2023, from https://www.mass.gov/doc/property-type-classification-codes-non-arms-length-codes-and-sales-report-spreadsheet/download

Industrial development includes All-Purpose Storage located adjacent to Colony Road, near State Highway 140 in Gardner. MarLee Texen, Image Diagnostics, Inc., and MR Resources are manufacturing companies located along Authority Drive, near State Highway Route 2 in Fitchburg. There are a few industrial developments near Beverly Drive and Legate Hill Road in Sterling. Additionally, commercial areas are sparsely distributed within the Project Route near Colony Road, Gardner, and Lock Drive near State Highway Route 2 in Leominster. ROW land use (19 acres) includes transportation corridors such as State Highway Route 2, MBTA Fitchburg Line, and MassDOT roads.

Sensitive receptor land uses are defined as public facilities including hospitals, elder care facilities and nursing homes, public and private schools, cemeteries, licensed daycares, district courts, police stations, fire stations, and places of worship. Two sensitive receptors – a fire station, and a police station, located within the same building in the Town of Royalston, are located within 55 feet of the Project ROW.[34]

Avoidance, Minimization, and Mitigation

There are no anticipated permanent changes to abutting land uses associated with construction of the Project along the Project Route and no property acquisitions are necessary. The Rebuilt Lines and Taps are replacing Existing Lines and Taps within the Project ROW corridors held in fee or easement by NEP. This is consistent with the existing and surrounding utility infrastructure and current land uses. While Project construction may result in temporary impacts to abutting stakeholders, the Project infrastructure is not anticipated to interfere with any residential, business, or other public facilities.

A construction communication plan will be developed for the Project that will provide outreach during construction and a consistent point of contact for the public. Recognizing the varying needs of its stakeholders, NEP is developing various communication methods to inform stakeholders of construction activities, including, as needed: work area signage; advance notification of scheduled construction; personal contact with residents, community groups, and businesses; and regular e-mail updates to residents (upon request) and local officials that will include information on upcoming construction activity. A public website ("https://www.newenglanda1b2.com/") has been made available for this Project which provides details of the Project, an interactive map, and contact information.

As discussed in further detail in the Sections that follow, NEP will mitigate temporary impacts related to noise (*Section 5.4.9*) and traffic and transportation (*Section 5.4.10*). With the implementation of these measures, the anticipated impacts of the Project on adjacent land uses will be minimized.

5.4.2. Protected Lands, Open Space and Recreation

Within areas classified as protected lands or open space and recreation, Project construction is contained within existing NEP ROWs and along historically utilized access routes. As such, there are no anticipated permanent changes to open space and recreational land uses associated with construction of the Project along the Project Route and no additional easements or property acquisitions are necessary. However, NEP has evaluated protected lands and properties used for open space and recreation within the Project ROWs, as well as adjacent lands within 300 feet, to identify potential impacts to abutting stakeholders during construction.

[34] The distance from the edge of the building to the ROW is approximately 55 feet.

Protected open space and recreational land uses were identified using the MassGIS Protected and Recreational Open Space data layer[35] and are depicted in the Map Book in Appendix 5-1. Table 5-3 shows a summary of all Open Space and Recreation Resources identified for the Project. As part of this analysis, NEP also evaluated Areas of Critical Environmental Concern[36] ("ACECs"), No ACECs are located within proximity of the Project ROW and within 300 feet of the ROW.

Table 5-3: Open Space and Recreation Resources[37]

Open Space and Recreation Resources				
Municipality	**Site Name**	**Agency**	**Owner**	**Primary Purpose**
ATHOL	Millers River Watershed Management Area) (WMA)	State	MA Department of Fish and Game	Conservation
	Minnie French Conservation Area	Local	Town of Athol	Conservation
FITCHBURG	Leominster State Forest	State	MA DCR - Division of State Parks and Recreation	Recreation
GARDNER	Crystal Lake West	Local	City of Gardner	Recreation
	Municipal Golf Course	Local	City of Gardner	Recreation
	Bailey Brook Conservation Area	Local	City of Gardner	Conservation
	Gardner Water Supply Land	Local	City of Gardner	Water Supply
	North County Land Trust Conservation Restriction ("CR")	Local	North County Land Trust	Conservation
	Crystal Lake Cemetery	Local	City of Gardner	Cemetery
LEOMINSTER	Nashua Valley Conservation Area	Local	City of Leominster	Conservation
	Notown Reservoir Watershed	Local	City of Leominster	Water Supply
	Notown Reservoir	Local	City of Leominster	Water Supply
	Fall Brook Reservoir	Local	City of Leominster	Water Supply
	Leominster State Forest	State	DCR - Division of State Parks and Recreation	Recreation
	Cutler Conservation Area	Local	City of Leominster	Conservation

[35] MassGIS (Bureau of Geographic Information); December 2021.

[36] ACECs are identified as environmentally significant places in Massachusetts that receive special recognition because of the quality, uniqueness, and significance of their natural and cultural resources.

[37] This list contains G.L. c. 59 §2A - Land which is not otherwise classified, and which is not taxable under the provisions of Chapter 61, 61A or 61B, or taxable under a permanent conservation restriction, and which land is not held for the production of income but is maintained in an open or natural condition and which contributes significantly to the benefit and enjoyment of the public. Chapter 61, 61A, 61B Property Being Classified as Open Space Source might overlap with Exempt Property above. Source - Bureau of Local Assessment. (2019, April). Property Type Classification Codes - Massachusetts. PROPERTY TYPE CLASSIFICATION CODES. Retrieved April 4, 2023, from https://www.mass.gov/doc/property-type-classification-codes-non-arms-length-codes-and-sales-report-spreadsheet/download

Open Space and Recreation Resources				
Municipality	**Site Name**	**Agency**	**Owner**	**Primary Purpose**
	Elm Street Conservation Area	Local	Leominster Land Trust	Conservation
	City of Leominster CR/Agricultural Preservation Restriction (“APR”)	Local	City of Leominster	Conservation/Agricultural
	Powers Lawrence APR	Private	Powers, Lawrence, and Sharon	Agricultural
	Hill Street Conservation Area	Local	Leominster Land Trust	Conservation
ROYALSTON	Royalston State Forest	State	DCR - Division of State Parks and Recreation	Conservation and Recreation
	Chase Memorial Forest	Local	New England Forestry Foundation	Conservation
	Fish Brook Wildlife Conservation Easement (“CE” or “WCE”)	Local	Corser, R.	Conservation
	Jacobs Hill Reservation	Local	The Trustees of Reservations	Conservation
	Stockwell & Tully CR	Local	Mount Grace Land Conservation Trust	Conservation
	Chase Memorial Forest	Local	New England Forestry Foundation	Conservation
	Otter River State Forest	State	DCR - Division of State Parks and Recreation	Conservation and Recreation
	Davis Hill Farm CR	Private	Longsworth, Charles R and Mary O	Conservation and Recreation
	Lawrence Brook WCE	Private	Byers, Frank H.	Conservation
	Millers River WMA	State	Department of Fish and Game	Conservation
	Birch Hill WMA	State	Department of Fish and Game	Conservation
	Tully Lake	Federal	USACE	Conservation
WARWICK	Jay CR	Private	Jay, Ralph L.	Conservation
	Warwick State Forest	State	DCR – Division of State Parks and Recreation	Conservation and Recreation
WESTMINSTER	Conservation Area	Local	Town of Westminster	Conservation
	Schenk Farm Conservation Area	Local	Town of Westminster	Conservation
	High Ridge WMA	State	Department of Fish and Game	Conservation

Open Space and Recreation Resources				
Municipality	**Site Name**	**Agency**	**Owner**	**Primary Purpose**
	Tophet Swamp Conservation Area	Local	North County Land Trust	Conservation
WINCHENDON	Lake Dennison Recreation Area	Federal	USACE	Recreation
	Unnamed	Federal	USACE	N/A
	Bailey Brook Conservation Area	Local	City of Gardner	Conservation
	Otter River State Forest	State	DCR – Division of State Parks and Recreation	Conservation and Recreation

NEP identified 37 federal, state, private, municipal, and non-profit owned open space lands located within or adjacent to the Project ROWs, consisting of a total of approximately 341 acres of open space within the Project ROW and 1,398 acres within 300 feet of the Project ROW. The primary purposes of these protected lands include recreation, conservation, habitat protection, water supply protection, and cultural/historical. Many of these areas provide year-round recreational opportunities such as hiking and nature study, and seasonal activities such as fishing. The majority of the open space areas located adjacent to the Project ROWs provide scenic views and are often associated with rivers, reservoirs, wetlands, streams, rivers, and state forests.

DCR owns and manages four state forests within 300 feet of the Project ROWs. These properties account for 79.5 acres of land within the Project ROWs, and approximately 378 acres within 300 feet. The largest state forest area is the Warwick State Forest in Warwick. Warwick State Forest is a protected forest popular for hiking and outdoor pursuits with a large trout lake. A number of trails within the State Forest cross the Existing ROWs. The other state forests consist of the Royalston State Forest in Royalston, the Otter River State Forest in Royalston and Winchendon, and the Leominster State Forest in Fitchburg. These DCR properties offer opportunities for recreational activities to residents and visitors. Several multi-use trails intersect the existing ROWs. DCR trails vary in type from forest roads and trails with natural surfaces to processed gravel, varying in width and condition.

The majority of Project construction activities will take place within the existing ROWs to minimize impacts to adjacent open spaces. NEP's easements for the Existing Lines and Taps predate the establishment of DCR properties and state forests in these areas. NEP holds easements that grant rights for the construction and maintenance of towers, poles, wires, and other structures for the transmission of electric power in these locations. The Project has been designed to utilize existing access within NEP easements wherever feasible. However, improvements to existing access and construction of new access ways within existing easements will be required within State Forest lands. The off-ROW access improvements are within NEP's legal rights under its existing easements. Because of these existing easement rights, NEP does not need to proceed through the Article 97 disposition process to construct the Project. However, discussions are ongoing with DCR. Construction Access Permits will be obtained from DCR for the proposed off-ROW access improvements.

Avoidance, Minimization, and Mitigation

The Project Route is located within existing ROWs held in fee or easement by NEP. Rebuilding the Existing Lines and Taps along the Project Route is consistent with the existing use of these ROWs. Since the Project will continue to support utility infrastructure, it is not anticipated to interfere with any long-term existing or future land uses. In addition, the Project has been designed to utilize existing access rights, except in two locations where additional rights will be required from private landowners.

NEP will provide notification of the intended construction plan and schedule to any affected abutters so that the effect of any temporary disruptions may be minimized. To mitigate temporary construction-phase disturbances to public open spaces, specifically existing trail systems, NEP will coordinate with the affected stakeholders and will develop an outreach plan to include safety signage and temporary detours around active construction zones. Normal operation at all facilities will continue and existing land uses will be allowed to continue following construction.

Some wildlife habitat functions associated with forested areas will be permanently altered as a result of tree removal; however, they will be replaced with the increasingly scarce scrub/shrub habitat. Post-construction stabilization and restoration of the ROWs will also facilitate natural revegetation on the ROW and reestablish available wildlife habitats on the ROW.

With the implementation of these measures, the anticipated impacts of the Project on protected, open space, and recreational lands will be minimized.

5.4.3. Historic and Archaeological Resources

This section describes archaeological sites and historic architectural properties present in the vicinity of the Project. Historic and archaeologic resources include, but are not limited to, buried archaeological sites, standing historic structures, or thematically related groups of buildings, structures, or properties (usually organized as historic "districts" or "areas").

NEP contracted SWCA Environmental Consultants ("SWCA") to conduct a cultural resource due diligence review of the Project. SWCA consulted with MHC and reviewed the MHC's *Inventory of Historic and Archaeological Assets of the Commonwealth* through the Massachusetts Cultural Resource Information System in June and July 2020. The background research included coalescing land use history of the project corridor, previous archaeological surveys, recorded archaeological sites both Native American and of the Historic period, National Register of Historic Places ("NRHP"), historical inventory points, and cemeteries. To be considered significant and eligible for listing on the State or National Registers of Historic Places (State/National Register), a cultural resource must exhibit physical integrity and contribute to American history, architecture, archaeology, technology, or culture, and must meet at least one of the following four criteria (Code of Federal Regulations (36 CFR 60):

- Association with important historic events;
- Association with important persons;
- Distinctive design or physical characteristics; or
- Potential to provide important new information about the pre-contact, contact, or historic periods of history.

SWCA established a study area at one kilometer ("km") from the A1/B2 centerline, as well as one km from the centerline of the Tap Lines to account for all known archaeological and cultural resources. Approximately 60 archaeological sites were recorded within this study area. Out of these, 14 are Native American sites and 46 are historic archaeological sites. Using MHC's online database, Royalston, Winchendon, and Fitchburg were found to have denser concentrations of archaeological sites. Additionally, eight NRHP properties fall within the study area, although only two intersect with the Project Route. The

Existing Lines cross through Royalston Historic District around Structures 260-263. Because the Project consists of replacing existing electrical transmission structures with new ones, SWCA concluded that the Project will not change the feel, setting, or characteristics of the Historic District, and therefore will have no effect on these historical properties.

The location of archaeological resources is sensitive and protected information per G.L. c. 9, §26A.

Avoidance, Minimization, and Mitigation

The Project Route is located within established ROWs associated with the Existing Lines and Taps. For the majority of the Project Route, the Rebuilt Lines and Taps and associated tree removals are not expected to impact the existing viewshed from abutting above-ground resources. However, discussions are ongoing with the Royalston Historic District Commission regarding potential impacts associated with the new structure types and locations. Construction within the ROW has the potential to impact archaeological sites depending on the depth and extent of planned ground disturbance in relation to archaeological resources.

The Project will be subject to review under Section 106 of the National Historic Preservation Act ("Section 106") and will require a permit from the USACE. The Project will also be subject to review by the MHC under G.L. c. 9, §§ 26–27C. NEP will coordinate with the USACE and MHC to incorporate avoidance and/or minimization measures as needed to avoid adverse effects to potential NRHP-eligible or -listed cultural resources. As part of the USACE Section 404 permit review, and pursuant to Section 106, the USACE will also consult with federally recognized Native American Indian Tribes that express an interest in the cultural resources that may be affected by the Project.

NEP will continue to coordinate with SWCA, in consultation with MHC and the USACE, to identify historic, archaeological, or cultural resources prior to construction and to avoid, minimize, or mitigate impacts to cultural and historic resources. Any protection or avoidance measures required to avoid or minimize impacts to significant resources will be outlined in an Avoidance and Protection Plan. Procedures to handle unanticipated discoveries during construction will be specified as part of a Post Review Discoveries Plan.

5.4.4. Tree Removal

As described in *Section 5.4.1*, the Project ROWs primarily traverse forested, Exempt Properties. To provide a safe area for construction, future maintenance, and operation, and to ensure the reliability of the Rebuilt Lines and Taps, NEP will remove trees in select locations along the edges of the existing Project ROWs as follows:

- The A1/B2 ROW is currently cleared of tall woody vegetation to approximately 85 feet wide on average throughout the corridor. NEP is proposing to remove trees in select locations to maintain approximately 100 feet of its 100-to-450-foot-wide ROW.
- The Athol Taps ROW is currently cleared of tall woody vegetation to approximately 115 feet wide on average throughout the corridor. NEP is proposing to remove trees in select locations to maintain approximately 125 feet of its 125-foot-wide ROW.
- The Crystal Lake Taps ROW is currently cleared of tall woody vegetation to approximately 85 feet wide on average throughout the corridor. NEP is proposing to remove trees in select locations to maintain approximately 100 feet of its 100-foot-wide ROW.

In order to operate the Rebuilt Lines in accordance with the North American Electric Reliability Corporation ("NERC") document FAC-003-4 "Transmission Vegetation Management" with the conductors under "blowout" conditions (six pounds per square foot of wind on wire) approximately 100 acres of tree removal, including 91.5 acres of upland and 8.5 acres of wetland, will be required within the forested areas of the Project ROWs.

Table 5-4: Proposed Tree Removal for the Project Route

Tree Removal Location	Project Route (on-ROW) (acreage)[38]	Access (off-ROW) (acreage)
Forested Uplands	91.5	30.5
Forested Wetlands [39]	8.5	0.7
Subtotal Tree Removal	**100**	**31.2**
Total Tree Removal	**131.2 Acres[40]**	

Additionally, up to approximately 31.2 acres of off-ROW tree removal will be required to accommodate new, improved, or reestablished access ways in areas where on-ROW access would result in greater wetland and traffic impacts[41] (Refer to Environmental Resources Maps in Appendix 5-1). Where historic access requires widening or grading, or new access is required to accommodate modern equipment, more extensive tree removal will be required.

Temporary impacts to wildlife are anticipated in association with tree removal along the forested edge of the Project Route. However, large blocks of intact woodland will not be impacted and will remain for wildlife use. Larger, more mobile species such as large mammals (white-tailed deer) are expected to temporarily relocate from construction areas but are unlikely to be permanently impacted by the displacement. Small mammals such as gray squirrels (*Sciurus carolinensis*), woodchucks (*Marmota monax*), and possibly furbearers (skunks and raccoons), as well as herpetofauna are also likely to be temporarily displaced; however, upon the recovery of the habitat, the increased availability of maintained, early seral stage habitat will enhance habitat diversity for herptiles and other cold-blooded fauna (insects and other invertebrates). Depending upon the time of year, some avifauna may also be temporarily displaced, possibly affecting breeding and nesting activities; however, these species are likely to return after construction and in subsequent years.

[38] Rounded to the nearest 100th. Acreage includes the approximate, existing canopy cover to be removed as a result of trees being removed from within the ROW.

[39] Wetlands include local, state, and federal freshwater wetlands as defined in the Federal Clean Water Act (33 U.S.C. §§ 1251 et seq., Section 404 and Section 401), MWPA (G.L. c. 131 § 40) and Regulations (310 CMR 10.00), and local bylaws/ordinances for each municipality along the Project Route. These wetlands include all field delineated Bordering Vegetated Wetland ("BVW") within and adjacent to the Project ROW.

[40] As a result of further analysis by the Project team during the 75% design phase, and a general reduction in the limit of disturbance associated with Project activities, tree removal impacts have been reduced since the MEPA EENF was filed in October 2022.

[41] Two new off ROW access routes are proposed to limit future impacts to an extensive wetland system and state highway traffic patterns.

Avoidance, Minimization, and Mitigation

Utilizing the existing ROWs associated with the Project Route greatly minimizes the need for new tree removal for the Project. Specifically, the majority of the Project Route consists of the existing A1/B2 ROW, which has been maintained in its corridor for over a century. Therefore, approximately 47 miles of the 54-mile Project Route likely predated many of the adjacent land uses, and the vegetation maintenance cycle has regularly modified the landscape on- and off-ROW for decades. Similarly, the Tap Lines have been refurbished and maintained regularly in their existing ROWs.

For tree removal within the Project ROWs, NEP used Light Detection and Ranging data to measure, digitize, and assess vegetation heights. This analysis, coupled with field reviews, allowed NEP to determine where tree removal would be required to ensure conformance with the appropriate vegetation management operating criteria within the ROWs, and where trimming, pruning, or other management techniques would be sufficient. Lower growing shrubs identified during this analysis will be allowed to remain in all areas not required for construction work pads and access roads.

For tree removal off-ROW, where access is located along historically used access routes, and minimal improvements are required, trees adjacent to each access way will be evaluated in the field. With the approval of landowners, only trees required to safely accommodate passage of construction equipment and vehicles will be removed. Of the 31.2 acres of tree removal proposed, 14.5 acres will be evaluated using this selective tree removal methodology.

Due to the avoidance and mitigation measures summarized above, tree removal proposed in forested wetlands is minimal. However, where necessary, felled trees and/or snags and slash piles may be left in place and may provide some wildlife habitat features. As feasible, trees may be topped to offer wildlife habitat benefits. Low scrub-shrub wetland plant communities will be left intact with the exception of access routes where temporary construction matting is proposed.

Prior to tree removal, trimming, and mowing, the boundaries of wetlands will be clearly marked to prevent unauthorized vehicular encroachment into wetland areas. Appropriate forestry techniques will be implemented within wetlands to minimize ground disturbance. Other sensitive resources, such as cultural resource features and NHESP state-listed plant species, will be flagged and encompassed with protective fencing prior to removal of vegetation on the ROW. Temporary construction mats will be used to gain access to and across wetlands, to minimize wetland disturbance, and to provide stable platforms for safe equipment operation.

NEP anticipates the final mitigation package will be developed during the federal, state, and local permitting processes outlined in the next section, and that the package will fully address the required permit conditions and agency concerns. If required or otherwise determined to be necessary, a mitigation plan using native plant species may be implemented to supplement the re-establishment of vegetation.

5.4.5. Wetlands, Water Resources and Vernal Pools

The Project's wetland, watercourse, and vernal pool impacts have been minimized to the greatest extent practicable by utilizing ROWs associated with the Existing Lines and Taps and existing access ways where feasible. However, given the scale and landscape setting of the Project, certain wetland impacts cannot be avoided.

The assessment of wetlands and watercourses within the Project ROWs is based on field reviews and wetland delineations performed for the Project in Spring 2020, Summer 2021, and Spring 2022. The vernal pool assessment and identification of wetlands, water crossings, and vernal pools located outside of the Project ROWs is based on field delineations and the following digital data layers:

- MassDEP Wetlands Data[42]
- USGS National Hydrography Data ("NHD")[43]
- MassGIS NHESP Certified Vernal Pool ("CVP") Maps[44]

Table 5-5 summarizes the wetlands, watercourses, and vernal pools associated with the Project, which are also depicted in the Map Book in Appendix 5-1.

Table 5-5: Wetlands, Watercourses, and Vernal Pools Associated with the Project

Resources	Units	Existing Wetlands along Project Route		Potential Impacts (acreage)		
		ROW[1]	Off-ROW[1]	Temporary	Secondary	Permanent
Wetlands[45]	Acreage	169	16[46]	38	9	0[2]
Streams (Perennial)	Number	49	15	0.3	0.2	0
Streams (Intermittent)	Number	43	37	0[3]	0.1	0[4]
Certified Vernal Pools	Number	1	6	0[5]	0	0

[1]Based on field delineated data of NEP overhead transmission line ROW.
[2] Rounded to the nearest tenth. Equivalent to a total of 2,302 square feet.
[3] Rounded to the nearest tenth. Equivalent to a total of 3,071 square feet
[4] Rounded to the nearest tenth. Equivalent to a total of 79 square feet.
[5] Rounded to the nearest tenth. Equivalent to a total of 1,003 square feet.

In summary, a total of 185 acres of wetlands were identified along the Project Route. Approximately 169 acres of wetlands were identified within the Project ROWs, and 16 acres were delineated off-ROW adjacent to Project activities (e.g., access improvements). Wetlands are found sporadically throughout the entire Project Route. These wetlands typically consist of scrub-shrub, emergent marsh, or wet meadow communities. In accordance with the federal classification system found in Cowardian (1979),[47] Palustrine Forested Wetlands, Palustrine Emergent Wetlands, and Palustrine Scrub Shrub Wetlands, were identified

[42] MassGIS. 2017. MassGIS Data: MassDEP Wetlands. Retrieved October 26, 2022 from https://www.mass.gov/info-details/massgis-data-massdep-wetlands-2005#downloads-.
[43] United States Geological Survey. 2016. NHD Viewer. Retrieved May 26, 2021, from https://nhd.usgs.gov/NHD_High_Resolution.html.
[44] MassGIS. 2022. MassGIS Data: NHESP Certified Vernal Pools. Retrieved October 26, 2022 from https://www.mass.gov/info-details/massgis-data-nhesp-certified-vernal-pools.
[45] Wetlands include local, state, and federal freshwater wetlands as defined in the Federal Clean Water Act (33 U.S.C. §§ 1251 et seq., Section 404 and Section 401), MWPA (G.L. c. 131 § 40) and Regulations (310 CMR 10.00), and local bylaws/ordinances for each municipality along the Project Route. These wetlands include all field delineated BVW within and adjacent to Project ROW.
[46] Calculated for within 30 feet of the access routes.
[47] The Cowardin system is used by the USFWS for the National Wetlands Inventory. In this system, wetlands are classified by landscape position, vegetation cover and hydrologic regime. The Cowardin system includes five major wetland types: marine, tidal, lacustrine, palustrine, and riverine.

on the existing ROWs. Additional information on field delineated wetlands for the Project Route is outlined in the EENF in Appendix 6-1.

Construction will result in temporary, secondary, and permanent impacts to wetland resources. Temporary impacts associated with the construction of the Project include placement of construction matting, secondary impacts include tree removal, and permanent impacts include fill associated with the installation of the structures. Based on preliminary design, construction of the Project will result in approximately 38 acres of temporary impacts, nine acres of secondary impacts, and 0.05 acres (or 2,381 square feet) of permanent impacts to wetlands.

Avoidance, Minimization, and Mitigation

To reduce the impacts associated with the construction and operation of the Project, NEP incorporated design measures to minimize permanent impacts and BMPs to minimize temporary alterations associated with construction. In addition to using existing ROWs, design measures include utilizing existing access routes and avoiding the placement and construction of structures and access in wetlands and watercourses where possible. This has resulted in the avoidance and minimization of impacts to wetlands, watercourses, and vernal pools to the greatest extent practicable.

Additional impact minimization measures include utilizing temporary construction mats for wetland access and work pads instead of permanent fill (i.e., stone, or similar) and selective tree removal where feasible for off-ROW access. As described in *Section 5.3.1*, NEP will install and maintain erosion and sediment controls throughout construction, as well as other typical measures described in National Grid's BMPs.

NEP is currently in the preliminary phases of discussions with the USACE, MassDEP, and NHESP, and will be consulting with all applicable Conservation Commissions, to develop an appropriate mitigation package so there is no net loss of wetland functions and values as a result of the Project. Examples of possible wetland mitigation strategies include wetland restoration, targeted property acquisition for land preservation, and participation in the USACE Massachusetts in-lieu fee program.

Permit applications to be submitted to state and federal regulatory agencies will provide the specific mitigation information required for the Project. At the local level, NEP will work with local Conservation Commissions to discuss impacts and proposed mitigation as part of the Notice of Intent process. In addition, post construction, NEP will prepare applications for Certificates of Compliance from each of the Conservation Commissions. These Certificates ensure that wetland resources have been restored and losses have been mitigated, as applicable.

NEP is committed to developing a mitigation package appropriate to address impacts of the Project. It is anticipated that mitigation will result in no net loss of existing wetland functions values and statutory interests within the watershed. While Project information presented herein is thorough with regard to impacts, and proposed mitigation measures are identified and described, NEP is still evaluating specific details related to wetland mitigation.

5.4.6. Rare Species Habitat

Impacts to rare species have been minimized to the greatest extent practicable by utilizing existing, managed ROWs and existing access routes where feasible. The vegetation maintenance cycle and ROW maintenance and improvements have modified the landscape on and off the ROW for decades. However, improvements to access and construction of new access and work pads will temporarily and permanently alter habitats within the ROWs.

To assess the potential for plant and/or animal species listed as state or federally endangered, threatened, and/or special concern to be present along the Project Route, NEP reviewed MassGIS 2021 Priority and Estimated Habitat data layers, solicited database information from the NHESP, and followed the USFWS Information for Planning and Consultation ("IPAC") available on their website. Field assessments and surveys were also conducted in 2021 and 2022 to support the consultation process with NHESP.

The results of the USFWS IPAC determined that four federally listed species may be present within the Project area. One species is a threatened mammal, one species is a candidate insect, one species is an endangered plant, and one species is a threatened plant. Additionally, based on NHESP data layers and information, the Project Route contains habitat for nine state-listed species (two reptiles, one amphibian, two invertebrates, three birds and one plant), along portions of the Project Route in Warwick, Royalston, Winchendon, Athol, Fitchburg, and Leominster. Specific species are not identified herein at the agency's request.

The Priority Habitat ("PH") data layer available from MassGIS depicts approximately 86 acres, or 8.2% of the ROW, within rare species habitat. Based on the preliminary project design, approximately six acres (2.5 acres upland, 3.5 acres wetland) of tree removal is proposed in PH, and 12.9 acres, all upland, will be permanently impacted by access and work pad improvements. The permanent impacts to PH will occur within the Towns of Royalston, Winchendon, and Leominster. Consultation is ongoing with NHESP to determine if any of these impacts will constitute a "take" of rare species.

During the regulatory review process, NHESP staff will review activities proposed within rare species habitat to determine whether the Project will impact state-listed species and their habitats. If it is determined that a proposed action will result in a "take" and cannot be revised to avoid a "take," then NEP will file for the issuance of a Conservation and Management Permit ("CMP") and take action to meet the performance standards for the CMP.

Avoidance, Minimization, and Mitigation

In addition to using existing, managed ROWs and access to the maximum extent practicable, the habitat information obtained through assessments and field surveys was used to design the Project to avoid and minimize impacts to rare species habitat where feasible. Wherever possible, permanent impacts to PH will be minimized by limiting the extent of access and work pads to the minimum safe size required for conducting utility line maintenance work.

In addition to avoiding and minimizing species and habitat impacts to the maximum extent feasible, NEP is working closely with NHESP to develop mitigation measures for each species associated with the Project Route. At this time, proposed mitigation includes, but is not limited to, the following:

- Habitat restoration;
- Species-specific protection plans;
- Protective enclosures and fencing;
- Extensive "sweeps" and monitoring during construction; and
- Training for construction personnel.

Consultation with NHESP is ongoing and NEP will implement the necessary actions to avoid, minimize, and mitigate Project-related impacts to comply with the Massachusetts Endangered Species Act ("MESA") permit issued for the Project. If, after consultation with NHESP, it is determined that a "take" will occur, a CMP will be prepared to comply with MESA. Mitigation options under a CMP may include, but are not limited to, funding of programs that directly benefit the affected species, onsite and/or offsite habitat protection and/or creation. Offsite habitat protection typically requires the acquisition of land, under fee ownership or conservation restriction, for permanent habitat conservation. Other mitigation options include financial contribution toward land acquisition, conservation research funding, habitat management, or other programs that directly benefit the affected species. With the implementation of these measures, impacts to rare species and their habitats as a result of the Project will be minimized.

5.4.7. Public Water Supplies

The existing Project ROWs traverse various public water supply resources as summarized in Table 5-6. However, potential impacts are anticipated to be negligible and associated with construction only.

Public water supplies can be sourced from either groundwater aquifers or surface waters. To identify public water supply areas within the Project ROWs, the following resources were used:

- MassGIS ORW Datalayer (2010)[48]
- MassGIS Aquifers (2007)[49]
- MassGIS Approved Wellhead Protection Areas (Zone II, Zone I, IWPA) Datalayer (2022)[50]
- USGS NHD Waterbody (2022)[51]
- MassGIS Major Watershed (2000)[52]

As stated in 310 CMR 22.02, a Zone II Wellhead Protection Area is defined as "that area of an aquifer which contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at safe yield, with no recharge from precipitation). It is bounded by the groundwater divides which result from pumping the well and by the contact of the aquifer with less permeable materials such as till or bedrock."

MassGIS Aquifer Dataset maps show high, medium, and low yield aquifers. The definition of high and medium yield varies between panels, as it does on the source manuscripts. Medium yield aquifers for most basins are between 100 and 300 gallons per minute ("gpm"); this range may vary greatly from basin to basin. High and low yield definitions vary from basin to basin as well.

MassDEP has established a category of waterbodies known as ORWs which are designated in the Massachusetts Surface Water Quality Standards Regulations (314 CMR 4.00) and include high quality waters with socioeconomic, recreational, ecological and/or aesthetic values. Class A Public Water Supplies and their tributaries, and NHESP CVPs, are ORWs. Other waters can be specifically designated by the

[48] MassGIS. 2010. MassGIS Data: Outstanding Resource Waters. Retrieved November 11, 2022 from https://www.mass.gov/info-details/massgis-data-outstanding-resource-waters#downloads.
[49] MassGIS. 2007. MassGIS Data: Aquifers. Retrieved November 11, 2022 from https://www.mass.gov/info-details/massgis-data-aquifers#downloads.
[50] MassGIS. 2022.MassDEP Wellhead Protection Areas (Zone II, Zone I, IWPA). Retrieved November 11, 2022 from https://www.mass.gov/info-details/massgis-data-massdep-wellhead-protection-areas-zone-ii-zone-i-iwpa#downloads.
[51] USGS. 2022. NHD Waterbody. Retrieved November 11, 2022 from https://www.usgs.gov/national-hydrography/access-national-hydrography-products.
[52] MassGIS. 2000. MassGIS Data: Major Watersheds. Retrieved November 11, 2022 from https://www.mass.gov/info-details/massgis-data-major-watersheds#downloads.

MassDEP as ORWs. Replacement structures, temporary construction mat access, pull pads, and work envelopes are proposed within wetlands mapped as ORWs associated with Crystal Lake, Goodfellow Pond, Simonds Pond, Notown Reservoir, Distributing Reservoir, Morse Reservoir, Fall Brook Reservoir, and Perley Brook Reservoir. Public water supply information and aquifer locations for the Project Route are provided in the Map Book in Appendix 5-1.

Table 5-6: Public Water Supplies Traversed by the Project

Resource Areas	Name	Project Route (acres)
Zone II	469 Athol DPW Water Division, 435 Leominster Water Division	148
Aquifers	Miller River Basin	26
ORWs	Crystal Lake, Goodfellow Pond, Simonds Pond, Notown Reservoir, Distributing Reservoir, Morse Reservoir, Fall Brook Reservoir, and Perley Brook Reservoir	412
Water Supply Watersheds	Nashua, Miller	988.5
Reservoirs	Crystal Lake, Fall Brook Reservoir, Notown Reservoir, Perley Brook Reservoir	1

Avoidance, Minimization, and Mitigation

Potential impacts to surface water supplies could occur only as a result of unanticipated failure of sedimentation and erosion controls during construction. Therefore, impacts to public water supply sources are not anticipated. However, if an impact were to occur as a result of construction activity, it would be negligible. Potential impacts to groundwater supplies could occur from spills of fuel or hydraulic oil related to the construction equipment. Equipment used for the construction of the Rebuilt Lines and Taps will be properly maintained and operated to reduce the chances of spill occurrences of petroleum products. Refueling equipment will be required to carry spill containment and prevention devices (i.e., drip pans, absorbent pads, etc.) and fueling of equipment will only occur in upland areas, unless equipment cannot be moved. Since the Project will consist of direct embedded steel structures along most of the route length, if ledge is encountered, it is generally preferable to drill for the required structure embedment depth than to blast. No blasting will occur within the two Zone IIs along the Project Route.

Proposed structures and work areas for the Project have been sited and will be constructed to avoid permanent impacts to ORWs to the extent practicable. In locations where ORWs cannot be avoided, sediment and erosion controls will be implemented to minimize sediment migration outside of the limits of disturbance. Any temporary construction matting will be removed immediately after the construction activities are complete. Any required restoration or stabilization, after the mat removal, will be completed as the equipment and vehicles de-mobilize from the ROW.

It is anticipated that most tree and vegetation removal will be done mechanically. The Project will comply with the National Pollutant Discharge Elimination System Construction General Permit and SWPPP requirements, requirements of the Section 401 Water Quality Certification, Massachusetts Wetlands Protection Act ("MWPA") and implementing regulations, and other restrictions as may be applied by the local Conservation Commissions in accordance with the MWPA.

Appropriate sediment and erosion control, spill prevention, and response measures will be implemented, and these controls will be closely monitored and managed. NEP will require its contractors to adhere to BMPs regarding the storage and handling of oil and potentially hazardous materials during the Project. Equipment used for the construction of the Rebuilt Lines and Taps will be properly maintained and operated to reduce the chances of spill occurrences of petroleum products. Refueling equipment will be required to carry spill containment and prevention devices (e.g., drip pans, absorbent pads).

Following construction, the normal operation and maintenance of the transmission line facilities will have no impact on public water supply resources. Vegetation management within sensitive areas, including public water supply areas, will follow the same procedures as are currently used on the ROW and described in National Grid's Vegetation Management Plan.

5.4.8. Visual Impact Assessment

This section describes the potential visual impacts of the Project from properties and public ROWs located adjacent to or within close proximity to the Project.

Most of the Project Route traverses Exempt Properties that are predominantly densely forested areas where structures are only seen from road crossings, open water, open fields, and occasional commercial or residential uses directly adjacent to the ROW as shown in Land Use Maps in Appendix 5-1. Since the Rebuilt Lines and Taps will be located within the existing ROWs, tree removal will be minimized and limited to discrete areas where the ROWs have not been fully maintained and where additional tree removal is required to achieve compliance with vegetation management standards. Therefore, existing vegetation will provide some screening.

For this Project, 21 key observation points were identified where there is a potential for greater visibility and/or sensitivity to views of new structures. These observation points have been grouped into two categories based on the location of the viewpoint for the photo simulation. One category includes views from points that are accessible to the public, such as highways, roads, sidewalks, and publicly owned land. The second category includes views from points on privately owned land where the property owner permitted such photos to be taken. These locations are described in Table 5-7, Viewpoints to the Project ROW. The viewpoints are identified by a View number and Line location.

Table 5-7: Viewpoints to the Project ROW

Viewpoints from Public Streets		
Location	**Viewpoint/Line**	**Description**
Winchester Road, Warwick	View 129/A1/B2 ROW	Represents view of new transmission line structure from the street adjacent to residential property along Winchester Road.
Old Winchester Road, Warwick	View 142/A1/B2 ROW	Represents view of new transmission line structure from the street adjacent to residential property along Old Winchester Road.
Athol-Richmond Road, Royalston	View 217/A1/B2 ROW	Represents view of new transmission line structure from the street adjacent to residential property and fields along Athol-Richmond Road.
Millyard Road, Royalston	View 270/A1/B2 ROW	Represents view from Millyard Road adjacent to Millers River Wildlife Management Area.
Leo Drive, Gardner	View 406/North Baldwinville Taps	Represents view of new transmission line structure from the street adjacent to residential property along and adjacent to Leo Drive and Brookside Drive.

Viewpoints from Public Streets		
Robert Drive, Gardner	View 451/A1/B2 ROW	Represents view of new transmission line structure from the street adjacent to residential property along and adjacent to Robert Drive and Shawn Avenue.
Pearl Street, Gardner	View 453/A1/B2 ROW	Represents view of new transmission line structure from the closest residential property located on Pearl Street.
Chapel Street, Gardner	View 465/A1/B2 ROW	Represents view of new transmission line structure to be located behind residential property along Chapel Street.
Common Road, Westminster	View 502/Westminster Taps	Represents view of new transmission line structure from the closest residence located on or adjacent to Common Road.
Viewpoints from Private Properties		
Bathrick Road, Westminster	View 513/Westminster Taps	Represents view of transmission line structure from the closest residential property located on Bathrick Road.
Robbins Road, Warwick	View 137/A1/B2 ROW	Represents view of transmission line structure from the closest residential property located on Robbins Road.
Robbins Road, Warwick	View 139/ A1/B2 ROW	Represents view of transmission line structure from the closest residential property located on Robbins Road.
Mill Glen Road, Winchendon	View 349/A1/B2 ROW	Represents view of transmission line structure from the closest residential property located on Mill Glen Road.
Mill Glen Road, Winchendon	View 353/A1/B2 ROW	Represents view of transmission line structure from the utility ROW located adjacent to Mill Glen Road.
Mill Glen Road, Winchendon	View 362/A1/B2 ROW	Represents view of transmission line structure from the closest residential property located on Mill Glen Road.
Matthews Street, Gardner	View 129/A1/B2 ROW	Represents view of transmission line structure from the closest residential property located on Mathews St.
Smith Street, Gardner	View 458/A1/B2 ROW	Represents view of the transmission line structure from the closest residential property located on Smith Street.
Town Farm Road, Westminster	View 504/A1/B2 ROW	Represents view of the transmission line structure from the closest residential property located on Town Farm Road.
Park Street, Gardner	Crystal Lake Tap Lines	Represents view of transmission lines from the closest residence located on Park Street.
4 Stockwell Road, Royalston	Athol Taps Lines	Represents view of the transmission line structures from the closest residential property located on Stockwell Road.
1128 Main Street, Athol	Athol Tap Lines	Represents views from the closest residence located on or adjacent to Main Street.

Visual renderings were prepared from these observation points. Appendix 5-4 depicts existing and simulated future conditions at these representative locations along the Project Route.

The Existing Lines and Taps are presently visible to varying degrees from all 21 observation points listed in Table 5-7. The Existing Lines generally include three types of structures:

- Grey metal lattice structures ranging from 51 to 58 feet high on the A1/B2 Lines.
- Wooden H-Frame and Chair Frame structures at 43 feet high on the Athol Tap Lines.

- Wooden monopole structures at 43 feet high on the Crystal Lake Tap Lines.

The existing monopoles are more visually solid than lattice structures.

The proposed replacement structures will be taller than the existing structures. Proposed structures range from 93 to 121 feet high (averaging 95 feet in height), an approximate 42 to 63 feet height increase. The visual contrast between existing views is most distinct where the height of the new structures extends above adjacent vegetation and can be discerned more clearly and/or from a greater distance. In many instances new structures on the horizon will be more visible than the existing structures.

In cases where brown weathering steel monopoles are visible against the sky, they may represent a greater contrast than grey or galvanized structures. However, when viewed against the tree line by a person standing at close proximity to the poles, the weathering steel structures are less discernable against dark backgrounds (e.g., vegetation) as compared to galvanized poles from the same perspective. Only limited vegetation removal will be required in the Project ROW to accommodate the installation of the monopole structures. Therefore, the color of the structures will have little impact on change in visibility.

The majority of locations where structures are visible are where they cross public roads. For some residents, such as the view to Structure 137, the primary view change is within or behind the property. To better understand how this change presents at landscape scale refer to Appendix 5-4.

Overall, the potential for visual impact along the Project Route has been minimized through use of existing ROWs associated with the Existing Lines and Taps. These ROWs are located primarily in undeveloped and forested areas with relatively few residential or commercial abutters.

Avoidance, Minimization, and Mitigation

Impacts from the Project will be minimized due to the limited need for tree removal in locations near sensitive viewers and the location of the Project within managed ROWs. NEP will work with abutting landowners who experience a material change in view as a result of construction to determine reasonable and practical screening that could be provided on their properties. Screening options may be in “soft” form (e.g., vegetation) or “hard” form (e.g., fencing), or a combination of the two. With the implementation of these measures, the visual impact of the Project will be minimized.

5.4.9. Noise

This section evaluates the potential for noise impacts from construction of the Project. The Project is not anticipated to generate noise during operation; consequently, noise impacts associated with the Rebuilt Lines and Taps will be limited to the construction period, which currently is anticipated to extend over a 43-month period from May 2025 to December 2029, following the transmission line construction sequence described in *Section 5.3.1*. Construction is expected to occur during typical work hours, though in specific instances, at some locations, or at the request of a municipality or state agency, NEP may seek municipal approval to work at night. The noise ordinances applicable to the municipalities that the planned construction will affect are shown in Table 5-8.

Table 5-8: Municipal Noise Ordinance and Bylaw Summary

Municipality Code	Allowed Construction Hours		Exceptions/Decibel Limits
	Weekday	Weekend	
Town of Athol Zoning Bylaws 3.8.1.1	Not Specified	Not Specified	No prescribed decibel level limits in bylaw. No noise, sound from public address or other amplification systems, vibration, or flashing shall be normally perceptible more than 350 ft. from the premises if in an industrial or general district, more than 50 feet from the premises if in a commercial district, and more than 20 feet from the premises if in a residential district. Interferences originating in an industrial or general district shall not normally be perceptible more than 150 feet within a commercial district, or more than 100 feet within a residential district.
Town of Winchendon Site Plan Regulations Section 5.1.2: Construction Standards, No Nuisance	Not Specified	Not Specified	The Board will require adequate measures including, without limitation, barriers, and restricted hours of operation to ensure that the work does not become a nuisance to abutters.
City of Fitchburg Zoning Ordinance Section 132	7 a.m. – 7 p.m.	8 a.m. – 7 p.m.	Generation of any noise from construction and demolition activity is prohibited at any hour on Sundays and legal holidays except by a permit issued in accordance with Subsection. Emergency utility or other emergency repair work such as restoring electric power line is exempt from this article. Construction hours are limited, "except as may be needed for public safety and welfare." Noise Level at Residential Lots: It is unlawful for any person to operate any construction devices if the operation emits noise, measures at the lot line of a residential lot, in excess of 50 dBa between the hours of 6 p.m. and 7 a.m.
Town of Westminster Zoning Bylaw 97-10(2) Earth Removal	Not Specified	Not Specified	No prescribed decibel level limits in bylaw. No permit shall be issued for the removal of earth or the placement of fill in any location if such an operation: Will produce noise, dust, or other noxious effects observable at the lot lines of the property in amounts objectionable or detrimental to the normal use of adjacent properties.
Town of Sterling Protective Bylaws	Not specified	Not specified	No use shall be permitted that produces noise in excess of 55 dBa as measured at any point along lot lines during the hours of 7 a.m. to 7 p.m. or 45 dBa during the hours of 7 p.m. to 7 a.m. This standard may be relaxed along I-190. All construction work within a subdivision or on an approval-not-required (ANR) lot is

Municipality Code	Allowed Construction Hours		Exceptions/Decibel Limits
	Weekday	Weekend	
			prohibited between the hours of 4:00 p.m. on Saturday through 7:00 a.m. Monday and on federal and state holidays.
City of Gardner Zoning Bylaw, 675-1010(2.a.1) Site Plan Review, Environmental Impact Standards	Not Specified	Not Specified	No prescribed decibel level limits in bylaw. The proposed development shall not create any significant emission of noise, dust, fumes, noxious gases, radiation, or water pollutants, or any other similar significant adverse environmental impact.
Town of Royalston	Not Specified	Not Specified	No prescribed decibel level limits in bylaw.
City of Leominster Code of Ordinances Section 14-8	7 a.m. – 8 p.m.	8 a.m. to 5 p.m. on Saturday and 1 p.m. to 5 p.m. on Sunday	No prescribed decibel level limits in bylaw. Limited on Sundays, unless the work is for a public service, municipal utility department, or qualifies as "emergency work."
Town of Warwick	--	--	No available information.

Construction of the Rebuilt Lines and Taps will require the use of various types of equipment during the construction sequence. Table 5-9 identifies the types of equipment to be used for each phase of construction and provides a range of typical sound levels from the equipment at a specific location and for the Project as a whole. The typical sound levels are provided at a distance of 50 feet from the source and have also been extrapolated for noise levels at 100, 200, and 300 feet. The estimated noise levels range from 80 dBA to 98 dBA at a distance of 50 feet from the construction activity.

Table 5-9: Typical Construction Sound Levels Along the Project Route

Description of Activity	Types of Equipment	Typical Sound Levels at 50 Feet (dBA)	Estimated Sound Levels (dBA) at Various Distances from Noise Sources		
			100 Feet	200 Feet	300 Feet
Vegetation Removal and ROW Mowing	• Grapple trucks • Bulldozers • Track-mounted mowers • Motorized tree shears • Log forwarders • Chippers, Chain saws • Box trailers	84 to 98	78 to 92	72 to 86	69 to 83
Erosion/Sediment Controls and Access Route Improvements and Maintenance	• Dump trucks • Bulldozers, Excavators, Backhoes • Graders, Forwarders • 10-wheel trucks with grapples, Cranes	80 to 93	74 to 87	68 to 81	65 to 78
Installation of Foundations and Structures	• Backhoes and Excavators • Rock drills mounted on excavators	80 to 90	74 to 84	68 to 78	65 to 75

Description of Activity	Types of Equipment	Typical Sound Levels at 50 Feet (dBA)	Estimated Sound Levels (dBA) at Various Distances from Noise Sources		
			100 Feet	200 Feet	300 Feet
	• Cluster drills with truck mounted compressors • Concrete trucks • Cranes • Aerial lift equipment • Tractor trailers				
Conductor and Shield Wire Installation	• Puller-tensioners • Conductor reel stands • Cranes • Bucket trucks • Flatbed trucks	80 to 93	74 to 87	68 to 81	65 to 78
Removal and Disposal of Existing Transmission Line Components	• Cranes • Flatbed trucks • Pullers with take-up reel • Excavators	80 to 90	74 to 84	68 to 78	65 to 75
Restoration of the ROW	• Bulldozers Excavators • Tractor-mounted York rakes • Straw blowers • Hydro-seeders	80 to 90	74 to 84	68 to 78	65 to 75

As shown on Table 5-10, the closest residence is approximately 28 feet away from the A1/B2 ROW in Westminster. Residences within 50-feet, 100-feet, 200-feet and 300-feet of the Existing Lines and Taps may potentially be impacted by construction noise during one or more phases of construction. However, typical sound levels of construction noise experienced at any given residence will be temporary and intermittent.

Table 5-10: Residences Along the Project Route

Project Component	Closest Residence (ft)	Residences within 50-ft of ROW	Residences within 100 ft of ROW	Residences within 200 ft of ROW	Residences within 300 ft of ROW
A1/B2 ROW	28	44	37	103	93
Athol Taps ROW	31	2	0	8	9
Crystal Lake Taps ROW	76	0	3	9	21

Avoidance, Minimization, and Mitigation

To the extent practicable, NEP will comply with the noise ordinances in the municipalities within which the Project is proposed. Some work tasks, once started, may require continuous operation until completion. Work requiring scheduled outages and work that requires continuous operation until completion may need to be performed on a limited basis outside of normal work hours, including Sundays and holidays. In these instances, NEP will seek advanced approval from the applicable municipality and provide notice to abutters.

Temporary noise impacts from construction equipment will be mitigated by maintaining equipment in good working condition and by the use of appropriate mufflers. Noise sources that may operate continually during the day, such as generators or air compressors, will be located away from populated areas to the extent possible. NEP and its contractors will also comply with state law (G.L. c. 90, § 161A) and MassDEP regulations (310 CMR 7.11(1)(b)), which limit vehicle idling to no more than five minutes, to the greatest extent feasible based upon the construction task, type of equipment/vehicle, and weather conditions. There are exceptions for vehicles being serviced, vehicles making deliveries that need to keep their engines running, and vehicles that need to run their engines to operate accessories. Where construction takes place adjacent to residences, NEP will notify landowners in advance of construction and will provide a point of contact for Project related questions and concerns. With the implementation of these measures, noise impacts associated with the Project will be minimized.

5.4.10. Traffic and Transportation

The Project will not have any permanent traffic impacts and post-construction traffic impacts will be limited to those associated with occasional ROW and transmission line maintenance activities. However, limited temporary construction related impacts are anticipated for the Project. Potential traffic impacts were evaluated using the MassGIS Open Data Portal. Roadways are identified by six functional classification system categories developed by MassDOT as shown in Table 5-11.

Table 5-11: Roadways Crossed by the Project Route

Functional Classification System Category	Project Route
Local Street or Road (Class 0)	43
Interstate (Class 1)	0
Urban or Rural Principal Arterial (Class 2 & 3)	6
Urban Minor Arterial or Collector (Class 5 & 6)	18
Subtotal	**67**
Railroad Crossings (active)	2

Construction of the Project along the Project Route will not result in a significant increase in traffic or material impacts to existing traffic patterns. During construction, the main impacts will occur when stringing transmission conductors over road crossings and at ROW construction access locations. At the ROW access locations, construction equipment and personnel will enter and exit the ROW from public roads and temporarily increase traffic. Since the various construction tasks will occur at different times and locations, traffic at these entry roadways will be intermittent. Generally, the larger construction equipment will enter the ROW once while working in a specific area; however multiple trips may be conducted when delivering materials such as construction matting or stone. Smaller vehicles such as pickup trucks carrying construction workers will access the ROW daily.

Additional impacts, including lane closures or temporary traffic stops, are anticipated when conductors and shield wire need to be strung over public roadways. At such times, boom trucks may be set up in travel lanes, shoulders, or medians to serve as support to the lines as they are attached to the permanent transmission line structures. In addition, construction equipment may be necessary to install temporary guard structures. Traffic will be stopped for a short period of time to allow a rope to be manually pulled across the roadway. Conductor will then be attached to this rope and pulled above the roadway onto the temporary guard structures; traffic typically will be able to flow while the conductors are attached to the structures. Line stringing will be required along the Project Route across 67 roadway crossings and two railroad crossing. Permits from MassDOT will be required for this work at state highway crossings.

Along local roadways, NEP will coordinate with the municipalities on requirements for work hours, signage, and police details.

Avoidance, Minimization, and Mitigation

Traffic impacts associated with the Project will be temporary in nature and confined to the amount of time necessary for construction. NEP will carefully coordinate construction to minimize impacts to adjacent residences and businesses and others relying on neighboring transportation corridors. Prior to beginning construction, NEP will work closely with the municipalities and MassDOT to develop construction Traffic Management Plans ("TMPs"), which include construction-phase traffic controls, and to minimize the impacts of construction on the traveling public. Implementation of a well-designed TMP will reduce the potential for traffic disruptions and inconvenience to drivers. The TMP may include closures to travel lanes and/or roadway shoulders in order to set up the work zone. All TMP work must conform to the Manual of Uniform Traffic Control Devices and MassDOT standards. With the implementation of these measures, the temporary traffic disruptions anticipated from the Project will be minimized.

5.4.11. Electric and Magnetic Fields

NEP's consultant, Gradient, assessed EMF associated with the Existing and Rebuilt Lines and Taps along the Project Route at annual average and system peak loading conditions. Gradient conducted the EMF modeling at a height of one meter (3.28 feet) above the ground surface with conductors at the lowest clearance permissible by governing code. Modeling was performed for three cases:

- The existing overhead circuit configuration ("pre-Project case").
- The overhead circuit configuration after the A1/B2 Lines have been replaced, with current loadings representative of the in-service year operating at 69 kV ("69 kV post-Project case").
- The overhead circuit configuration after the A1/B2 Lines have been replaced, with current loadings representative of the in-service year operating at 115 kV ("115 kV post-Project case").

EMF modeling was conducted for both annual average and system peak load levels for each of the three cases.

Modeling was conducted for 26 representative cross sections, including 23 cross sections along the A1/B2 ROW, two cross sections along the Athol Taps, and one cross section along the Crystal Lake Taps. Additional information about Gradient's modeling methods and results are provided in Appendix 5-5. Gradient's results are summarized below.

Magnetic Fields

Table 5-12 summarizes magnetic field modeling results for annual average loading conditions. Cross sections B-15191-NE Sh. 1 through Sh. 21 represent various locations along the A1/B2 ROW. Cross sections B-15192-NE Sh. 1 and Sh. 2 represent locations along the Athol Taps ROW; and cross section B-15193-NE Sh. 1 represents the Crystal Lake Taps ROW.

Table 5-12: Summary of Modeled Pre-Project and Post-Project Edge-of-ROW Magnetic Fields for the Representative ROW Cross Sections for Annual Average Loading Scenarios

Line Segment	Cross Section	Magnetic Field (mG)					
		Northern Edge-of-ROW			Southern Edge-of-ROW		
		Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)	Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)
Vernon – Royalston	B-15191-NE Sh. 1	3.2	6.7	4.3	3.3	5.9	3.8
	B-15191-NE Sh. 2	3.2	7.5	4.9	3.3	6.5	4.2
	B-15191-NE Sh. 3	1.6	7.9	5.1	1.8	6.8	4.4
Royalston – Otter River	B-15191-NE Sh. 4	<1	1.1	<1	1.7	2.1	1.5
	B-15191-NE Sh. 5	<1	1.0	<1	2.1	1.9	1.4
	B-15191-NE Sh. 6	<1	5.3	3.4	2.1	4.9	3.2
	B-15191-NE Sh. 7	<1	5.3	3.2	2.1	4.8	3.0
	B-15191-NE Sh. 8	<1	6.3	3.8	1.7	5.6	3.5
Otter River – Gardner	B-15191-NE Sh. 9	<1	1.7	1.3	1.8	3.3	2.3
	B-15191-NE Sh. 10	1.8	1.6	1.3	2.4	3.0	2.1
	B-15191-NE Sh. 11	1.8	4.9	3.0	2.4	4.9	3.1
	B-15191-NE Sh. 12	1.8	4.0	2.5	2.4	4.2	2.7
Gardner – Westminster	B-15191-NE Sh. 13	<1	1.3	<1	<1	<1	<1
Westminster – East Westminster	B-15191-NE Sh. 13	<1	2.6	1.4	<1	2.2	1.0
	B-15191-NE Sh. 14	<1	<1	1.1	<1	<1	<1
East Westminster – Pratts Junction	B-15191-NE Sh. 14	<1	2.3	<1	1.4	2.9	<1
	B-15191-NE Sh. 15	<1	<1	<1	1.2	1.6	1.1
	B-15191-NE Sh. 16	<1	<1	<1	1.2	2.5	1.3
	B-15191-NE Sh. 17	<1	<1	<1	2.9	2.4	1.3

Line Segment	Cross Section	Magnetic Field (mG)					
		Northern Edge-of-ROW			Southern Edge-of-ROW		
		Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)	Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)
	B-15191-NE Sh. 18	1.1	1.1	1.0	4.1	5.5	3.0
	B-15191-NE Sh. 19	1.2	1.3	1.2	7.7	7.5	7.3
	B-15191-NE Sh. 20	1.3	1.3	1.2	7.9	7.7	7.5
	B-15191-NE Sh. 21	1.3	1.4	1.3	7.3	6.9	6.8
Royalston – Chestnut Hill	B-15192-NE Sh. 1	4.8	<1	<1	4.8	<1	<1
	B-15192-NE Sh. 2	4.8	<1	<1	4.8	<1	<1
Gardner – Crystal Lake	B-15193-NE Sh. 1	<1	4.0	2.6	1.9	5.1	3.4

Note: kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way; Sh. = Sheet.

As shown in Table 5-12, construction of the Project results in modest increases in modeled magnetic fields along most of the A1/B2 ROW. The Project reduces modeled magnetic fields along the Athol Taps and increases them slightly along the Crystal Lake Taps. Modeled magnetic fields are lower when the Rebuilt Lines are assumed to operate at 115 kV.

Both pre- and post-Project magnetic field levels are extremely low under the annual average loading scenario. Edge-of-ROW fields are below 8 mG for both the 69 kV and 115 kV post-Project case.[53] For both cases, magnetic field levels drop below 3 mG in all locations at a distance of 50 feet from the ROW edges.

Table 5-13 summarizes pre- and post-Project magnetic fields under the system peak loading scenario.

[53] MF levels for the post-Project modeling cases with current loadings for the 115 kV operating voltage for the A1 and B2 Lines are generally lower than the results for the corresponding 69 kV operating voltage due to reduced currents for the higher operating voltage.

Table 5-13: Summary of Modeled Pre-Project and Post-Project Edge-of-ROW Magnetic Fields for the Representative ROW Cross Sections for System Peak Loading Scenarios

Line Segment	Cross Section	Magnetic Field (mG)					
		Northern Edge-of-ROW			Southern Edge-of-ROW		
		Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)	Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)
Vernon – Royalston	B-15191-NE Sh. 1	4.1	12.1	7.3	4.3	10.0	6.1
	B-15191-NE Sh. 2	4.1	13.5	8.1	4.3	10.8	6.6
	B-15191-NE Sh. 3	2.2	13.5	8.1	2.5	10.8	6.6
Royalston – Otter River	B-15191-NE Sh. 4	1.2	1.9	1.1	2.4	4.0	2.6
	B-15191-NE Sh. 5	1.1	1.9	1.1	2.9	4.0	2.6
	B-15191-NE Sh. 6	1.1	9.0	5.7	2.9	8.3	5.2
	B-15191-NE Sh. 7	1.1	9.7	5.3	2.9	8.6	4.9
	B-15191-NE Sh. 8	1.2	9.7	5.3	2.4	8.6	4.9
Otter River – Gardner	B-15191-NE Sh. 9	1.1	2.7	2.0	2.5	5.4	3.5
	B-15191-NE Sh. 10	2.2	1.6	1.3	3.1	3.0	2.1
	B-15191-NE Sh. 11	2.2	4.9	3.0	3.1	4.9	3.1
	B-15191-NE Sh. 12	2.2	4.0	2.5	3.1	4.2	2.7
Gardner – Westminster	B-15191-NE Sh. 13	<1	2.4	1.1	<1	1.0	<1
Westminster – East Westminster	B-15191-NE Sh. 13	<1	4.5	2.2	<1	3.8	1.8
	B-15191-NE Sh. 14	<1	<1	<1	<1	1.5	<1
East Westminster – Pratts Junction	B-15191-NE Sh. 14	<1	3.0	1.5	1.2	4.0	2.0
	B-15191-NE Sh. 15	<1	<1	<1	1.2	1.8	1.2
	B-15191-NE Sh. 16	<1	<1	<1	1.2	2.4	1.3
	B-15191-NE Sh. 17	<1	<1	<1	3.2	2.4	1.3
	B-15191-NE Sh. 18	<1	<1	<1	5.2	6.4	4.1
	B-15191-NE Sh. 19	1.2	1.2	1.2	13.9	13.3	13.4
	B-15191-NE Sh. 20	1.2	1.2	1.2	13.9	13.3	13.4

Line Segment	Cross Section	Magnetic Field (mG)					
		Northern Edge-of-ROW			Southern Edge-of-ROW		
		Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)	Pre-Project	Post-Project (69-kV)	Post-Project (115-kV)
	B-15191-NE Sh. 21	1.3	1.3	1.2	13.9	13.3	13.4
Royalston – Chestnut Hill	B-15192-NE Sh. 1	5.5	2.1	<1	5.5	2.1	<1
	B-15192-NE Sh. 2	5.5	1.2	<1	5.5	1.2	<1
Gardner – Crystal Lake	B-15193-NE Sh. 1	1.7	5.1	3.4	2.9	8.2	5.1

Note: kV = Kilovolt; mG = Milligauss; ROW = Right-of-Way; Sh. = Sheet.

Under this scenario, the Project increases modeled magnetic fields along most of the A1/B2 ROW, except near the southern end of the ROW where field levels are essentially the same pre- and post-Project. The Project reduces modeled magnetic fields along the Athol Taps and increases them slightly along the Crystal Lake Taps. Under the system peak loading scenario, magnetic fields are below 14 mG at all edge-of-ROW locations and drop below 4 mG in all locations at a distance of 50 feet from the ROW edges.

In order to minimize magnetic fields associated with the Rebuilt Lines, NEP has selected conductor arrangements and phasing configurations that promote magnetic field cancellation. Exposure to magnetic fields is further mitigated by the Project's primarily rural setting and the very limited number of residential structures located within 50 feet of the Project ROWs (see Table 5-14).

Table 5-14: Residential Structures located within 50 feet of the Project ROW

Town	Line	Residences within 50 feet
Warwick	A1/B2 Lines	4
Winchendon	A1/B2 Lines	2
Gardner	A1/B2 Lines	13
Westminster	A1/B2 Lines	11
Leominster	A1/B2 Lines	14
Athol	Athol Tap Lines	4
Total		**46**

In short, Gradient's modeling indicates that the Project will result in minor magnetic field increases along the A1/B2 ROW, minor decreases along the Athol Tap ROW, and minor increases along the Crystal Lake Tap ROW. The resulting post-Project magnetic field levels are unusually low for a transmission line ROW and are well below both the International Commission on Non-Ionizing Radiation Protection ("ICNIRP") health-based guidelines of 2,000 mG for allowable public exposure to 60-Hertz ("Hz") MF. Finally, public exposure to magnetic fields is minimized by the generally rural location of the Project.

Electric Fields

Table 5-15 summarizes electric field modeling for both annual average and system peak loading scenarios. As can be seen Table 5-15, pre- and post-Project edge-of-ROW electric field levels are very similar, with a maximum change of <0.4 kV/m. Although electric fields are not dependent on conductor loading (i.e., current), different sets of results were obtained for the annual average and system peak loading scenarios. This difference in calculated electric field values is due to the differences in the midspan heights of the Project conductors at the low point of conductor sag that were modeled for the two loading scenarios. Pre- and post-Project electric field levels modeled at the ROW edges are well below the ICNIRP health-based guideline of 4.2 kV/m for all pre-Project and post-Project cases.

Table 5-15: Summary of Modeled Pre-Project and Post-Project Edge-of-ROW Electric Field Values for the Representative ROW Cross Sections

Line Segment	Cross Section	Loading Scenario	Electric Field (kV/m)					
			Northern Edge-of-ROW			Southern Edge-of-ROW		
			Pre-Project	Post-Project (69 kV)	Post-Project (115 kV)	Pre-Project	Post-Project (69 kV)	Post-Project (115 kV)
Vernon – Royalston	B-15191-NE Sh. 1	Ann. Avg.	0.13	0.14	0.23	0.12	0.09	0.15
		Sys. Pk.	0.12	0.08	0.14	0.13	0.05	0.09
	B-15191-NE Sh. 2	Ann. Avg.	0.13	0.16	0.27	0.12	0.10	0.17
		Sys. Pk.	0.12	0.10	0.17	0.13	0.08	0.13
	B-15191-NE Sh. 3	Ann. Avg.	0.08	0.15	0.26	0.07	0.09	0.16
		Sys. Pk.	0.08	0.10	0.17	0.08	0.08	0.13
Royalston – Otter River	B-15191-NE Sh. 4	Ann. Avg.	0.08	0.08	0.13	0.08	0.05	0.09
		Sys. Pk.	0.07	0.08	0.14	0.08	0.05	0.08
	B-15191-NE Sh. 5	Ann. Avg.	0.09	0.08	0.13	0.09	0.05	0.09
		Sys. Pk.	0.09	0.08	0.14	0.09	0.05	0.08
	B-15191-NE Sh. 6	Ann. Avg.	0.09	0.15	0.25	0.09	0.09	0.16
		Sys. Pk.	0.09	0.08	0.14	0.09	0.06	0.10
	B-15191-NE Sh. 7	Ann. Avg.	0.09	0.15	0.25	0.09	0.10	0.16
		Sys. Pk.	0.09	0.10	0.17	0.09	0.08	0.13
	B-15191-NE Sh. 8	Ann. Avg.	0.08	0.13	0.21	0.08	0.08	0.13
		Sys. Pk.	0.07	0.10	0.17	0.08	0.08	0.13
Otter River – Gardner	B-15191-NE Sh. 9	Ann. Avg.	0.10	0.09	0.14	0.10	0.05	0.09
		Sys. Pk.	0.10	0.08	0.13	0.10	0.05	0.07
	B-15191-NE Sh. 10	Ann. Avg.	0.13	0.09	0.14	0.13	0.05	0.09
		Sys. Pk.	0.13	0.08	0.13	0.13	0.05	0.07
	B-15191-NE Sh. 11	Ann. Avg.	0.13	0.15	0.24	0.13	0.09	0.15
		Sys. Pk.	0.13	0.15	0.24	0.13	0.09	0.15
	B-15191-NE Sh. 12	Ann. Avg.	0.13	0.13	0.22	0.13	0.08	0.14
		Sys. Pk.	0.13	0.13	0.22	0.13	0.08	0.14
Gardner – Westminster	B-15191-NE Sh. 13	Ann. Avg.	0.12	0.09	0.14	0.12	0.06	0.09
		Sys. Pk.	0.09	0.10	0.14	0.09	0.07	0.09
Westminster – East Westminster	B-15191-NE Sh. 13	Ann. Avg.	0.10	0.13	0.25	0.10	0.08	0.15
		Sys. Pk.	0.08	0.10	0.17	0.08	0.09	0.13
	B-15191-NE Sh. 14	Ann. Avg.	0.10	0.09	0.21	0.10	0.05	0.13

Line Segment	Cross Section	Loading Scenario	Electric Field (kV/m)					
			Northern Edge-of-ROW			Southern Edge-of-ROW		
			Pre-Project	Post-Project (69 kV)	Post-Project (115 kV)	Pre-Project	Post-Project (69 kV)	Post-Project (115 kV)
		Sys. Pk.	0.08	0.08	0.14	0.08	0.05	0.09
East Westminster – Pratts Junction	B-15191-NE Sh. 14	Ann. Avg.	0.12	0.10	0.15	0.12	0.06	0.09
		Sys. Pk.	0.10	0.07	0.13	0.10	0.04	0.07
	B-15191-NE Sh. 15	Ann. Avg.	0.04	0.03	0.03	0.10	0.02	0.02
		Sys. Pk.	0.03	0.03	0.03	0.11	0.03	0.05
	B-15191-NE Sh. 16	Ann. Avg.	0.04	0.05	0.05	0.10	0.05	0.08
		Sys. Pk.	0.03	0.03	0.03	0.11	0.06	0.09
	B-15191-NE Sh. 17	Ann. Avg.	0.04	0.05	0.06	0.15	0.04	0.07
		Sys. Pk.	0.03	0.03	0.03	0.14	0.06	0.09
	B-15191-NE Sh. 18	Ann. Avg.	0.04	0.05	0.05	0.15	0.13	0.20
		Sys. Pk.	0.03	0.03	0.03	0.16	0.08	0.13
East Westminster – Pratts Junction (continued)	B-15191-NE Sh. 19	Ann. Avg.	0.05	0.05	0.06	0.91	0.90	0.89
		Sys. Pk.	0.04	0.04	0.03	0.89	0.86	0.85
	B-15191-NE Sh. 20	Ann. Avg.	0.04	0.05	0.05	0.91	0.90	0.89
		Sys. Pk.	0.04	0.04	0.03	0.89	0.86	0.85
	B-15191-NE Sh. 21	Ann. Avg.	0.04	0.05	0.05	0.90	0.88	0.87
		Sys. Pk.	0.04	0.04	0.04	0.89	0.86	0.85
Royalston – Chestnut Hill	B-15192-NE Sh. 1	Ann. Avg.	0.18	0.25	0.43	0.18	0.25	0.43
		Sys. Pk.	0.18	0.31	0.53	0.18	0.31	0.53
	B-15192-NE Sh. 2	Ann. Avg.	0.18	0.04	0.07	0.18	0.04	0.07
		Sys. Pk.	0.18	0.04	0.07	0.18	0.04	0.07
Gardner – Crystal Lake	B-15193-NE Sh. 1	Ann. Avg.	0.07	0.11	0.19	0.07	0.12	0.20
		Sys. Pk.	0.15	0.04	0.06	0.15	0.04	0.06

Notes: Ann. Avg. = Annual Average; kV = Kilovolt; kV/m = Kilovolts per Meter; ROW = Right-of-Way; Sh. = Sheet; Sys. Pk. = System Peak.

Conclusion

Gradient's EMF modeling demonstrates that the Project will result in modest changes to magnetic and electric fields along the Project ROWs. At annual average loading levels, edge-of-ROW magnetic fields levels will be less than 8 mG in all locations and will drop below 3 mG in all locations at a distance of 50 feet from the ROW. Conductor arrangements and phasing configurations have been selected to minimize magnetic fields, and exposure to magnetic fields is further limited by the Project's primarily rural setting. Post-Project changes to modeled electric field levels at the ROW edges are below 0.4 kV/m in all cases. Modeled EMF levels are both far below relevant health-based standards.

5.4.12. Climate Change Considerations

This Project is part of NEP's efforts to ensure the long-term longevity and reliability of the region's electrical infrastructure in the face of growing demand for electricity and the changing climate. The Project will result in a more climate-ready and resilient transmission system that can withstand more extreme weather events; address existing system capacity shortages and increased demand; and support future interconnection of renewable energy projects.

The increased capacity of the Rebuilt Lines and Taps will support higher volumes of currently active and forecasted renewable energy resources in this region. This longer-term view aligns with the State Hazard Mitigation & Climate Adaptation Plan, which projects electricity consumption during summer may triple, as well as preliminary results of the ISO-NE 2050 Transmission Study, which point to a long-term need for additional capacity across the New England transmission system to support long term electric load growth driven by regional commitments for renewable and clean energy, GHG reduction, and net-zero carbon policies.

NEP consulted the Resilient MA Action Team Climate Resilience Design Standards Tool for the Project. The Tool assigns climate risks based on three variables: sea level rise and storm surge, extreme precipitation including urban flooding and riverine flooding, and extreme heat. According to the preliminary analysis, the Project Route is at high risk from extreme precipitation and extreme heat. It is not exposed to sea level rise/storm surge. The Rebuilt Lines and Taps will be made more resilient through installation of concrete caisson foundations, steel structures, and state of the art conductors that respond well to corrosion and operate at higher maximum operating temperatures. Further, the Project's engineering design used structure loading criteria required by the National Electrical Safety Code ("NESC"), 220 CMR 125, and National Grid Design Loads for Overhead Transmission Structures. The NESC load criteria require consideration of combined ice and wind district loading, extreme wind conditions, and extreme ice with concurrent wind conditions. Local compensatory flood storage will be provided in accordance with local and state regulations for any proposed fill in Bordering Land Subject to Flooding.

Together, the Rebuilt Lines and Taps contribute to regional climate resilience by providing capacity to meet the region's growing energy demand, reducing the frequency of outages, and incorporating provisions such as enhanced ROW access and modernized transmission line switches, which should reduce response times., shortening the duration of outages when they do occur.

5.4.13. Environmental Justice Considerations

This section reviews the Company's efforts to identify and engage with EJ populations within the designated geographic area i.e., a one-mile radius of the Project Route, along with the potential impacts to these EJ communities. EJ communities within the one-mile radius of the Project are depicted in the Map Book under Environmental Justice Maps in Appendix 5-1. NEP is developing and implementing this Project consistent with the Commonwealth's environmental and resource use laws and policies, including enhancing opportunities for public involvement. NEP aims to promote a robust transmission system and to properly plan for and address the Commonwealth's energy needs in an efficient and timely way. NEP has taken proactive steps to enhance community involvement and engagement during the planning of the Project.

As part of its stakeholder outreach plan, NEP has promoted and will continue to promote public involvement by the EJ populations located within one mile of the Project Route through the use and dissemination of multi-lingual Project fact sheets, website content, meeting invitations, and translation services for future outreach in English, Spanish, and any additional language identified since the filing of the EENF (both in writing and in-person if needed). Based on review of the Massachusetts EJ Populations Mapping Tool, there are 19 EJ populations within one mile of the Project, distributed in five municipalities, including Athol, Fitchburg, Gardner, Lancaster, and Leominster. Table 5-16 lists the EJ populations in the vicinity of the Project Route.

Table 5-16: Environmental Justice Populations within One Mile of the Project Route[54]

Community	Census Tracts
Athol	Tract 7031 – Block Group 1; Tract 7031 – Block Group 2; Tract 7033 – Block Group 1
Fitchburg	Tract 7102 – Block Group 3; Tract 7103 – Block Group 2
Gardner	Tract 7071 – Block Group 2; Tract 7072 – Block Group 2; Tract 7073 – Block Group 1; Tract 7073 – Block Group 2; Tract 7073 – Block Group 3; Tract 7074 – Block Group 2; Tract 7075 – Block Group 1; Tract 7075 – Block Group 2
Lancaster	Tract 7131 – Block Group 4
Leominster	Tract 7092.01 - Block Group 2; Tract 7092.01 - Block Group 3; Tract 7092.03 - Block Group 1; Tract 7092.03 - Block Group 2; Tract 7092.04 - Block Group 1

The Project is proposed within the existing ROW, thereby minimizing adverse environmental impacts. Due to the nature of the Project, outage constraints in the region, and NEP's efforts to reduce impacts to the natural and human environment, Project activities will be sequenced. No long-term impacts to soil, bedrock, vegetation, surface water, groundwater, wetland resources, or air quality will occur. NEP will be implementing measures to avoid, minimize, and mitigate potential environmental impacts throughout the entire Project alignment, including where it crosses through or is within one mile of mapped EJ populations. These include, but are not limited to, use of construction matting in wetlands to reduce soil disturbance and protect water quality, as well as implementation of the SWPPP to avoid impacts to receiving waters from sediment laden stormwater runoff or from spills or other inadvertent releases of fuels, oils, or other hazardous materials used in equipment or as incidental use during construction.

Because the nature and severity of Project impacts are minimal on all populations, including EJ populations, the Project will not materially exacerbate any existing unfair or inequitable environmental or public health burden impacting the EJ population. Overall, the Project will improve transmission system infrastructure and comply with comprehensive regional plans for maintaining electric transmission reliability in New England, for EJ and non-EJ Populations alike.

The Company will continue outreach to EJ community members during the permitting and development phases of the Project to support participation by the EJ community.

5.4.14. Conclusion – Environmental Impacts

The preceding sections have reviewed the environmental and community impacts associated with the Project, including those related to land use, protected land and open space, historical/archeological sites, tree removal, wetlands and water crossings, rare species habitat, public water supplies, visual, noise, traffic, and EMF. In addition, these sections have addressed climate change considerations and the potential for impacts to EJ populations. Since the Project Route is aligned along the existing A1/B2 and Tap Line ROWs,

[54] Table contains revised block groups since the filing of the EENF based on the updated Massachusetts 2020 Environmental Justice Population Interactive Map (Updated November 2022). https://mass-eoeea.maps.arcgis.com/apps/webappviewer/index.html?id=1d6f63e7762a48e5930de84ed4849212

which have been operated and maintained by NEP for decades, permanent impacts to abutters and communities have been minimized. Construction related impacts will be mitigated through use of BMPs, which will be designed and implemented in compliance with federal, state, and local rules and regulations.

5.5 PROJECT COST

NEP estimates that the total cost of rebuilding the Existing Lines and Taps across all three states is approximately $347.3 million. This estimate is provided with an assumed accuracy level of –25%/+50%. Based on line length alone, NEP estimates that approximately $304 million of this cost will be incurred in Massachusetts.

5.6 CONCLUSION

The Project will provide a reliable and resilient energy supply for the Commonwealth with minimum impact on the environment at the lowest possible cost. Therefore, NEP concludes that, consistent with the Siting Board's statutory mandate, the construction of the Project along the Project Route properly minimizes environmental impacts and achieves an appropriate balance among conflicting environmental concerns, as well as among environmental impacts, cost, and reliability.

6 CONSISTENCY WITH THE CURRENT HEALTH, ENVIRONMENTAL PROTECTION, AND RESOURCE USE AND DEVELOPMENT POLICIES OF THE COMMONWEALTH

6.1 INTRODUCTION

Pursuant to G.L. c. 164, § 69J, the Siting Board shall approve a petition to construct a facility only if it determines that the plans for the applicant's new facilities are consistent with current health, environmental protection, and resource use and development policies of the Commonwealth. As discussed below and in more detail throughout this Application, the Project not only satisfies the requirements of this standard, but is also fully consistent with other important state energy laws and policies, such as the Electric Utility Restructuring Act of 1997 (the "Restructuring Act"), the Green Communities Act (c. 169 of the Acts of 2008), the Global Warming Solutions Act (c. 298 of the Acts of 2008) (the "GWSA"), the Energy Diversity Act (c. 188 of the Acts of 2016), the Clean Energy Act (c. 227 of the Acts of 2018), An Act Creating a Next Generation Roadmap for Massachusetts Climate Policy (c. 8 of the Acts of 2021) (the "Roadmap Act") and An Act Driving Clean Energy and Offshore Wind (c. 179 of the Acts of 2002) (the "Drive Act"). The Project also complies with all laws and policies of the Commonwealth regarding EJ.

6.2 HEALTH POLICIES

The Restructuring Act provides that reliable electric service is of the utmost importance to the safety, health and welfare of the Commonwealth's citizens and economy. The Legislature has expressly determined that an adequate and reliable supply of energy is critical to the state's citizens and economy. The Project will be fully consistent with this tenet of the Restructuring Act. As discussed in the Application, the Project will enhance the reliability of the Company's transmission system that is served by the Rebuilt Lines and, thus, the regional electric grid, enabling the Company to continue to ensure the availability of sufficient and reliable electric service to the citizens and businesses of the Commonwealth and the region.

The Company will design, build, and maintain the Project so that the health and safety of the public are protected. Throughout the construction and operation of the Project, the Company will adhere to all applicable federal, state, and local regulations, and industry standards and guidelines established for protection of the public. As discussed in *Section 5* of the Application, all design, construction, and operational activities will comply with applicable governmental and industry standards and will have no adverse health effects. The Project will be designed in accordance with sound engineering practices using established design codes and guides published by, among others, the DPU, the Institute of Electrical and Electronic Engineers, the American Society of Civil Engineers, the American Concrete Institute, and the American National Standards Institute.

Because the Project will be consistent with, and promote, the Commonwealth's energy policies as outlined in the Restructuring Act, and because reliable electric service is of "utmost importance to the safety, health and welfare of the Commonwealth's citizens and economy," the Project will also be consistent with the Commonwealth's health policies.

6.3 ENVIRONMENTAL PROTECTION POLICIES

The Company will obtain all environmental approvals and permits required by federal, state, and local agencies and will construct and operate the Project in full compliance with applicable federal, state, and municipal statutes, regulations, and environmental policies. Thus, the Project will contribute to a reliable, low cost, diverse energy supply for the Commonwealth while avoiding, minimizing, and mitigating environmental impacts to the maximum extent practicable. Table 6-1 identifies the anticipated permits, reviews, and approvals required for the Project (in addition to the Siting Board's review). By meeting the requirements for acquiring each of these federal, state, and local permits, the Project will comply with applicable state and local environmental policies.

Table 6-1: Required Federal, State and Local Permits

Agency	Permit	Status
FEDERAL		
USACE	Section 404 Pre-Construction Notification ("PCN") Permit and consultations under Section 106 of National Historic Preservation Act and Section 7 of the Endangered Species Act	Targeted to be filed in May 2023.
USEPA	National Pollutant Discharge Elimination System Construction General Permit Authorization, Clean Water Act, 33 U.S.C. §1251 et. seq.: General Permit for Stormwater Discharges and Construction Dewatering Activities/SWPPP	To be filed at least 14 days prior to the start of construction.
STATE		
DPU	G.L. c. 164, § 72, approval to construct and operate a transmission line ("Section 72 Petition")	NEP filed motions with the Siting Board and the Department requesting that the Section 72 Petition be referred to the Siting Board and consolidated for hearing with the Section 69J Petition.
Executive Office of Energy & Environmental Affairs ("EEA")	MEPA, 301 CMR 11.00	Certificate on the EENF[55] issued on October 31, 2022; anticipated June 2023 filing for DEIR.
MassDEP	• Section 401 of the Federal Clean Water Act (Water Quality Certificate); 314 CMR 9.00 • Superseding Order of Condition 310 CMR 10.00 (Potential) • Chapter 91 Waterways Notice of Minor Project Modification 310 CMR 9.00 (Potential)	Targeted to be filed in July 2023.
MHC	Consultation under G.L. c. 9 in accordance with 950 CMR 70-71	Consultation with MHC is ongoing.
MassDOT	• State Highway Access Permit (G.L. c.81 §21/G.L. c.85 § 2) • Permits for crossing over state roads with utility lines.	In progress. Consultation with MassDOT is ongoing. Targeted to be filed in July 2023.

[55] The EENF for the Project is provided as Appendix 6-1, while the Secretary's Certificate on the EENF is provided as Appendix 6-2.

Agency	Permit	Status
DCR	Construction Access Permit	In progress. Consultation with DCR is ongoing.
LOCAL		
Athol Conservation Commission, Fitchburg Conservation Commission, Gardner Conservation Commission, Leominster Conservation Commission, Royalston Conservation Commission, Sterling Conservation Commission, Warwick Conservation Commission, Westminster Conservation Commission, and Winchendon Conservation Commission	Order of Conditions per the MWPA[56] and local bylaws	Targeted to be filed in Winter 2023/2024.
Fitchburg Commissioner of Public Works	Stormwater Permit	Targeted to be filed in Winter 2023/2024.
Fitchburg Tree Warden	Tree Trimming/Removal Permit	Targeted to be filed in Winter 2023/2024.
Gardner Zoning Board of Appeals	Special Permit – Earthmoving & Earth Alteration	Targeted to be filed in Winter 2023/2024.
Royalston Conservation Commission	Stormwater Management Permit	Targeted to be filed in Winter 2023/2024.
Royalston BOS	Written permission for soil removal activities	Targeted to be filed in Winter 2023/2024.
Sterling Conservation Commission	Stormwater Management Permit	Targeted to be filed in Winter 2023/2024.
Sterling Zoning Board of Appeals	Earth Removal Permit	Targeted to be filed in Winter 2023/2024.
Westminster Zoning Board of Appeals	Earth Removal Permit	Targeted to be filed in Winter 2023/2024.
Winchendon Zoning Board of Appeals	Earth Removal Permit	Targeted to be filed in Winter 2023/2024.

6.3.1 The Restructuring Act

The Restructuring Act requires that the Company demonstrate that the Project minimizes environmental impacts consistent with the minimization of costs associated with avoidance, minimization, and mitigation of the environmental impacts of the Project. Accordingly, an assessment of all impacts of a proposed project is necessary to determine whether an appropriate balance is achieved both among conflicting environmental concerns as well as among environmental impacts, cost, and reliability. A project that achieves the appropriate balance meets the requirement in G.L. c. 164, § 69J to minimize environmental impacts at the lowest possible cost.

To determine if a petitioner has achieved the proper balance among environmental impacts, cost and reliability, the Siting Board first determines if the petitioner has provided sufficient information regarding environmental impacts and potential mitigation measures. The Siting Board then determines whether

[56] MA WPA Orders of Conditions are local permits unless and until a superseding Order of Conditions is issued by MassDEP.

environmental impacts are avoided, minimized, and mitigated to the maximum extent possible. Similarly, the Siting Board evaluates whether the petitioner has demonstrated that the project is needed and has provided sufficient cost information in order to determine if the appropriate balance among environmental impacts, cost, and reliability has been achieved.

Sections 3, 4, and 5 of this Application demonstrate that the Company compared a range of alternative projects and potential route options, and proposed specific plans to avoid, minimize and mitigate environmental impacts associated with the construction, operation, and maintenance of the proposed transmission line, consistent with cost minimization. As such, the Project is consistent with the environmental policies of the Commonwealth as set forth in the Restructuring Act.

6.3.2 Green Communities Act

The Green Communities Act is a comprehensive, multi-faceted energy reform law that encourages energy and building efficiency, promotes renewable energy, creates green communities, implements elements of the Regional Greenhouse Gas Initiative (a program where Northeastern and Mid-Atlantic states cooperate to reduce GHG emissions) and provides market incentives and funding for various types of energy generation. The Green Communities Act (as amended and supplemented by St. 2012, c. 209, An Act Relative to Competitively Priced Electricity) has resulted in greater renewable supplies and substantial new conservation initiatives since enactment and continuing in future years.

The replacement of the Existing Lines and Taps will strengthen and improve the reliability of the Company's transmission system. While the primary Project purpose is to meet that specific need, the more robust system of new transmission lines will also enable integration of additional clean energy generated by renewables suppliers, expansion of electrification projects in the area, and will support increased usage of electric vehicles and the associated installation of electric charging stations, consistent with the Green Communities Act. Further, as part of the Company's evaluation of project alternatives, full consideration was given to the fact that the Rebuilt Lines will enable the Company to continue to bring hydropower to customers in Massachusetts and interconnect DER. The Project will meet the identified need in a reliable, cost-effective, and environmentally benign manner and therefore, is consistent with the Green Communities Act.

6.3.3 Global Warming Solutions Act and the Roadmap Act

The GWSA established aggressive GHG emissions reduction targets of 25 percent from 1990 levels by 2020 and 80 percent from 1990 levels by 2050. Pursuant to the GWSA, the Secretary of the EEA issued the Clean Energy & Climate Plan for 2020 in December 2010 and updated the plan in December 2015. Among other provisions, the GWSA requires administrative agencies such as the Siting Board, in considering and issuing permits, to consider reasonably foreseeable climate change impacts (e.g., additional GHG emissions) and related effects (e.g., sea level rise). More recently, in April 2020, the Secretary of EEA established a 2050 statewide emissions limit of net zero GHG emissions (and in no event greater than 85% below 1990 levels). Further, in December 2020, the Secretary issued the Massachusetts 2050 Decarbonization Roadmap that calls for increased electrification (e.g., electric vehicles, electric home heating, new heat pump technologies), new local renewable resources (e.g., wind, solar and battery storage), and the delivery of power from remote clean energy resources, such as offshore wind.

On March 26, 2021, former Governor Baker signed the Roadmap Act into law. The Roadmap Act codified the Baker Administration's commitment to net-zero emissions by 2050 and advances and extends the goals of the GWSA by establishing new interim goals for emissions reductions and authorizing a voluntary energy efficient building code for municipalities. The interim goals include: (1) by 2030, emissions must be 50% lower than they were in Massachusetts in 1990; and (2) by 2040, emissions must be 75% lower. The Roadmap Act also increases the required percentage of Massachusetts electricity that comes from renewable sources, requires an additional 2,400 MW of offshore wind, bringing the state's total target to 5,600 MW, and improves access to solar power through a low-income services solar program trust.

Finally, the GWSA amended MEPA to require that agencies, departments, boards, commissions, and authorities, in considering and issuing permits, licenses, and other administrative approvals and decisions, consider reasonably foreseeable climate change impacts, including additional GHG emissions, and effects, such as predicted sea level rise. In response, in 2010, MEPA issued the Massachusetts Environmental Policy Act GHG Emissions Policy and Protocol ("GHG Policy"), which requires that projects undergoing review under MEPA quantify the project's GHG emissions and identify measures to avoid, minimize, or mitigate such emissions. The GHG Policy also requires proponents to quantify the impact of proposed mitigation in terms of emissions and energy savings.

The Project complies with the requirements of the GWSA and the Roadmap Act. GHG emissions from the Project will be below the applicable reporting threshold and during the construction phase, short-term localized air quality effects will be minimal. On September 12, 2022, NEP submitted an EENF for the Project in accordance with MEPA. In her October 31, 2022, Certificate on the EENF, the Secretary required the filing of a DEIR and that it include a further discussion of the Company's compliance with the GHG Policy, including a discussion of mitigation measures related to loss of carbon sequestration from tree removals and limited soil disturbance. NEP anticipates filing the DEIR in the summer of 2023.

Moreover, NEP has taken steps to promote climate change adaptation and resiliency in the design of the Project and continues to consider climate change and long-term infrastructure resiliency as an important goal in its long-term infrastructure planning. The Project will result in a more climate-ready and resilient transmission system that can withstand more extreme weather events; address existing system capacity shortages and increased demand; and support future interconnections from renewable energy projects. In addition, the Project uses existing ROWs, thereby minimizing alteration of new land resources to construct the Project.

The system upgrades, as proposed, are intended to help ensure the long-term longevity and reliability of the region's electrical infrastructure in the face of growing demand and the changing climate. The Rebuilt Lines and the access route improvements will improve the resiliency of this energy infrastructure and provide high speed communications between substations, which will improve outage response times and help protect communities from outages during severe weather events.

The proposed Project has been designed in alignment with NEP's reliability goals and strategies in the following ways:

- Incorporates new design standards and the latest in design;
- Provides needed upgrades to existing electric transmission infrastructure;
- Provides the shortest project delivery time to meet the identified needs;
- Minimizes impacts to natural and social environments; and
- Provides a stronger electrical transmission system, vital to the public's safety, security, and economic prosperity.

The Project as designed will strengthen the regional transmission system and is consistent with both the Commonwealth's electric facility siting requirements and these future-state and local planning initiatives. Consequently, the Project is consistent with the GWSA and the Roadmap Act.

6.3.4 Energy Diversity Act and Clean Energy Act

On August 8, 2016, former Governor Baker signed into law the Energy Diversity Act, which facilitates the procurement and integration of renewable energy generation resources, including new offshore wind energy generation, firm service hydroelectric generation, and a new class of renewable energy facilities that meet eligibility criteria.

On August 9, 2018, former Governor Baker signed into law the Clean Energy Act, which amends the Energy Diversity Act to further encourage energy storage efforts and requires the Department of Energy Resources to investigate the potential for additional clean energy solicitations.

The Project will not only improve the reliability of the transmission system, but the new transmission lines will also be able to accommodate increased injections of renewable and other clean energy resources, such as new energy storage units, solar and wind. Accordingly, the Project is consistent with the Energy Diversity Act as amended by the Clean Energy Act.

6.3.5 Drive Act

On August 11, 2022, former Governor Baker signed a significant new climate bill, the Drive Act, which includes several new climate change measures, including those aimed at renewable energy and transportation sector GHG emissions. The statute provides funding for offshore wind energy and electricity grid improvements and aims to bolster offshore wind industry by removing the price bidding cap. The law also increases offshore wind procurement to 5,600 MW and authorizes Massachusetts to join with other New England states when bidding for renewable energy projects, such as wind and solar. In addition, the Drive Act provides for the potential procurement of transmission infrastructure necessary to support the development of offshore wind generation for Massachusetts and the region. The Project is consistent with the Drive Act in that the Rebuilt Lines will be able to accommodate increased injections of renewable and other clean energy resources that may come online in the future.

6.4 ENVIRONMENTAL JUSTICE

The Roadmap Act also includes several provisions that address EJ. It requires the Secretary to direct EEA agencies to consider EJ principles in making "any policy, determination or taking any other action related to a project review, or in undertaking any project pursuant to MEPA and related regulations that is likely to affect environmental justice populations." The Roadmap Act defines those EJ principles as including: (1) the meaningful involvement of all people with respect to the development, implementation and enforcement of environmental laws, regulations, and policies, including climate change policies; and (2) the equitable distribution of energy and environmental benefits and environmental burdens.

The Roadmap Act includes revisions to the MEPA review process and requires the Secretary to consider EJ principles during MEPA review to "reduce the potential for unfair or inequitable effects upon an environmental justice population." For projects subject to MEPA, the Roadmap Act requires an environmental impact report ("EIR") for any project that is "likely to cause damage to the environment" and that is located within one mile of an EJ population; this distance extended to five miles for a project that impacts air quality. The EIR must assess any existing unfair or inequitable environmental burden and related public health consequences impacting the EJ population from any prior or current operation or project that has damaged the environment; if such assessment indicates an unfair or inequitable environmental burden or related health consequence, the EIR must also: (1) identify any environmental and public health impact from the proposed project that would likely result in a disproportionate adverse effect on such population; and (2) potential impact or consequence from the proposed project that would increase or reduce the effects of climate change on the EJ population.

The Roadmap Act also requires the Secretary to provide opportunities for meaningful public involvement through the MEPA review process. Where an EJ population is present within the one-mile designated geographic area (or five miles if the project impacts air quality), and lacks English language proficiency, the proponent is required to indicate on an ENF if the population is reasonably likely to be affected negatively by the project. In such cases, the Secretary must require additional measures to improve public participation by the EJ populations, including: (1) translating public notices, ENFs, EIRs, and other key documents related to the Secretary's review and decisions in languages spoken by a significant number of the affected EJ population; (2) providing interpretation services at public meetings where a significant portion of the affected EJ population lacks English language proficiency; (3) requiring public meetings be held in accessible locations that are near public transportation; (4) providing appropriate information about the project review procedure for a proposed project; and (5) establishing a local repository for project review documents. MEPA has promulgated updated regulations and issued protocol to implement the provisions of the Roadmap Act (MEPA Interim Protocol for Analysis of Project Impacts on Environmental Justice Populations and the MEPA Public Involvement Protocol for Environmental Justice Populations).

The Company has implemented all EJ requirements that are applicable to the Project. There are 18 EJ populations within one mile of the Project, distributed in five municipalities, including Gardner, Athol, Fitchburg, Leominster, and Lancaster. The Company has taken measures to enhance public involvement by EJ populations and conducted a baseline assessment of any existing unfair or inequitable environmental burden and related public health consequences impacting EJ populations. The Company facilitated meaningful participation of residents of the proximate EJ communities by encouraging participation in outreach activities and soliciting feedback from the diverse cross section of the neighborhoods the Project will traverse. As part of the stakeholder outreach plan, NEP has promoted and will continue to promote public involvement by the EJ populations located within one mile of the Project through the use and dissemination of multi-lingual Project fact sheets, website content, meeting invitations and translation services for future presentations in English and Spanish (both in writing and in-person). NEP has held a Virtual Open House for all affected communities to learn about the Project and has provided presentations to City Council's and/or BOSs within these communities as a way to seek out meaningful feedback. NEP will be hosting in-person open houses within these EJ communities to engage in conversations and seek feedback about the Project and its impacts on the community.

Moreover, NEP has designed the Project to minimize the Project's impacts to all populations, including EJ populations. The Company has undertaken, and will continue to undertake, ongoing community outreach in EJ communities in or adjacent to the Project area to facilitate the meaningful opportunity to participate by all. The continued outreach to EJ communities will be consistent with the Roadmap Act and the rules and protocols promulgated thereunder. As such, the Project is consistent with the Commonwealth's EJ policies as codified in the Roadmap Act.

6.5 RESOURCE USE AND DEVELOPMENT POLICIES

The Project, which will contribute to the long-term maintenance and reliability of the electric transmission system in the Project area and the region, will be constructed and operated in compliance with

Massachusetts's policies regarding resource use and development. For example, in 2007, the EEA's Smart Growth/Smart Energy policy established the Commonwealth's Sustainable Development Principles, including: (1) supporting the revitalization of city centers and neighborhoods by promoting development that is compact, conserves land, protects historic resources and integrates uses; (2) encouraging remediation and reuse of existing sites, structures and infrastructure rather than new construction in undeveloped areas; and (3) protecting environmentally sensitive lands, natural resources, critical habitats, wetlands and water resources and cultural and historic landscapes. As described more fully in *Section 5* of this Analysis, the Project will support these principles because, among other reasons, the Rebuilt Lines will support the reliability of service to central Massachusetts, thereby supporting its revitalization and will not adversely affect environmentally sensitive lands because it will be predominantly located within previously disturbed parcels of land on existing ROWs.

Accordingly, the Project is in compliance with, and furthers, the Commonwealth's policies regarding resource use and development.