Robinson+Cole

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Also admitted in Massachusetts, Connecticut and Vermont

Via Hand Delivery

May 16, 2025

Tina L. Mastroianni, City Clerk
City of Providence
25 Dorrance Street
Providence, RI 02903

Re: **The Narragansett Electric Company**
Q143S/R144 Lines Rebuild Project
(Providence, North Providence, Lincoln and North Smithfield)

Dear Ms. Mastroianni:

Pursuant to Rhode Island General Laws § 42-98-9.1(a) and the Energy Facility Siting Board's ("EFSB") Rules of Practice and Procedure Rule 1.6(F), enclosed is a copy of The Narragansett Electric Company's 90 Day Notice of Intent filing (the "Application") for the rebuild of the existing Q143S and R144 115 kilovolt transmission lines that was filed today with the EFSB. The aforementioned provisions require notice of applications to "the councils of the towns and cities affected" by the proposed project. Enclosed for distribution to each member of the Town Council are copies of the Application, Siting Report, and Siting Report Figures.

The EFSB will notify you when the application is docketed and when the public comment hearing is scheduled. Please feel free to contact Kristen Masse, Coordinator with the EFSB, at (401) 780-2106 or me with any questions or comments.

Sincerely,

George W. Watson III

Enclosures

IN CITY COUNCIL
JUN 05 2025
READ
WHEREUPON IT IS ORDERED THAT
THE SAME BE RECEIVED.
Tina L. Mastroianni CLERK

Robinson+Cole

Copy to: Patricia S. Lucarelli, Esq. *(w/o enclosures)*
Brett P. Smiley, Mayor, City of Providence *(w/ enclosures, via Hand Delivery)*
Jeffrey Dana, Esq., Providence City Solicitor *(w/ enclosures, via Hand Delivery)*
Jennifer Brooks Hutchinson, Sr. Counsel – Rhode Island, The Narragansett Electric Company *(w/o enclosures)*
Joanne Scanlon, Rhode Island Legal Operations Coordinator, The Narragansett Electric Company *(w/o enclosures)*

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Also admitted in Massachusetts,
Connecticut and Vermont

Via Hand Delivery and Electronic Mail

May 16, 2025

Kristen Masse, Coordinator
Energy Facility Siting Board
89 Jefferson Boulevard
Warwick, RI 02888

Re: **The Narragansett Electric Company**
Q143S/R144 Lines Rebuild Project
(Providence, North Providence, Lincoln and North Smithfield)

Dear Ms. Masse:

I am enclosing for filing on behalf of The Narragansett Electric Company an original and six (6) copies of a 90 Day Notice of Intent filing (the "Application"), which is submitted pursuant to Rule 1.6(F) of the Energy Facility Siting Board Rules of Practice and Procedure, for the rebuild of the existing Q143S and R144 115 kilovolt transmission lines located in Providence, North Providence, Lincoln and North Smithfield. The Application includes the following:

- Siting Report; and
- Siting Report Figure.

Electronic copies of the Application will be provided to you via secure link.

If you need additional hard copies of the above, please advise and we will provide them.

Robinson+Cole

Thank you for your cooperation.

Sincerely,

George W. Watson III

Enclosures

Copy to: Patricia S. Lucarelli, Esq. (w/o enclosures)
Tina L. Mastroianni, Providence, City Clerk (via Hand Delivery)
Jeffrey Dana, Esq., Providence City Solicitor (via Hand Delivery)
Mary Ann DeAngelus, North Providence Town Clerk (Via Fed Ex)
Anthony M. Gallone, Jr., Esq., North Providence Town Solicitor (via Fed Ex)
Lillian Frye, Lincoln Town Clerk (via Fed Ex)
Anthony DeSisto, Esq., Lincoln Town Solicitor (via Fed Ex)
Joanne Buttie, North Smithfield Town Clerk (via Fed Ex)
Scott Gibbs, North Smithfield Town Administrator (via Fed Ex)
David Igliozzi, Esq., North Smithfield Town Solicitor (via Fed Ex)
Jennifer Brooks Hutchinson, Sr. Counsel – Rhode Island, The Narragansett Electric Company (w/o enclosures)
Joanne Scanlon, Rhode Island Legal Operations Coordinator, The Narragansett Electric Company (w/o enclosures)

STATE OF RHODE ISLAND
ENERGY FACILITY SITING BOARD

In re: The Narragansett Electric Company	:	
Q143/R144 Lines Rebuild Project	:	
Providence, North Providence,	:	Docket No.
Lincoln, North Smithfield	:	

Notice of Intent Application of
The Narragansett Electric Company

Counsel:

Andrew Marcaccio
The Narragansett Electric Company
280 Melrose Street
Providence, RI 02907
(401) 578-2700

George W. Watson, III
Robinson & Cole LLP
One Financial Plaza, 14th Floor
Providence, RI 02903
(401) 709-3351

May 16, 2025

TABLE OF CONTENTS

INTRODUCTION

The Narragansett Electric Company (the "Company"), with a principal place of business at 280 Melrose Street, Providence, Rhode Island 02907, hereby submits this Notice of Intent Application to the Energy Facility Siting Board (the "Board" or "EFSB") for the review of a project consisting of the rebuild of existing transmission lines within the State of Rhode Island, pursuant to the applicable provisions of Rhode Island General Laws §§ 42-98-1, et seq. and the Board's Rules of Practice and Procedure, 445 RICR-00-00-1, as amended (the "EFSB Rules").

This Application is filed by the Company pursuant to Rule 1.6(F) of the EFSB Rules which provides an abbreviated review for (i) the construction of power lines of more than 1,000 feet but less than 6,000 feet or (ii) the modification or relocation of power lines. As noted in Rule 1.3(A)(4), "'modification' includes reconductoring and rebuilding an existing power line." Rule 1.6 provides for an abbreviated application, a public hearing "in one or more of the cities or towns affected by [the] application," and a determination within sixty (60) days of the filing as to "whether the project may result in a significant impact on the environment or the public health, safety and welfare," thereby requiring a full EFSB review. (See EFSB Rules 1.6(F), 1.6(G), and 1.6(H)). If the Board does not find that the project may result in a significant impact on the environment or the public health, safety and welfare, the project does not constitute an "alteration" and the project may proceed without further review. (See EFSB Rules 1.3(A)(4) and 1.6(F)).

The Company is proposing to rebuild the Q143S and R144 115 kilovolt ("kV") Transmission Lines (the "Lines"), which includes replacing all of the structures, wires, and shield wires (collectively, the "Project"). This Project focuses on improving the condition and

performance of the Lines between (i) the Admiral Street Cable Terminal located at the corner of Admiral Street and Clarkson Street in Providence and the Woonsocket Substation located at 76 Greenville Road in North Smithfield and (ii) the tap lines from the Admiral Street Cable Terminal to the Admiral Street Substation located at the corner of Admiral Street and Chad Brown Street in Providence. The Lines have been identified for refurbishment because the conductors are nearing the end of their useful life and the existing wood structures are unable to support the new conductor.

The Company is filing herewith and incorporates herein a Siting Report entitled "Q143/R144 Rebuild Project" (the "Siting Report"). This application follows the organization of Rule 1.6(F) and identifies the sections of the Siting Report where the issues identified in the EFSB Rules are discussed.

1. Identification of the owner(s) of the facility.[1]

a. The owner of the facility is The Narragansett Electric Company, a Rhode Island chartered public utility, with its principal place of business at:

280 Melrose Street
Providence, RI 02907

b. The affiliates of The Narragansett Electric Company include its parent, PPL Rhode Island Holdings, LLC, PPL Energy Holdings, LLC, PPL Subsidiary Holdings, LLC, and PPL Corporation ("PPL"). The corporate relationships for the Company are shown on Exhibit 1, attached. A listing of PPL owned affiliates is available upon request.

[1] EFSB Rule 1.6(F)(1) requires the applicant to provide "[i]dentification of the owner(s) of the facility[,] including identification of all affiliates of the proposed owners[,] as such term is defined in R.I. Gen[.] Laws § 39-3-27."

2. Detailed description of the proposed facility.[2]

The Project will consist of rebuilding the existing Q143S and R144 Lines from the Woonsocket Substation in North Smithfield to the Admiral Street Cable Terminal in Providence and rebuilding the tap line from the Admiral Street Cable Terminal in Providence to the Admiral Street Substation in Providence. The Project area from the Admiral Street Substation to the Woonsocket Substation is approximately 11.5 miles. The rebuild includes the replacement of all structures, wires, insulators and shieldwires. Once the lines are rebuilt the Company will restore and stabilize the affected areas within the right-of-way ("ROW").

The Project is described in more detail in Section 3 of the Siting Report.

3. Detailed description and analysis of the impact of the Project on the physical and social environment.[3]

The environmental characteristics of the Project area are described in Section 5 of the Siting Report and the affected social environment is discussed in Section 6. The impact of the Project on the natural and social environments is described in Section 7 of the Siting Report. A review of current health research pertaining to electric and magnetic fields is included as Appendix A of the Siting Report. The existing and projected levels of electric and magnetic fields at the edges of the ROWs are provided in Section 7.16 of the Siting Report.

[2] EFSB Rule 1.6(F)(2) requires the applicant to provide a "[d]etailed description of the proposed facility, including its length, route, function and operating characteristics, and complete plans as to all structures associated with the proposed facilities."

[3] EFSB Rule 1.6(F)(3) requires the applicant to provide a "[d]etailed description and analysis of the impact of the Project on the physical and social environment. The applicant shall also provide a review of the current independent scientific research pertaining to electromagnetic fields ("EMF") and shall provide data on the anticipated levels of EMF exposure and potential health risks associated with this exposure. To the extent the proposed project will have only negligible impact on any particular resource in the natural and social environment the applicant may so state and need not provide a detailed analysis of the baseline conditions for that resource."

4. All studies and forecasts that demonstrate the need for the proposed facility.[4]

The Project is needed to address the asset condition of the current lines. The conductor is approaching the end of its life expectancy and the existing wood poles are unable to support the new conductor. If the Lines are not rebuilt, the area may face future reliability issues resulting from the asset conditions of the Lines.

The need for the Project is described in Section 2 of the Siting Report.

5. The reasons why the Project does not constitute the alteration of a major energy facility.

Transmission lines of 69 kV and above are included in the definition of "major energy facility" in Rule 1.3(A)(16) of the EFSB Rules. Rule 1.3(A)(4), however, states that

> [t]he construction of a new power line which is more than 1,000 but less than 6000 feet in length or the modification[5] or relocation of an existing power line shall not be an alteration unless the Board determines that the project may result in a significant impact on the environment or the public health, safety and welfare. [Emphasis added.]

Thus, the Project would constitute the alteration of a major energy facility and be subject to the full EFSB permitting process only if the Board determines that it "may result in a significant impact on the environment or the public health, safety and welfare."

As explained in Section 3 of the Siting Report, the Project involves rebuilding the existing Lines. The impacts of the Project are discussed in Section 7 of the Siting Report. The mitigation measures are discussed in Section 8 of the Siting Report. In summary, any impact on environmental resources and the social environment will be negligible. Consequently, because

[4] EFSB Rule 1.6(F)(4) requires the applicant to provide "[a]ll studies and forecasts which demonstrate the need for the proposed facility under the statewide master construction plan submitted annually."

[5] Per EFSB Rule 1.3(A)(4), modification "includes reconductoring and rebuilding an existing power line."

the Project does not significantly impact the environment or the public health, safety and welfare, the Board should determine that the Project does not constitute an alteration and it may proceed without further review by the Board.

CONCLUSION

This Application and the Siting Report, which are filed herewith and incorporated herein, and the other supporting material clearly demonstrate that the proposal to rebuild the existing Lines will not result in a significant impact on the environment or the public health, safety and welfare.

For the reasons stated herein, The Narragansett Electric Company requests that the Board finds that the further review is not required because Project as described herein will not result in a significant impact on the environment or the public health, safety and welfare.

Respectfully submitted,

THE NARRAGANSETT ELECTRIC COMPANY

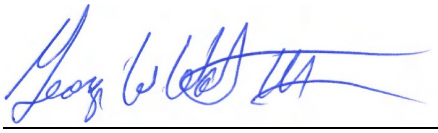
Signature: Joseph Lookup (May 15, 2025 18:51 EDT)

Email: jblookup@pplweb.com

Joseph B. Lookup
Vice President T&D Planning & Asset Management
280 Melrose Street
Providence, RI 02907

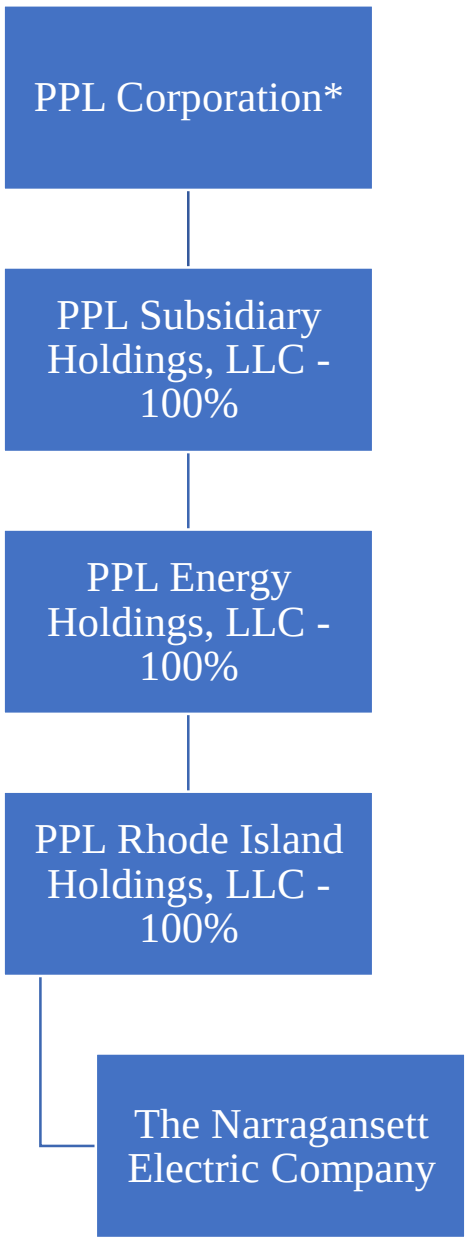
By its Attorneys,

Andrew Marcaccio
The Narragansett Electric Company
280 Melrose Street
Providence, RI 02907
(401) 578-2700



George W. Watson, III
Robinson & Cole LLP
One Financial Plaza, 14th Floor
Providence, RI 02903
(401) 709-3351

Organization Chart – The Narragansett Electric Company – June 2022



* Other subsidiaries of PPL Corporation are omitted.

Exhibit TNEC-2

May 2025

THE NARRAGANSETT ELECTRIC COMPANY

Q143S/R144 LINES REBUILD PROJECT

Rhode Island Energy Facility Siting Board

Siting Report

Prepared for:
The Narragansett Electric Company
280 Melrose Street
Providence, RI 02907

BSC Project No. 0101322.00

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Rhode Island Energy Facility Siting Board

Siting Report

PREPARED FOR:

THE NARRAGANSETT ELECTRIC COMPANY
280 MELROSE STREET
PROVIDENCE, RI 02907

FOR SUBMITTAL TO:

STATE OF RHODE ISLAND ENERGY FACILITY SITING BOARD
89 JEFFERSON BOULEVARD
WARWICK, RI 02888

PREPARED BY:

BSC GROUP INC.
1 MERCANTILE STREET, SUITE 610
WORCESTER, MA 01608

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TABLE OF CONTENTS

TABLES:

FIGURES:

APPENDICES:

ACRONYMS AND ABBREVIATIONS

ACGIH	American Conference of Governmental and Industrial Hygienists
ACI	American Concrete Institute
ACSR	Aluminum Conductor Steel-Reinforced cable
ACSS	Aluminum Conductor Steel-Supported cable
Act	Energy Facility Siting Act (the "Act")
ANSI	American National Standards Institute
AOI	Area Of Interest (Soil Mapping)
APE	Area of Potential Effects (Cultural resources assessment)
ASCE	American Society of Civil Engineers
ASF	Areas Subject to Flooding
ASSF	Areas Subject to Storm Flowage
BMP	Best Management Practices
BSC	BSC Group, Inc.
CFR	Code of Federal Regulations
Company	The Narragansett Electric Company
dB	Decibels
DC	Double Circuit
EFSB	Energy Facility Siting Board
EFSB Rules	EFSB's "Rules of Practice and Procedure" effective November 8, 2018
EG-303	TNEC's ROW Access, Maintenance and Construction Best Management Practices for New England
EG-802	TNEC's Environmental Guidance EP-8; Air Emissions Management
EMF	Electric and Magnetic Fields
ESA	Endangered Species Act
Exponent	Exponent, Inc.
FEMA	Federal Emergency Management Agency
GA	RI Groundwater Classification – waters known or presumed to be suitable for drinking water use without treatment and located outside of the three priority areas described under GAA.
GAA	RI Groundwater Classification – waters known or presumed to be suitable for drinking water use without treatment, and located within a major stratified drift aquifer, wellhead protection area or groundwater dependent area.
GB	RI Groundwater Classification – groundwater which may not be suitable for drinking water use without treatment due to known or presumed degradation.
GC	RI Groundwater Classification – groundwater classified GC is or may be unsuitable for drinking water use due to certain waste disposal practices.
Hz	Hertz
ICES	International Committee on Electromagnetic Safety
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEEE	Institute of Electrical and Electronic Engineers
IpaC	Information for Planning and Conservation
ISO-NE	Independent System Operator – New England
kV	kilovolt
kV/m	kilovolts per meter
mG	milliGauss
NESC	National Electrical Safety Code
NHESP	Natural Heritage Endangered Species Program
NLEB	Northern Long-Eared Bat
NOI	Notice of Intent

NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
OHGW	Overhead Ground Wire
OPGW	Optic Fiber Ground Wire
PAL	Public Archaeology Laboratory
PBO	Programmatic Biological Opinion
Project	Q143S/R144 Rebuild Project
Report	Siting Report
RI	Rhode Island
RIDEM	Rhode Island Department of Environmental Management
RIDOT	Rhode Island Department of Transportation
RIGIS	Rhode Island Geographic Information System
R.I.G.L	Rhode Island General Laws
RIHPHC	Rhode Island Historic Preservation and Heritage Commission
ROW	Right-of-Way
Rules	Rhode Island Fresh Water Wetlands Act and Rules
SC	Single Circuit
SESC	Soil Erosion and Sediment Control
SHPO	State Historic Preservation Office
SHWTD	Seasonal High Water Table Depth
TMDL	Total Maximum Daily Load
TNEC	The Narragansett Electric Company
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife
USGS	United States Geological Survey
V	Volt
V/m	volts per meter

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1 INTRODUCTION

1.1 Project Overview

This Siting Report (the "Report") has been prepared in accordance with Rule 1.6(F) of the Rhode Island ("RI") Energy Facility Siting Board ("EFSB") Rules of Practice and Procedure to support a Notice of Intent ("NOI") for The Narragansett Electric Company's ("TNEC" or the "Company") rebuild of a section of the existing Q143S and R144 115 kV ("kilovolt") North Smithfield – Providence transmission lines ("Q143S and R144 Lines" or "Lines"), which run parallel to each other within an existing transmission Right-of-Way ("ROW"), located in Providence, North Providence, Lincoln, and North Smithfield(the "Project"). The Project area for the Q143S and R144 Lines is between the Woonsocket Substation and Admiral Street Cable Terminal and the tap line from the Admiral Street Cable Terminal to the Admiral Street Substation ("Project area"). In total, the Project spans a length of approximately 11.5 miles. The Project is the rebuild of both Lines on double circuit steel monopole structures centered on the existing Q143S circuit centerline. Please refer to Project Overview Map (Figure 1-1), for details of the Project ROW.

1.2 Project Team

This Report has been prepared by TNEC employees and consultants retained by TNEC. The description of the affected natural and social environments, and impact analyses were prepared by BSC Group, Inc ("BSC"). Other consultants contributing to the Report include Public Archaeology Laboratory ("PAL") for cultural resources; Exponent, Inc. ("Exponent") for analysis of health effects of electric and magnetic fields ("EMF"); and Robinson & Cole LLP for legal counsel. Westwood is responsible for Project engineering and design.

1.3 Compliance with EFSB Requirements

This Report has been prepared in accordance with Rule 1.6(F) of the EFSB Rules of Practice and Procedure to support an NOI. Rule 1.6(F) provides:

> *"In the case of the construction of a power line of more than 1000 feet but less than 6000 feet in length with a capacity of 69 kV or more or the modification or relocation of a power line with a capacity of 69 kV or more, a notice of intent for such project shall be filed with the Board and the council of any town or city affected by said construction at least 90 days before commencing construction."*

This Report is being submitted to satisfy the applicable requirements of Rhode Island General Laws ("R.I.G.L.") 42-98-1 et seq., the Energy Facility Siting Act (the "Act"), in compliance with Section 4 of the Energy Facility Siting Act, which states that: "*No person shall site, construct, or alter a major energy facility within the state without first obtaining a license from the siting board pursuant to this chapter.*" Under the Act, transmission lines with a design rating of greater than or equal to 69 kV are classified as major energy facilities. The Report filing requirements and associated procedures for a major generating facility are established in the EFSB's "Rules of Practice and Procedure" effective November 8, 2018 (the "EFSB Rules").

1.4 Arrangement of the Report

This Report has been prepared in support of an application to the EFSB. The Report has been prepared in accordance with the EFSB Rules to provide information on the potential impacts of the electric transmission system improvements proposed by TNEC. The Report describes the Project and explains the need for the Project. In addition, the Report discusses the alternatives to the Project that were considered and analyzed, describes the specific natural and social features that have been assessed for the evaluation of impacts, discusses potential impacts, presents a mitigation plan for potential impacts associated with the construction

of the Project, and describes permit requirements. The Purpose and Need for the Project is detailed in Section 2.0 of this Report. Section 3.0 provides: a detailed description of each of the components of the Project; discusses construction practices; and includes ROW maintenance practices, safety and public health considerations, Public Outreach, estimated costs for the Project, and the anticipated Project schedule. An analysis of the alternatives to the Project, together with reasons for the rejection of these alternatives, is presented in Section 4.0 of this report. Detailed descriptions of the characteristics of the natural and social environment within and immediately surrounding the Project location are included in Sections 5.0 and 6.0, respectively. Section 7.0 of this Report identifies the potential impacts of the Project on the natural and social environments. Section 8.0 summarizes proposed mitigation measures intended to offset or eliminate the potential impacts associated with the Project. The Figures section contains supporting mapping and figures. The Appendices of this Report contain supporting reports and project guidance documents, as applicable.

2 PROJECT NEED AND BENEFITS

2.1 Project Need

The purpose of the Project is to maintain existing assets so that Company can continue to provide reliable delivery of electrical service across the region. The wood pole H-frame structures on the lines (which were installed between 1963 and 2019), have proven to be more susceptible to premature failures than anticipated, which could result in catastrophic damage or complete failure of the structure, thus threatening the reliability of the system. Replacing the older population of wood poles with steel monopoles will result in a more reliable system for customers, with fewer line outages. This Project will implement the Asset Optimization Strategy ("AOS") Team recommendations to upgrade or rebuild aging TNEC transmission line facilities to improve reliability and longevity of our system while reducing maintenance costs.

The Lines still have the original 4/0 7 strand copper conductor from 1963, making the conductor 62 years old. The useful life[1] for conductor is typically about 65 years, so the existing conductor has around 3 years left of useful life. With the work completing in December of 2026, the conductor will be reaching 64 years of age which is right at the end of its useful life. As the structures, shield wire, and conductor reach the end of their useful life, the number of defects will exponentially increase and will need to be maintained or replaced to prevent failures.

Assets at or near end of life are at an increased likelihood of failure and need to be addressed to maintain system reliability and, most importantly, public safety. Continuing to perform extensive maintenance on aging assets would not be a financially prudent option for customers and does not fully mitigate the risk of component failure. Failure of infrastructure may result in system reliability issues, long outages for customers, dangerous conditions for the public, damage to nearby facilities, needing emergency response personnel, expensive repairs, or other negative impacts. Additionally, failure of conductor or its components may result in downed live wires which pose an immediate safety threat to nearby individuals, vehicles, and wildlife. Load in the area is expected to increase slightly (~5MW) with the completion of upgrades at the Admiral Street Substation in mid-2026. The proposed conductor allows for future load growth and reduces likelihood of revisiting the corridor multiple times resulting in less disturbance to the environment and lower mobilization costs to complete the work.

The Lines are original vintage, and there have been numerous defects[2] identified through inspections of the lines and assets. Roughly 95% (approximately 286) of the structures on the lines are wood pole structures. Although the line was partially refurbished in 2014 as 134 structures were replaced, modeling has indicated that neither the original structures nor the replacement structures would be able to support the new, heavier conductor. A representative section of the line was modeled with the existing H-frames supporting new 1113 Aluminum Conductor Steel-Supported cable ("ACSS") "Finch" conductor and 0.567" Optic Fiber Ground Wire ("OPGW"). These new cables were graphically sagged to LiDAR to match the existing cable sags. The Company found that 12 out of 21 structures failed to support the new conductor. This occurs under NESC 250C. The structures were modeled as class 2 H-frames with steel crossarms and adjusted pole heights as necessary to match the existing conditions. These structures are all tangent suspension structures. It is assumed that any tension structures or angle structures would fare worse with the heavier conductor. With the new Finch ACSS, 18 out of 23 spans failed to meet clearance requirements under the max operating temperature of the ACSS conductor. As such, the existing wood structures will be replaced with steel structures. The steel structures will have the additional advantages of having a longer useful life

[1] Expected useful life was defined as the age when the facility exhibits a significant and sustained increase in maintenance costs with a higher likelihood of component failure. The Team recommends that these transmission line facilities be rebuilt to the latest TNEC design standards rather than continuing to perform extensive maintenance.

[2] Some of the defects identified to date include pole top cracking, backed out conductor cotter keys, pulled shoes on shield wire, and missing armor rod on Overhead Ground Wire ("OHGW").

of 60 years (compared to the 40-50 year estimated life of a wood pole), as well as providing additional protection as woodpeckers will not be able to create holes in the structures.

2.2 Project Benefit

Replacing the older population of wood poles with steel monopoles will result in a more reliable system, and latent reliability issues (such as porcelain insulators and inadequate grounding) will also be addressed to ensure efficiency of work. Fiber needs will also be addressed to expand and strengthen the Company's fiber network. If no action is taken, TNEC expects to see an increase in component failures and outages, compromising the reliability of the transmission system and leading to increased maintenance, increased costs to customers, and repeated disturbance of surrounding areas.

3 PROJECT DESCRIPTION

3.1 Introduction

This section of the Report summarizes: the scope of the Project, the proposed facilities, TNEC's construction practices, estimated Project costs, and the anticipated Project schedule.

3.2 Description of Existing Transmission Lines

The Lines span approximately 11.5 miles between the Woonsocket Substation to the Admiral Street Cable Terminal and from the Admiral Street Cable Terminal to the Admiral Street Substation. The existing 115kV circuits (Q143S and R144 Lines) consist predominantly of wood H-frame structures, with some wood three-pole structures, steel two-pole structures, and steel monopoles. Existing conductor types include 4/0 7-strant copper and 795 KCMIL 54/7 Aluminum Conductor Steel-Reinforced cable ("ACSR") "Condor", with one 3/8″ HS Steel shield wire and one OHGW shield wire.

3.3 Scope of the Project

The rebuilt Lines will share double circuit towers centered on the existing Q143S Line. The proposed structure framing is based on the Company's 115/138kV double circuit steel pole standard geometries from construction standard 7-008. The Project will utilize 1113 KCMIL "Finch" 54/19 ACSS conductor and OPGW for its entire overhead length.

Ground line asset condition inspections, aerial comprehensive inspections, and various other inspections of the Q143S and R144 Lines have identified deteriorated wood pole assets. The older wood H-frame structures have proven to be more susceptible to premature failures than anticipated, resulting in catastrophic damage or complete failure of the structure, thus threatening the reliability of the system. Replacing the older population of wood poles with steel monopoles will result in a more reliable system for customers, with fewer line outages. Latent reliability issues such as porcelain insulators and inadequate grounding will also be addressed to improve reliability. In addition, the existing circuits need to be reconductored. As such, the Project will utilize 1113.0 KCMIL 54/19 ACSS "Finch" conductor to replace the existing circuits. The existing shield wires will be replaced with dual OPGW to provide high-speed communication between substations. The Line rebuild will also include structure replacements, overhead maintenance, stonework area construction (in select locations), and minor repairs to pre-existing access roads (filling ruts and potholes).

In total, 302 structures will be replaced. Structure replacements will be Single Circuit ("SC") and Double Circuit ("DC") Steel Monopoles supported on concrete caisson foundations or directly embedded into the ground. The existing SC wood H-frame structures are being converted to DC steel monopoles for the majority of the proposed rebuild. The Project will replace outdated wood H-frames and three-pole structures, along with steel two-pole and monopoles with new single- and double-circuit monopole structures, following a pole-for-pole replacement strategy along the existing ROW. This approach addresses the existing line's deteriorating wood pole structures, which include 246 single-circuit wood H-frames, 40 single-circuit wood three-pole structures, 12 single-circuit steel two-pole structures and four (4) monopole structures. A series of monopole structures will replace wood H-frames, utilizing direct embedment and foundation-supported designs in line with TNEC framing standards.

The Project proposes the installation of 113 direct embedded structures (on a total of 116 embedded poles), and 43 caisson-supported structures (on a total of 45 caisson foundations). Pole heights will range from 51 to 121 feet, with an average height of 83 feet, supporting a configuration that meets clearance requirements and minimizes visual impacts where feasible.

Design methodology prioritizes reliability and minimizes impacts by using existing line alignments and locations, with only minor adjustments to meet clearance needs or reduce property impacts. In order to

provide adequate line clearances, and avoid outage risks from falling tree branches, 0.18 acres of tree removals are required along the Project ROW. The Project also includes guy and anchor installations for five structures using ¾" extra high strength ("EHS") steel guy wires with 36" disk anchors to reinforce specific poles. A staged red-tag outage sequence will ensure continuous service, with the Q143S circuit constructed first and retained temporarily for emergency needs, followed by the R144 circuit installation and final removal of existing structures.

3.4 Construction and Maintenance Practices

3.4.1 Construction Sequence

The Project will be constructed using conventional overhead electric transmission line method and techniques. TNEC and its consultants conducted detailed constructability field reviews to determine access and workspace requirements and to evaluate measures to avoid or minimize environmental impacts.

The transmission lines will be constructed in a progression of activities that typically proceed in the sequence, and with the equipment, described below in Table 3-1.

TABLE 3-1: TYPICAL CONSTRUCTION EQUIPMENT

Construction Phase	Typical Equipment Required	
ROW Mowing	• Grapple trucks • Track-mounted mowers • Chippers • Brush hogs, skidders • Bucket trucks	• Chain saws • Low-bed trailers, flatbed trucks • Pickup trucks
Soil Erosion/Sediment Controls	• Stake body trucks • Pickup and other small trucks	• Small excavators • Trencher
Access Roads Improvement and Maintenance	• Dump trucks • Bulldozers • Excavators • Backhoes • Front end loaders	• Pick-up trucks • Low-bed trailers • Stake body trucks • Graders
Removal, Disposal and Replacement of Existing Transmission Line Components	• Cranes • Flatbed trucks • Pullers with take-up reels • Excavators	• Backhoes • Trucks with welding equipment • Dump trucks • Storage containers
Conductor and Shield Wire Installation	• Bucket trucks • Puller-tensioners • Conductor reel stands	• Cranes • Flatbed trucks • Pickup trucks • Tracked carriers or skidders
Restoration of the ROW	• Pickup and other small trucks • Excavators • Backhoes • Bulldozers	• Dump trucks • Tractor-mounted York rakes • Straw blowers

3.4.1.1 ROW Mowing & Tree Removals in Advance of Construction

Vegetation mowing may be required to provide safe work areas for personnel within the ROW. Tree removals (on or off-ROW) are expected for the Project. Only trees that present a hazard or prohibit access will be removed. Prior to vegetation removal and mowing, the boundaries of wetlands will be clearly

marked to prevent unauthorized encroachment of equipment. Appropriate forestry techniques will be implemented within wetlands to minimize ground disturbance. Other sensitive resources will be flagged and enclosed with protective fencing prior to removal of vegetation on the ROW. Existing access routes along the ROW will be used by the vegetation removal personnel and equipment to the extent practicable, and road improvements will be kept to a minimum during this phase of the work. The use of temporary swamp mats will be required to gain access to and across wetlands, to minimize wetland disturbance, and to provide a stable platform for safe equipment operation.

Generally, shrubs will be cut close to the ground, leaving the stumps and roots in place to reduce soil disturbance and erosion. If grading is required for access road improvements or at structure sites, stumps will be removed and disposed of off-site. Small trees and shrubs within the ROW will be mowed as necessary with the intent of preserving roots and low-growing vegetation to the extent practical. Brush, limbs, and cleared trees will be chipped or removed from the site.

3.4.1.2 Installation of Soil Erosion and Sediment Controls

Following vegetation removal activities, TNEC will install appropriate soil erosion and sediment control devices, such as straw wattles/bales, siltation fencing, and/or chip bales in accordance with approved plans and permit requirements. The soil erosion and sediment control program for the Project will follow the procedures identified in the *Rhode Island Soil Erosion and Sediment Control Handbook*, the *Rhode Island Stormwater Design and Installation Standards Manual*, the Rhode Island Department of Environmental Management's ("RIDEM") manual of best management practices ("BMP")*: Wetland BMP Manual: Techniques for Avoidance and Mitigation,* and TNEC's *ROW Access, Maintenance and Construction Best Management Practices for New England* ("EG-303").

The installation of these erosion and sediment control devices will be supervised by TNEC's environmental monitor. During construction, these devices will be periodically inspected and monitored by the environmental monitor, and the environmental monitor's findings will be reported regularly to TNEC's Construction Supervisor. Where work activities will disturb soils and potentially cause soil erosion and sedimentation, sediment and erosion controls will be installed between work areas and environmentally sensitive areas (such as wetlands, streams, and drainage courses), roads, and adjacent properties. Sediment and erosion controls 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.

Where feasible, staging areas and equipment storage will be situated outside of watershed protection areas, wetlands, and other environmentally sensitive areas. Equipment refueling (except for large, fixed equipment), will occur outside of environmentally sensitive areas (such as waterways and wetlands). If extenuating circumstances arise requiring refueling within or in close proximity to sensitive areas, secondary containment devices and other spill prevention BMPs (such absorbent pads), will be used during refueling.

In resource areas temporarily disturbed by construction, swamp mats, soil erosion and sediment controls, and other measures will be installed in accordance with BMPs. Herbaceous vegetation in disturbed areas will be restored using a native wetland or conservation seed mix. Enhancements proposed as mitigation for important wildlife features lost due to construction activities may include seeding, planting native shrub species, leaving snags, and placing woody debris and slash or stone piles to create wildlife cover. At the end of construction, swamp mats will be removed and cleaned prior to being moved to another location or off-site.

3.4.1.3 Access Road and Work Pad Maintenance

Access roads are required along the ROW to construct, inspect, and maintain the existing and proposed transmission line facilities. Typical access roads are 16 feet wide, with a travel lane of approximately 12 feet to accommodate the vehicles and equipment needed for the Project.

TNEC is planning to use the existing network of access roads on the ROW, and access road improvements will be limited to minor repairs (filling of ruts and potholes). Stabilized construction entrances may need to be refreshed where the ROW crosses public roadways.

Where upland access is not available, access across wetlands and streams will be accomplished by the placement of temporary swamp mats. Mats will be removed following completion of construction, and areas will be restored to pre-existing topography and hydrology. Swamp mats or similar matting may also be used to cross land in active agricultural use, or in other environmentally sensitive areas.

Any access road improvements and/or maintenance will be carried out in compliance with the conditions and approvals of the appropriate federal and state regulatory agencies. Exposed soils on access roads will be wetted and stabilized as necessary to suppress dust generation during construction. Crushed stone aprons/tracking pads will be used at all access road entrances to public roadways to clean the tires of construction vehicles and minimize the migration of soil off site.

Upland work pads will be constructed at structure locations by grading or adding gravel or crushed stone to provide a level work surface for construction equipment and crews. Once construction is complete, the work pads in uplands will remain in place, and will be stabilized with topsoil and mulched to allow vegetation to re-establish. In wetlands, these work pads will be constructed with temporary swamp mats and will be removed after the completion of construction activities.

3.4.1.4 Installation of Replacement 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 (these self-supporting structures also referred to as "caisson foundations"), as described in Table 3-2.

TABLE 3-2: INSTALLATION METHODS FOR DIRECT EMBED AND FOUNDATION 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 the pole directly in the ground and backfilling around the pole. To address engineering design requirements and construction feasibility, direct-embedded pole structures may be encased within a corrugated metal pipe ("CMP") or metal casing. Depending on structural loading, modified stone, flowable fill, or concrete will be used to backfill around the pole and within the CMP or casing.
Self-Supporting / Caisson Foundation Structure:	Caissons will be constructed by drilling a vertical shaft, installing a steel reinforcing cage (tied rebar), placing a steel anchor bolt cluster, pouring concrete, and backfilling. Structures will be lifted by a crane and placed and secured onto the anchor bolts. In some locations temporary casing shaft (oversized to fit the permanent casing) and/or permanent casing within the temporary casing may be utilized.

In general, any material excavated during structure installations will be placed next to the excavation. Steel culvert casings may be 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 3/4″ Minus gravel, flowable fill, or concrete 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, may be 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 a bucket truck or a crane with a basket is 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.

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.

3.4.1.5 Installation of Conductor

The new conductors will be installed using stringing blocks and tensioning equipment. The tensioning equipment is used to pull the conductors through the stringing blocks 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 to ensure the public safety and the continued operation of other utility equipment. To minimize any additional disturbance to soil and vegetation, existing access roads will be used for the placement of pulling and tensioning equipment.

Typical equipment used during conductor installation includes puller-tensioners and conductor reel stands, which will be located at stringing sites. Construction of temporary wire stringing and pulling sites is required to (i) provide a level workspace for equipment and personnel and (ii) to establish remote wire stringing set-up sites at angle points in the transmission line and at dead-end structures. Bucket trucks and platform cranes will be used at non-wetland locations to mount stringing blocks on the structures. To avoid setting temporary poles as guard structures in environmentally sensitive areas, the booms of small cranes and bucket trucks will be used as guard structures in such areas, to prevent the conductors from falling across roads or other utility lines. Pickup trucks will be used to transport work crews and small materials to work sites.

A “red-tag” outage sequence will be employed during construction of the new line components. The new line will be constructed in place of the existing line, while only the existing single 48F OPGW is operational until a new fiber path has been constructed. Then, the remaining poles and fiber will be removed, allowing for energization of the new circuit. Poles will be offset from the existing centerline at the angles to allow for safe clearances between energized circuits and setting of pole bases/foundations during construction.

3.4.1.6 Removal and Disposal of Existing Transmission Line Components

TNEC proposes to recycle as much of the material generated by construction as possible. Those components which cannot be salvaged, and any debris that cannot be recycled, will be removed from the ROW to an approved off-site facility. Handling of such materials will be performed in compliance with applicable laws and regulations, and in accordance with TNEC’s policy and procedures.

3.4.1.7 Restoration of the ROW

Restoration efforts, including removal of construction debris, final grading, stabilization of disturbed soil, and installation of permanent sediment control devices (water bars/diversion channels/rock fords), will be completed following construction. All disturbed areas around structures and other graded locations will be seeded with an appropriate conservation seed mixture and/or mulched to stabilize the soil in accordance with applicable regulations. Temporary sediment control devices will be removed following the stabilization of disturbed areas. Existing walls and fences will be restored if necessary. Regulated

environmental resource areas that are temporarily disturbed by construction will be restored to pre-construction conditions to the extent practicable, in accordance with applicable permit conditions.

3.4.2 Construction Traffic and Mitigation

Construction-related traffic will occur intermittently throughout the duration of construction. Construction equipment will typically access the ROW from public roadways, which cross the ROW at various locations along the route. Because construction tasks will occur at different times and locations over the course of construction, traffic will be intermittent and spread across these entry roadways. Traffic will consist of vehicles ranging from pick-up trucks to heavy construction equipment.

TNEC's contractors will coordinate closely with the Rhode Island Department of Transportation ("RIDOT") to develop acceptable traffic management plans for work within state highways. TNEC will coordinate with local authorities in the Town of North Smithfield 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 with appropriate police details.

3.4.3 Construction Work Hours

Proposed construction work hours for the Project will be between 7:00 a.m. and 7:00 p.m. Monday through Friday (when daylight permits), and, when necessary, between 7:00 a.m. and 5:00 p.m. on weekends. Some limited construction may have to occur outside of standard work hours when needed to complete certain activities. For example, once started, some work tasks (such as installing reels of conductor) must be continued through to completion, and may go beyond normal work hours.

The nature of transmission line construction requires line outages for certain procedures, including transmission line connections, equipment cutovers, or stringing under or over other transmission lines. Availability of these outages can be limited, and is dictated by the Independent System Operator - New England ("ISO-NE") based on regional system load and weather conditions. Such scheduled outages will have no effect on electric service to local customers. Work will be completed under red-tag/green-tag outage constraints, in which one circuit will remain energized while work is taking place on the other (unenergized) circuit. Work requiring scheduled outages and crossings of certain transportation and utility corridors may need to be performed on a limited basis outside of normal work hours, including on Sundays and holidays.

Prior to and during construction, TNEC will notify landowners, abutting property owners, municipal officials, the Town's Department of Public Works and Police and Fire Chiefs of the details of planned construction including the normal work hours and any extended work hours.

3.4.4 Environmental Compliance Monitoring

Throughout the construction process, TNEC will retain the services of an environmental monitor. The primary responsibility of the monitor will be to oversee construction activities including the installation and maintenance of soil erosion and sediment controls and other BMPs to ensure compliance with all federal, state and local permit commitments. Prior to the start of construction, all Project personnel will be trained in Project environmental requirements and permit conditions, including environmental, rare species, stormwater management, and cultural resources. Refresher training will be held as new crew members join the Project workforce, and as otherwise necessary. TNEC will conduct regular construction progress meetings to reinforce the contractor's awareness of these issues. Pre-construction "look-ahead meetings" will take place in the field with appropriate Project personnel. The environmental monitor will attend these meetings to provide feedback on environmental requirements and compliance to construction personnel.

During the construction process, the environmental monitor will verify and report on compliance with all federal, state, and local permit requirements and TNEC's policies and procedures. At regular intervals and

during periods of prolonged precipitation, the environmental monitor will inspect the environmental controls to determine whether they are functioning properly.

In addition to retaining the services of an environmental monitor, TNEC will require the construction contractor to designate an individual to be responsible for the daily inspection and maintenance of environmental controls. This person will also be responsible for providing direction to the other members of the construction crew regarding matters such as wetland access, appropriate work methods, driving safety, and good housekeeping practices along the ROW.

3.4.5 Safety and Public Health Considerations

TNEC will design, build, and maintain the Project so that the health and safety of the public are protected. This will be accomplished through adherence to all applicable regulations and industry standards and guidelines. Specifically, the Project will be designed, built, and maintained in accordance with the National Electric Safety Code ("NESC"). The facilities will be designed in accordance with sound engineering practices, using established design codes and guides published by (among others), the Institute of Electrical and Electronic Engineers ("IEEE"), the American Society of Civil Engineers ("ASCE"), the American Concrete Institute ("ACI"), and the American National Standards Institute ("ANSI"). The practices that TNEC will use to protect the public during construction include, but are not 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; use of temporary guard structures at road and electric line crossings to prevent accidental contact with conductors during installation; noise and dust control management; and coordination with the City of Providence and Towns of North Smithfield and Lincoln, as well as with RIDOT, during construction.

A report discussing the current status of the health research relevant to exposure to EMF was prepared by Exponent, and is attached as **Appendix A**.

3.4.6 Stakeholder Outreach

The Company believes in, and has committed to, a fully open, transparent, and regular two-way dialogue with project stakeholders throughout the life of its projects. The Company launched a comprehensive stakeholder outreach campaign to educate and inform neighborhood residents, municipal officials, and businesses about the full scope of work to be undertaken to support this Project. Pre-construction outreach has included notifications to abutters, and conversations with Project stakeholders regarding a variety of topics including: grants of access, environmental matting needs, proposed structure locations, and vegetation management. The Company hosted Community Information Sessions for the public to attend and ask questions of our Project team. The Company remains committed to maintaining those conversations throughout the Project.

The public outreach efforts include, but are not limited to, the following:

- Meetings with municipalities and relevant governmental organizations with interest in the Project scope;
- Community Open House events;
- Community outreach (e.g., door-to-door);
- A Project hotline and email;
- Fact sheets, door hangers, FAQs, timelines, etc; and
- Advertising project milestones and impacts, as needed.

The team will continue to maintain a high level of outreach to discuss the Project, receive comments, and answer questions throughout the permitting and construction phases.

3.4.6.1 State and Local Meetings

The Project team will continue to meet (as needed) with all relevant governmental bodies with interest in, or impacted by, the Project scope. In advance of the filing, the Project team met with Town representatives of North Smithfield, Lincoln, North Providence, and Providence, to outline the Project need, benefits, and high-level details around the Project route, local impacts, and tentative Project schedule. In addition, the Project team has briefed RIDOT and other relevant state agencies. The Project team will continue to meet regularly with governmental stakeholders throughout the Project schedule to ensure a timely flow of information and provide opportunities for input.

3.4.6.2 Open Houses/Community Outreach

The Company is fully committed to providing the community with the opportunity to see the Project plans and responding to questions and concerns. The Company hosted community open house meetings in the Project footprint to provide interested parties with an opportunity to learn more about the Project and ask questions of Project subject matter experts.

3.4.6.3 Project Hotline

A local phone number (401-400-5800) has been established for project-related Stakeholder inquiries. The Hotline number will be listed in all Project outreach materials, including fact sheets, mailings, and signage at community events. A Project representative will staff the hotline and the Company pledges to respond within two businesses days to all inquiries – most often on the same business day whenever practical.

3.4.6.4 Abutter Communications

The Company representatives expect to meet individually with Project abutters who have questions specific to their properties through the life of the Project. In addition, the Project team will be sending letters via U.S. Mail to keep all abutters informed of Project developments throughout the Project schedule.

3.4.6.5 Door-to-Door Outreach

The Company will engage in a select door-to-door outreach campaign, canvassing residents and businesses adjacent to Project activities. The purpose of this outreach is to provide information and answers to questions. If a resident is not available, a Company representative will leave Project-related information at the door. A similar effort will be undertaken with affected businesses and facilities along the Project route.

3.4.6.6 Construction Communication Plan

Building off the existing outreach and communications plan, the Company will develop a comprehensive construction communication plan to update residents, businesses, fire, police, emergency personnel, and municipal officials on work schedules, work locations, and construction activities. In addition to the hotline and email, this plan will include (as needed): work area signage; construction notifications; and direct contact with Project abutters.

The Company's Project representatives will be responsible for coordinating outreach during construction, and serving as a single point of contact for the public. Project information also will be communicated through various town and businesses websites as permitted.

3.4.6.7 Advertising

The Company will, in addition to the efforts outlined in the sections above, advertise/post important Project information to augment and support these communications efforts. For this Project, advertising will be placed in community newspapers and other publications, when necessary, to ensure maximum visibility in the community.

3.4.6.8 Project Materials

The Company will also produce Project materials – fact sheets, frequently asked questions and other background materials – for dissemination to affected Project abutters and elected officials.

3.4.7 Estimated Project Costs

TNEC has estimated the total Project cost at $52.677 million (+/- 20%).

3.4.8 Project Schedule

TNEC has developed a preliminary schedule based on time estimates for planning and engineering, permitting and licensing, and construction (Table 3-3). The Project is expected to be completed and in-service by the fall of 2026.

TABLE 3-3: PROJECT SCHEDULE

Activity	Estimated Start Date	Estimated Completion Date
Planning and Engineering	July 2023	October 2024
Permitting and Licensing	February 2024	August 2025
Construction	August 2025	September 2026
Facilities In-Service	October 2026	
Final Restoration	December 2026	

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4 PROJECT ALTERNATIVES

4.1 Introduction

This section describes the alternatives to the Project that were considered to address the need for general maintenance and system improvement activities along the existing Q143S and R144 Lines. These include the preferred rebuild alternative, which will involve the replacement of deteriorated wood poles with steel poles, replacing overhead shield wires and re-conductor of the existing circuits. This will allow TNEC to provide continued, reliable electrical service across the region, and to improve high-speed communication between substations.

Selecting a preferred design option involves evaluating a suite of comparable and feasible project alternatives, analyzing the alternative routes and configurations, general ranking of alternatives and identification of initial recommendations in the selection of a preferred solution. TNEC's overriding goal has been to select the alternative that best meets the Project need, with a minimum impact on the natural and social environment, at the lowest possible cost.

Section 4.2 describes the no-action alternative, Sections 4.3 and 4.4 describe Project alternatives, and Section 4.5 describes the Preferred Alternative (the Project). Given that the Project proposes upgrades to an existing cross-country transmission line, which needs to be in continuous service and to continue to provide interconnections between the two existing substations, there are no suitable alternatives for the Project.

4.2 No-Action Alternative

Due to the deteriorating condition of numerous assets along the Line, failure to replace these structures could result in major damage to the lines, line outages, and dangerous loss of clearance beneath the lines. The conductor and shield wire are both original vintages and have reached their end of useful life, which is 65 years for both components. Some factors that can affect the useful life include oxidation or corrosion, lightning strikes to the conductor or shield wire, and improper installation of fittings on splices of conductor. Concerns with not replacing the conductor and shield wire include additional corrosion of the assets which can result in failure and insufficient lightning protection. In summary, this alternative was dismissed as it would not address the Project needs and maintain reliable service to customers.

4.3 Wood Pole Replacement Alternative

TNEC considered a partial upgrade Project alternative, where existing wood pole structures would be reinforced or replaced in-kind with new wood pole structures. While this could address short-term concerns over critical failures of the oldest/most deteriorated wood pole assets, and would be a cheaper alternative in the short term, it would not provide a long-term solution. Wood poles have been found to be considerably less resilient than steel poles, so that new or remediated wood pole structures would be more prone to failure in the medium-to-long term. In addition, the Company's standards do not permit the installation of new wood poles for transmission line structures, including replacement structures.

4.4 Underground Alternative

TNEC also examined potential underground alternatives to the proposed Project. While an underground alternative could address the reliability and longevity requirements as discussed in Section 2.0, an underground alternative would incur significant cost, schedule, and operational disadvantages. TNEC evaluated use of the existing ROW for a potential underground alternative for the Project. There is one pond crossing and there would be state highway crossings under Route 146, Interstate 295, and Route 116. These features can be easily spanned by overhead transmission lines, but special construction techniques, such as horizontal directional drilling or pipe-jacking, would be needed to cross these obstructions with an

underground route. Environmental impacts would be substantially increased, as construction of the underground line would require the development of additional access roads and excavation along the full ROW. A new underground alternative would also take several years to design, license, and build, increasing the risk of structure failure and line outages in the interim.

Underground lines also present system and operational disadvantages versus an overhead transmission line. When an overhead transmission line experiences an outage, it can typically be repaired within 24 to 48 hours. In the case of a failure of an underground transmission cable, repair times can be in the range of two weeks to a month or more. Additionally, many faults on overhead lines are temporary in nature. Often it is possible to re-energize an overhead line after a temporary fault and return the line to service with only a brief interruption. Faults on underground transmission cables are almost never temporary, and the cable must remain out of service until the problem is diagnosed and repairs can be completed.

To underground a transmission line, there is a cost of roughly $17.5M per mile. The total cost for undergrounding this project would be $201.25M. Because of the high cost, extensive engineering, and environmental impacts, the underground option was not considered.

4.5 Transmission Line Rebuild (Preferred Alternative)

The Q143S and R144 Lines are of original vintage in both structure, conductor, and shield wire. The Lines have proven to be more susceptible to premature failures, resulting in catastrophic damage or complete failure of the structure, thus threatening the reliability of the system. The rebuilt Lines will address underlying issues associated with the existing Lines and will enhance reliability, increase resilience, and allow for easier future maintenance. The Project ensures the safe and reliable transmission of power to customers with a minimum impact on the environment at the lowest possible cost, as well as supports long term electric load growth.

In summary, TNEC determined that rebuilding the Q143S and R144 Lines on double circuit structures centered on the current centerline of the Q143S Line is the optimal solution to address system maintenance and reliability needs and is the preferred alternative.

5 DESCRIPTION OF AFFECTED NATURAL ENVIRONMENT

This section of the Report describes the existing natural environment that may be affected by the Project, both within and surrounding the Project ROW. As required by the EFSB Rules, a detailed description of environmental characteristics within and immediately surrounding the Project is provided below. This section describes the specific natural features that were evaluated using published resource information, the Rhode Island Geographic System ("RIGIS") database, various state and local agency databases, and field investigations of the Project ROW.

The Project involves work activities on existing 115 kV transmission lines with an established and maintained ROW, therefore the Project is anticipated to have only negligible impacts on the geology, surficial geology, air quality, population trends, and employment and labor force. For this reason, these environmental characteristics are not included in the below assessment.

5.1 Study Area

A Study Area was established to assess the existing environment both within and immediately adjacent to the existing ROW. This Study Area consists of a 5,000-foot-wide corridor, measured 2,500 feet on either side of the centerline of the ROW. The boundaries of this corridor were determined to allow for a detailed desktop analysis of existing conditions within and adjacent to the Project ROW (Figure 5-1).

5.2 Soils

Detailed information concerning the physical properties, classification, agricultural suitability, and erodibility of soils within the Project Study Area or Area of Interest (AOI) was obtained from the Natural Resource Conservation Service ("NRCS", 2019). In addition to the named series, map units include specific phase information that describes the texture and stoniness of the soil surface and the slope class. Table 5-1 (below) lists the characteristics of the soil phases (lower taxonomic units than series) found within the Study Area.

Table 5-2 and Table 5-3 provide a key to the drainage class codes, and hydrologic soil group ("HSG") / seasonal high water table depth ("SHWTD") codes, respectively. Study Area hydric soil status is depicted on Figure 5-2.

TABLE 5-1: CHARACTERISTICS OF SOIL PHASES WITHIN THE STUDY AREA

Map Unit Symbol	Map Unit Name	Drainage Class	Approximate Depth To Bedrock	Acres in AOI	% of AOI
AfA	Agawam fine sandy loam, 0 to 3% slopes	WD	>80"	3.3	1.2%
CaD	Canton-Charlton-Rock outcrop complex, 15 to 35% slopes, very stony	WD	>80"	1.4	0.5%
CB	Canton-Urban land complex	WD	>80"	3.2	1.2%
CdB	Canton and Charlton fine sandy loams, 3 to 8% slopes	WD	>80"	1	0.4%
CdC	Canton and Charlton fine sandy loams, 8 to 15% slopes	WD	>80"	2.3	0.8%
CeC	Canton and Charlton fine sandy loams, 3 to 15% slopes, very rocky	WD	>80"	27.8	10.1%
ChB	Canton and Charlton fine sandy loams, 0 to 8% slopes, very stony	WD	>80"	27.7	10.1%
ChC	Canton and Charlton fine sandy loams, 8 to 15% slopes, very stony	WD	>80"	7.7	2.8%

Map Unit Symbol	Map Unit Name	Drainage Class	Approximate Depth To Bedrock	Acres in AOI	% of AOI
CkC	Canton and Charlton fine sandy loams, 3 to 15% slopes, extremely stony	WD	>80”	18.4	6.7%
FeA	Freetown muck, 0 to 1% slopes	VPD	0 to 6”	1.9	0.7%
HkC	Hinckley loamy sand, 8 to 15% slopes	ED	>80”	10.5	3.8%
HkD	Hinckley loamy sand, 15 to 25% slopes	ED	>80”	1	0.4%
MmB	Merrimac fine sandy loam, 3 to 8% slopes	SWED	>80”	3.5	1.3%
MU	Merrimac-Urban land complex, 0 to 8% slopes	SWED	>80”	10.8	3.9%
Nt	Ninigret fine sandy loam, 0 to 3% slopes	MWD	17 to 39”	2	0.7%
PD	Paxton-Urban land complex, 3 to 15% slopes	WD	18 to 37”	1.1	0.4%
Pg	Pits, gravel	N/A	N/A	1.3	0.5%
Rf	Ridgebury, Leicester, and Whitman soils, 0 to 8% slopes, extremely stony	PD	0 to 6”	31.2	11.4%
Ru	Rippowam fine sandy loam	PD	0 to 18”	13.3	4.8%
Sb	Scarboro mucky fine sandy loam, 0 to 3% slopes	VPD	0 to 2”	6.8	2.5%
Ss	Sudbury sandy loam	MWD	18 to 36”	0.1	0%
StB	Sutton fine sandy loam, 3 to 8% slopes	MWD	12 to 27”	0.6	0.2%
SuB	Sutton fine sandy loam, 0 to 8% slopes, very stony	MWD	12 to 27”	17.2	6.3%
SvB	Sutton fine sandy loam, 0 to 8% slopes, extremely stony	MWD	12 to 27”	2.5	0.9%
SwA	Swansea muck, 0 to 1% slopes	VPD	0 to 6”	7	2.5%
Tb	Tisbury silt loam	MWD	18 to 30”	2	0.7%
UD	Udorthents-Urban land complex	N/A	42 to 54”	25.7	9.4%
Ur	Urban land	N/A	N/A	8.7	3.2%
W	Water	N/A	N/A	13.6	5.0%
Wa	Walpole sandy loam, 0 to 3% slopes	PD	0 to 4”	0.8	0.3%
WhA	Woodbridge fine sandy loam, 0 to 3% slopes	MWD	18 to 30”	1.7	0.6%
WhB	Woodbridge fine sandy loam, 3 to 8% slopes	MWD	18 to 30”	1	0.4%
WoB	Woodbridge fine sandy loam, 0 to 8% slopes, very stony	MWD	19 to 27”	17.3	6.3%

Sources: (NE Soil, 2024; NRCS, 2019).

TABLE 5-2: DRAINAGE CLASS CODES

Code	Drainage Class
ED	Excessively Drained
SWED	Somewhat Excessively Drained
WD	Well Drained
MWD	Moderately Well Drained
PD	Poorly Drained (hydric)
VPD	Very Poorly Drained (hydric)
SUBAQUIC	Permanently Submerged Soil (hydric)

TABLE 5-3: HYDROLOGIC SOIL GROUP AND SEASONAL HIGH WATER TABLE DEPTH

Field ID	Description
A, > 6 feet.	HSG A soils having low runoff potential, with seasonal high-water table greater than 6 feet.
B, > 6 feet.	HSG B soils having moderate runoff potential, with SHWT greater than 6 feet.
B, 1.5 feet.	HSG B soils having moderate runoff potential, with SHWT of 1.5 feet (one unit has 2.0 feet water).
B, > 6 feet., Bedrock	Soil complexes with map units consisting of HSG B (Canton and Charlton) and a bedrock component (CeC). This category includes soil units that are moderately shallow to rock that are not mapped separately, and where field investigation is needed to determine HSG.
C, 1.5 feet.	HSG C soils having high runoff potential, with SHWT of 1.5 feet. Most of these have restrictive layer in subsoil (densic). The SHWT ranges from 1.4 to 1.9 for this class.
D, 0 feet., HYDRIC	Soils that have SHWT at soil surface and are hydric soils.
D, 1.5 feet	Soils that have a SHWT within 1.5 feet and are in HSG D (these are typically moderately well drained soils with densic contact).
Variable	Variable rating is assigned where the HSG and/or SHWT is listed as variable or not rated.
Water	All subaquatic soils and mapped water bodies

5.2.1 Soil Series

The soil series detailed in the following subsections were identified within the Study Area. The following classifications are as published online ("NRCS", 2019).

Agawam: The Agawam series consists of very deep, well drained soils formed in sandy, water deposited materials. They are level to steep soils on outwash plains and high stream terraces. Slope ranges from 0 to 15 percent. Saturated hydraulic conductivity is moderately high or high in the upper solum and high or very high in the lower solum and substratum. Mean annual temperature is about 48 degrees F. and mean annual precipitation is about 47 inches.

Canton and Charlton Series: The Canton series consists of very deep, well drained soils formed in a loamy mantle underlain by sandy till. They are on nearly level to very steep moraines, hills, and ridges. Slope ranges from 0 to 45 percent. Saturated hydraulic conductivity is moderately high or high in the solum and high or very high in the substratum. The Charlton series consists of very deep, well drained soils formed in loamy melt-out till. They are nearly level to very steep soils on moraines, hills, and ridges. Slope ranges from 0 to 60 percent. Saturated hydraulic conductivity is moderately high or high.

Merrimac Series: The Merrimac series consists of very deep, somewhat excessively drained soils formed in outwash. They are nearly level through very steep soils on outwash terraces and plains and other glaciofluvial landforms. Slope ranges from 0 to 35 percent. Saturated hydraulic conductivity is high or very high. Mean annual temperature is about 48 degrees F. (9 degrees C.) and mean annual precipitation is about 42 inches (1067 millimeters).

Ninigret Series: The Ninigret series consists of very deep, moderately well drained soils formed in loamy over sandy and gravelly glacial outwash. They are nearly level to strongly sloping soils on glaciofluvial landforms, typically in slight depressions and broad drainage ways. Slope ranges from 0 through 15 percent. Saturated hydraulic conductivity is moderately high or high in the solum and high or very high in the substratum. The mean annual temperature is about 49 degrees F. and mean annual precipitation is about 48 inches.

Sudbury: The Sudbury series consists of very deep, moderately well and somewhat poorly drained soils on outwash plains. They are nearly level through strongly sloping soils in slight depressions and on terraces and foot slopes in areas of outwash or glaciofluvial deposits. Slope ranges from 0 through 15 percent.

Saturated hydraulic conductivity is moderately high or high in the upper solum and high or very high in the lower solum and substratum. The mean annual temperature is about 48 degrees F. (9 degrees C.) and the mean annual precipitation is about 43 inches (1092 millimeters).

Sutton Series: The Sutton series consists of very deep, moderately well drained loamy soils formed in melt-out till. They are nearly level to strongly sloping soils on hills, low ridges, and ground moraines, typically on footslopes, lower backslopes and in slight depressions. Slope ranges from 0 to 15 percent. Saturated hydraulic conductivity is moderately high or high throughout.

Swansea Series: The Swansea series consists of very poorly drained organic soils. They formed in 40 to 130 centimeters of highly decomposed organic material over sandy mineral. These soils are in depressions or on flat level areas on uplands and outwash plains. Saturated hydraulic conductivity is moderately high or high in the organic material and very high in the substratum. The mean annual temperature is about 9 degrees Celsius, and the mean annual precipitation is about 1143 millimeters.

Woodbridge: The Woodbridge series consists of moderately well drained loamy soils formed in lodgment till. They are very deep to bedrock and moderately deep to densic contact. They are nearly level to moderately steep soils on hills, drumlins, till plains, and ground moraines. Slope ranges from 0 to 25 percent. Saturated hydraulic conductivity ranges from moderately high to high in the surface layer and subsoil and low or moderately low in the dense substratum. The mean annual temperature is about 9 degrees C., and mean annual precipitation is about 1168 mm.

5.2.2 Prime Farmland Soils & Farmland of Statewide Importance

Prime farmland, as defined by the United States Department of Agriculture ("USDA") (USDA Soil Survey Staff, n.d.), is the land that is best suited to producing food, feed, forage, fiber, and oilseed crops. It has the soil quality, growing season, and moisture supply needed to economically produce a sustained yield of crops when it is treated and managed using acceptable farming methods. Urbanized land and water are exempt from consideration as prime farmland.

Farmland of statewide importance is land that is designated by the Rhode Island Department of Administration Division of Planning to be of statewide importance for the production of food, feed, fiber, storage, and oilseed crops. Generally, farmlands of statewide importance include those lands that do not meet the requirements to be considered prime farmland, but that economically produce high crop yields when treated and managed with modern farming methods. Some may produce as high a yield as prime farmland if conditions are favorable.

To extend the additional protection of state regulation to prime farmland, the state of Rhode Island has expanded its definition of farmland of stateside importance to include all prime farmland areas. Therefore, in Rhode Island all USDA-designated prime farmland soils are also farmland of statewide importance.

Table 5-4 (below) lists the prime farmland soil units and farmlands of statewide importance within the Study Area. The Project ROW crosses 15 areas of prime farmland, and nine areas of farmland of statewide importance, including areas of fine sand loams, silt loam, and sandy loam.

TABLE 5-4: USDA PRIME FARMLAND SOILS WITHIN STUDY AREA

Map Unit Symbol	Farmland Soils	Map Unit Name
AfA	All areas are prime farmland	Agawam fine sandy loam, 0 to 3 percent slopes
AfB	All areas are prime farmland	Agawam fine sandy loam, 3 to 8 percent slopes
CaC	Not prime farmland	Canton-Charlton-Rock outcrop complex, 3 to 15 percent slopes
CaD	Not prime farmland	Canton-Charlton-Rock outcrop complex, 15 to 35 percent slopes, very stony
CB	Not prime farmland	Canton-Urban land complex

Map Unit Symbol	Farmland Soils	Map Unit Name
CC	Not prime farmland	Canton-Urban land complex, very rocky
CdB	All areas are prime farmland	Canton and Charlton fine sandy loams, 3 to 8 percent slopes
CdC	Farmland of statewide importance	Canton and Charlton fine sandy loams, 8 to 15 percent slopes
CeC	Not prime farmland	Canton and Charlton fine sandy loams, 3 to 15 percent slopes, very rocky
ChB	Not prime farmland	Canton and Charlton fine sandy loams, 0 to 8 percent slopes, very stony
ChC	Not prime farmland	Canton and Charlton fine sandy loams, 8 to 15 percent slopes, very stony
ChD	Not prime farmland	Canton and Charlton very stony fine sandy loams, 15 to 25 percent slopes
CkC	Not prime farmland	Canton and Charlton fine sandy loams, 3 to 15 percent slopes, extremely stony
Dc	Farmland of statewide importance	Deerfield loamy fine sand, 0 to 3 percent slopes
FeA	Not prime farmland	Freetown muck, 0 to 1 percent slopes
GhC	Not prime farmland	Gloucester-Hinckley complex, 3 to 15 percent slopes, very stony
HkA	Farmland of statewide importance	Hinckley loamy sand, 0 to 3 percent slopes
HkC	Farmland of statewide importance	Hinckley loamy sand, 8 to 15 percent slopes
HkD	Not prime farmland	Hinckley loamy sand, 15 to 25 percent slopes
MmA	All areas are prime farmland	Merrimac fine sandy loam, 0 to 3 percent slopes
MmB	All areas are prime farmland	Merrimac fine sandy loam, 3 to 8 percent slopes
MU	Not prime farmland	Merrimac-Urban land complex, 0 to 8 percent slopes
Nt	All areas are prime farmland	Ninigret fine sandy loam, 0 to 3 percent slopes
PaA	All areas are prime farmland	Paxton fine sandy loam, 0 to 3 percent slopes
PaB	All areas are prime farmland	Paxton fine sandy loam, 3 to 8 percent slopes
PbB	Not prime farmland	Paxton fine sandy loam, 0 to 8 percent slopes, very stony
PD	Not prime farmland	Paxton-Urban land complex, 3 to 15 percent slopes
Pg	Not prime farmland	Pits, gravel
Re	Farmland of statewide importance	Ridgebury fine sandy loam, 0 to 3 percent slopes
Rf	Not prime farmland	Ridgebury, Leicester, and Whitman soils, 0 to 8 percent slopes, extremely stony
Ru	Farmland of statewide importance	Rippowam fine sandy loam
Sb	Not prime farmland	Scarboro mucky fine sandy loam, 0 to 3 percent slopes
Ss	All areas are prime farmland	Sudbury sandy loam
StA	All areas are prime farmland	Sutton fine sandy loam, 0 to 3 percent slopes
StB	All areas are prime farmland	Sutton fine sandy loam, 3 to 8 percent slopes
SuB	Not prime farmland	Sutton fine sandy loam, 0 to 8 percent slopes, very stony
SvB	Not prime farmland	Sutton fine sandy loam, 0 to 8 percent slopes, extremely stony
SwA	Not prime farmland	Swansea muck, 0 to 1 percent slopes
Tb	All areas are prime farmland	Tisbury silt loam
UD	Not prime farmland	Udorthents-Urban land complex
Ur	Not prime farmland	Urban land
W	Not prime farmland	Water
Wa	Farmland of statewide importance	Walpole sandy loam, 0 to 3 percent slopes

Map Unit Symbol	Farmland Soils	Map Unit Name
WgB	Farmland of statewide importance	Windsor loamy sand, 3 to 8 percent slopes
WhA	All areas are prime farmland	Woodbridge fine sandy loam, 0 to 3 percent slopes
WhB	All areas are prime farmland	Woodbridge fine sandy loam, 3 to 8 percent slopes
WoB	Not prime farmland	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony
WrB	Not prime farmland	Woodbridge fine sandy loam, 0 to 8 percent slopes, extremely stony

5.2.3 Erosive Soils

The erodibility of soils is dependent upon the slope of the land and the texture of the soil. Soils are given an erodibility factor ("K"), which is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values in Rhode Island range from 0.10 to 0.64 and vary throughout the depth of the soil profile with changes in soil texture. K values aid in determining locations where soil erosion and sediment controls may be necessary. Very poorly drained soils and certain floodplain soils usually occupy areas with little or no slope. Therefore, these soils are not subject to erosion under normal conditions and are not given an erodibility factor. Soil map units described as strongly sloping or rolling may include areas with slopes greater than eight percent. Soil map units with assigned K values within the Project Study Area are listed below in Table 5-5.

TABLE 5-5: STUDY AREA POTENTIALLY HIGHLY ERODIBLE SOIL MAPPING UNITS

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AfB	Agawam fine sandy loam, 3 to 8 percent slopes	0.37	12.3	0.2%
CaC	Canton-Charlton-Rock outcrop complex, 3 to 15 percent slopes	N/A	13.2	0.2%
CaD	Canton-Charlton-Rock outcrop complex, 15 to 35 percent slopes, very stony	N/A	132.6	1.8%
CdB	Canton and Charlton fine sandy loams, 3 to 8 percent slopes	0.24	56.6	0.8%
CdC	Canton and Charlton fine sandy loams, 8 to 15 percent slopes	0.24	15.9	0.2%
CeC	Canton and Charlton fine sandy loams, 3 to 15 percent slopes, very rocky	N/A	837.4	11.2%
ChB	Canton and Charlton fine sandy loams, 0 to 8 percent slopes, very stony	N/A	778.9	10.4%
ChC	Canton and Charlton fine sandy loams, 8 to 15 percent slopes, very stony	N/A	140.7	1.9%
ChD	Canton and Charlton very stony fine sandy loams, 15 to 25 percent slopes	N/A	17.2	0.2%
GhC	Gloucester-Hinckley complex, 3 to 15 percent slopes, very stony	N/A	14.6	0.2%
HkC	Hinckley loamy sand, 8 to 15 percent slopes	N/A	86.5	1.2%
HkD	Hinckley loamy sand, 15 to 25 percent slopes	N/A	38.3	0.5%
MmB	Merrimac fine sandy loam, 3 to 8 percent slopes	0.28	42	0.6%
PaB	Paxton fine sandy loam, 3 to 8 percent slopes	0.28	33.4	0.4%
StB	Sutton fine sandy loam, 3 to 8 percent slopes	0.24	62.5	0.8%
SuB	Sutton fine sandy loam, 0 to 8 percent slopes, very stony	N/A	245.2	3.3%
SvB	Sutton fine sandy loam, 0 to 8 percent slopes, extremely stony	N/A	92.6	1.2%
WhB	Woodbridge fine sandy loam, 3 to 8 percent slopes	0.28	32.7	0.4%
WoB	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	N/A	356.8	4.8%
WrB	Woodbridge fine sandy loam, 0 to 8 percent slopes, extremely stony	N/A	11	0.1%
Totals for Area of Interest			**3020.4**	**40.4%**

Source: (NRCS, 2019).

5.3 Surface Water

The Study Area is drained by waterways in the Blackstone River and Tributaries Watersheds, Narragansett Watershed, Woonasquatucket River Watershed, and the Moshassuck River Watershed. The major surface water resources and classifications within the Study Area are listed in Table 5-6. Only four (4) of these

resources (**listed in bold in Table 5-6**) are crossed by the Project ROW – Upper Canada Pond, Spring Brook, West River and Tributaries, and Crookfall Brook and Tributary. Waters of the State of Rhode Island (meaning all surface water and groundwater of the State) are assigned a "Use Classification" which is defined by the most sensitive uses which it is intended to protect. Waters are classified according to specific physical, chemical, and biological criteria, which establish parameters of minimum water quality necessary to support the water Use Classification. The Use Classifications of the major surface waters within the Study Area are identified in the Water Quality Standard column of Table 5-6, below.

TABLE 5-6: MAJOR SURFACE WATER RESOURCES WITHIN THE STUDY AREA

Water Body Name	Water Body Crossed by Project	Water Quality Standard	Fishery Designation	Impairment Category	Cause of Impairment
Upper Canada Pond	**Yes**	**B**	**Unassessed**	**3**	**N/A**
Woonsocket Reservoir #3	No	AA	Unassessed	3	N/A
Spring Brook	**Yes**	**AA**	**Warm**	**5**	**Enterococcus**
West River and Tributaries	**Yes**	**B**	**Warm**	**5**	**Enterococcus; Benthic Macroinvertebrates Bioassessments**
Crookfall Brook and Tributary	**Yes**	**AA**	**Cold**	**4A**	**Enterococcus**
Gilbanes Pond	No	N/A	Unassessed	N/A	N/A
North Central Pond	No	N/A	Unassessed	N/A	N/A

Source: RIDEM Environmental Resource Map:
https://ridemgis.maps.arcgis.com/apps/webappviewer/index.html?id=87e104c8adb449eb9f905e5f18020de5

Out of the four (4) surface waters that cross the Project ROW, two (2) are Class AA waters – Spring Brook and Crookfall Brook and Tributary. Class AA waters are designated as a source of public drinking water supply ("PDWS") or as tributary waters within a public drinking water supply watershed, for primary and secondary contact recreational activities and for fish and wildlife habitat. These waters shall have excellent aesthetic value. Class AA waters used for public drinking water supply may be subject to restricted recreational use by State and local authorities. The other two (2) surface waters that cross the Project ROW, Upper Canada Pond and West River and Tributaries, are classified as Class B. Class B waters are designated for primary and secondary contact recreational activities and for fish and wildlife habitat. They shall be suitable for compatible industrial processes and cooling, hydropower, aquacultural uses, navigation, and irrigation and other agricultural uses.

Pursuant to the requirements of Section 305(b) of the Federal Clean Water Act, water bodies that don't support their designated uses in whole or in part are considered impaired and scheduled for restoration. The causes of impairment are those pollutants or other stressors that contribute to the actual chemical contaminants, physical parameters, and biological parameters. Sources of impairment are not determined until a total maximum daily load ("TMDL") assessment is conducted on a water body. Surface waters within the Project ROW have been assigned an impairment category of Category 3 (Woonsocket Reservoir), Category 4A water (Crookfall Brook), and Category 5 (Upper Canda Pond and Spring Brook). Category 3 indicates that insufficient or no data and information are available to determine if any designated use is attained. Category 4A represents impaired waterbodies that have approved TMDLs. These are waters that have been identified as not meeting water quality standards but have already gone through the TMDL development process. Category 5 on the 303(d) list includes impaired waterbodies that do not meet state water quality standards and require the development of a TMDL to address the pollution. These waterbodies have been identified as needing pollution reduction strategies, and the TMDL will set limits on how much of a specific pollutant they can safely receive.

5.4 Groundwater Resources

The RIDEM classifies all the state's groundwater resources and establishes groundwater quality standards for each class. The four classes are designated GAA, GA, GB, and GC. Groundwater classified as GAA and GA is to be protected to maintain drinking water quality, whereas groundwater classified as GB and GC is known or presumed to be unsuitable for drinking water use without treatment. The presence and availability of groundwater resources is a direct function of geologic deposits in the vicinity of the Project.

Groundwater resources within the Study Area are depicted in Figure 5-4. Groundwater resources in the Study Area are predominantly protected to maintain drinking water quality (~76% of the Study Area classified as GA), ~22% are classified as GB and <1% are classified as GAA.

5.5 Vegetation

The Study Area contains a variety of vegetative covers typical of Southern New England as shown in **Error! Not a valid bookmark self-reference.** below. These include Urban/Suburban Built (42.9%), Oak Forest (29.4%), Urban/Recreational Grasses (6.1%), Forested Swamp (5.9%), Ruderal Grassland/Shrubland (5.2%), Ruderal Forest (2.7%), NC (2.3%), Fresh Water (2.2%), Cropland, Emergent Marsh, Hayfields/Pasture, Shrub Swamp and Tree Plantation (less than 1%) in term of vegetative communities in the Study Area. This section of the report focuses on upland communities. Wetland communities are discussed in Section 5.6 of this report. The Project occurs within existing ROWs maintained by TNEC as low-growth vegetative communities that are typical along overhead transmission line facilities.

TABLE 5-7: VEGETATIVE COMMUNITIES WITHIN THE 5,000 FEET STUDY AREA

System	Developed Land	Community	Acres of ROW	% of ROW	Acres of Study Area	% of Study Area
Palustrine	Forested Wetlands (Mineral and Peat Soils)	Forested Swamp	5.7	2.1%	430.2	6%
Palustrine	Fresh Water	Fresh Water	13.4	4.9%	15.1	0.2%
Palustrine	Open Mineral Soil Wetlands	Emergent Marsh	6.2	2.3%	38.2	0.5%
Palustrine	Open Mineral Soil Wetlands	Shrub Swamp	10.3	3.8%	56.8	0.8%
Upland	Agricultural	Cropland	0.9	0.3%	45.6	0.6%
Upland	Agricultural	Hayfields / Pasture	8.1	3%	51.7	0.7%
Upland	Deciduous Woodlands and Forests	Oak Forest	23.4	8.5%	2,168.6	30.2%
Upland	Developed Land	Urban / Recreational Grasses	3.3	1.2%	449.6	6.3%
Upland	Developed Land	Urban / Suburban Built	25.8	9.4%	3,176.2	44.2%
Upland	Mixed Deciduous/Coniferous Forests	NC	0.8	0.3%	169.4	2.4%
Upland	Open Uplands (Grassland and Shrubland)	Ruderal Grassland / Shrubland	169.7	61.9%	218.4	3%
Upland	Plantation and Ruderal Forest	Ruderal Forest	6.4	2.3%	197.5	2.8%
Upland	Plantation and Ruderal Forest	Tree Plantation	0.2	0.1%	28.5	0.4%

* The Northeastern Terrestrial Wildlife Habitat Classification ("NTHC") provides some guidance for classifying developed lands within an "Urban/Suburban Built" category, which is subdivided into "commercial/industrial" and four levels of "residential" based on the percentage of impervious surface within a subject area. Types include: Residential High, b. Residential Medium, c. Residential Low, d. Residential Rural, e. Commercial/Industrial, f. Highway/Runway (Pavement)

5.5.1 Vegetative Communities Typical of the Study Area

5.5.1.1 Urban/Suburban Built

Rhode Island Ecological Communities Classification includes the Urban/Suburban Built category for reference purposes only, as the suggested approach by the Northeast Terrestrial Wildlife Habitat Classification ("NTHC"). NTHC System classifies Urban/Suburban Built as a Macro group with five Habitat Systems: Commercial/Industrial, Residential - High Intensity, Residential - Medium Intensity, Residential - Low Intensity, and Residential - Rural / Sparse. Commercial/Industrial are developed areas where people reside or work in high numbers. Residential - High Intensity are areas with a mixture of constructed materials and vegetation in which impervious surfaces account for 50-80% of total cover (generally corresponding to lot sizes of <1/4 acre); mostly single-family housing units. Residential Medium and Low Intensity are similar, with impervious surfaces accounting for 25-50% and 15-25% respectively. Lastly, sparse residential areas, or housing along rural roadsides, in which impervious surfaces account for <15% of total cover (generally corresponding to lot sizes of > 1 acre); largely single-family housing.

5.5.1.2 Oak Forest

Oak Forests communities are dominated by oaks *(Quercus)*. The Species composition is generally dependent on-site conditions, especially soil type and hydrology. The variants include Black Oak/Scarlet Oak – Heath Forest, the predominant oak forest type in Rhode Island on well-drained, acidic soils. Chestnut oak and white oak may also be common constituents along with black birch (*Betula*), black gum (*Nyssa*), red maple (*Acer*), and sassafras (*Sassafras*). American chestnut (*Castanea*) was formally a common constituent. Understory is primarily ericaceous shrubs, especially huckleberry (*Gaylussacia*) and lowbush blueberries (*Vaccinium*). White Oak – Mountain Laurel Forest, is typically found on well drained coarse or gravelly soils such as on moraine deposits and eskers. The shrub layer is dominated by fairly dense cover of mountain laurel (*Kalmia*) with sparse herbaceous cover. They tend to occur in small patches within mixed oak and oak-pine forests. Chestnut Oak Forests are typically found on well-drained upper slopes and ridge tops with shallow soils. Red, black, and white oaks may also occur along with pitch pine (*Pinus*), with an ericaceous understory. Mixed Oak – American Holly Forest are typically found on moist, moderately well-drained silt and sandy loam soils, often at the upper edge of forested wetlands and upslope it often grades into oak – heath forest type. Black and scarlet oak are usually the dominant canopy trees, but red maple (*Acer*) may also be common; American holly (*Ilex*) is a prominent (>25% cover) sub-canopy tree. The understory shrub layer may be dense with highbush blueberry (*Vaccinium*) and pepperbush (*Clethra*) the predominant species. This oak-dominated forest community is characterized by a greater representation of hickory (*Carya*). Typically found on well-drained loams and sandy loams of ridge tops and slopes, oak/hickory forests usually occupy more mesic and nutrient-rich sites than the more widespread oak-heath type. The richer habitats abet a more diverse flora in all layers: Overstory trees include white ash, tuliptree, and the shrub layer is multi-layered with tall witch hazel and flowering dogwood, medium-height maple leaved viburnum, and short with sheep laurel and lowbush blueberry.

5.5.2 Vegetative Communities Typical within the ROW

5.5.2.1 Urban/Suburban Built

Rhode Island Ecological Communities Classification includes the Urban/Suburban Built category for reference purposes only, as the suggested approach by the Northeast Terrestrial Wildlife Habitat Classification ("NTHC"). NTHC System classifies Urban/Suburban Built as a Macro group with five

Habitat Systems: Commercial/Industrial, Residential - High Intensity, Residential - Medium Intensity, Residential - Low Intensity, and Residential - Rural / Sparse. Commercial/Industrial are developed areas where people reside or work in high numbers. Residential - High Intensity are areas with a mixture of constructed materials and vegetation in which impervious surfaces account for 50-80% of total cover (generally corresponding to lot sizes of <1/4 acre), mostly single-family housing units. Residential Medium and Low Intensity are similar, with impervious surfaces accounting for 25-50% and 15-25% respectively. Lastly, sparse residential areas, or housing along rural roadsides, in which impervious surfaces account for <15% of total cover (generally corresponding to lot sizes of > 1 acre); largely single-family housing.

5.5.2.2 Ruderal Grassland/Shrubland Community

Ruderal grasslands and shrublands encompass sites in the northern and central regions of the eastern United States that have been cleared and plowed (for farming or development) and then abandoned and are now dominated by weedy or generalist native and exotic forbs, grasses, ferns, and shrubs. They are also a common community type within ROWs, where vegetation management removes the tree canopy and re-sets successional communities periodically to herbaceous/scrub-shrub layers. The ROW has been managed to selectively remove trees, so they do not interfere with the operation of the existing transmission lines. Low shrub lands dominate portions of the ROW where succession of old field has occurred and where ROW management has resulted in tree sapling removal. Sweet fern (*Comptonia peregrina*), bayberry (*Myrica pensylvanica*), and northern arrowwood (*Viburnum recognitum*) are shrub species that are commonly found within the ROW.

Forest vegetation abuts the area of managed ROW in many places along the corridor. This forested edge contains species of trees, and the ROW contains saplings that require more sunlight, such as black cherry (*Prunus serotina*), grey birch (*Betula populifolia*) and eastern red cedar (*Juniperus virginiana*). Mature forest containing northern red oak (*Quercus rubra*) and red maple (*Acer rubrum*) are also present along the corridor, and saplings of these species are occasionally found in the ROW. Ruderal grassland/shrub type communities occupy approx. 6.2% of the Study Area.

5.6 Wetlands

Wetlands are resources which have ecological functions and societal values. Wetlands are characterized by three criteria: (i) the presence of undrained hydric soil, (ii) a prevalence (>50 percent) of hydrophytic vegetation, and (iii) wetland hydrology, where soils are saturated near the surface or flooded by shallow water during at least a portion of the growing season.

Federal and State-regulated freshwater wetlands and/or streams were identified and delineated within the Project ROW during the spring of 2023. Field methodology for the delineation of State-regulated resource areas within the ROW was based upon vegetative composition, presence of hydric soils, and evidence of wetland hydrology. The study methods included both on-site field investigations and off-site analysis to determine the wetland and watercourse resource areas on the Project ROWs. Wetlands outside the ROW within the Study Area were identified based on a desktop review of RIGIS wetlands data (RIGIS, 2014). Figure 5-3 depicts wetland resources within the Study Area, based on the results of this desktop analysis.

In total, 28 waterbodies and 405 wetlands (75 emergent wetland, 229 forested wetland, seven palustrine open water, 3 riverine nontidal open water, 91 scrub-shrub swamp), were mapped within the Study Area, as well as four perennial streams, seven connector streams. Of these wetlands and waterways, 93 wetlands and seven (7) streams within the Project ROW were identified.

The Rhode Island Fresh Water Wetlands Act and Rules (“Rules”), apply to the following jurisdictional areas: freshwater wetlands, buffer zones, floodplains, areas subject to storm flowage, areas subject to flooding, and contiguous areas that extend outward two hundred feet (200’) from the edge of a river or stream, two hundred feet (200’) from the edge of a drinking water supply reservoir, and one hundred feet

(100') from the edge of all other freshwater wetlands, except as otherwise provided for in R.I. Gen. Laws § 2-1-22(k) for farmers conducting normal farming and ranching activities.

In accordance with the provisions of the Rules, state-regulated freshwater wetlands are areas that are inundated or saturated by surface or groundwater 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. Freshwater wetlands include (but are not limited to) marshes, swamps, bogs, emergent and submergent plant communities, rivers, streams, ponds, and vernal pools. These freshwater wetland types are defined as follows:

Marshes are areas within standing or running water which, during the growing season, support one or more of the following plant groups: hydrophytic reeds (*Phragmites*), grasses (*Gramineae*), mannagrasses (*Glyceria*), cutgrasses (*Leersia*), pickerelweeds (*Pontederiaceae*), sedges (*Cyperaceae*), rushes (*Juncaceae*), cattails (*Typha*), water plantains (*Alismataceae*), burreeds (*Sparganiaceae*), pondweeds (*Zosteraceae*), frog's bits (*Hydrocharitaceae*), arums (*Araceae*), duckweeds (*Lemnaceae*), water lilies (*Nymphaeaceae*), water-milfoils (*Haloragaceae*), water-starworts (*Callitrichaceae*), bladderworts (*Utricularia*), pipeworts (*Eriocaulon*), sweet gale (*Myrica gale*), and buttonbush (*Cephalanthus occidentalis*).

Swamps are areas where groundwater is near or at the surface for a significant portion of the growing season, where runoff water collects frequently, and/or where the vegetational community is made up significantly of one or more of the following plant species: red maple (*Acer rubrum*), elm (*Ulmus americana*), black spruce (*Picea mariana*), white cedar (*Chamaecyparis thyoides*), ashes (*Fraxinus*), poison sumac (*Rhus vernix*), larch (*Larix laricina*), spice bush (*Lindera benzoin*), alders (*Alnus*), skunk cabbage (*Symplocarpus foetidus*), hellebore (*Veratrum viride*), hemlock (*Tsuga canadensis*), sphagnums (*Sphagnum*), azaleas (*Rhododendron*), black alder (*Ilex verticillata*), coast pepperbush (*Clethra alnifolia*), marsh marigold (*Caltha palustris*), blueberries (*Vaccinium*), buttonbush (*Cephalanthus occidentalis*), willow (*Salicaceae*), water willow (*Decodon verticillatus*), tupelo (*Nyssa sylvatica*), laurels (*Kalmia*), swamp white oak (*Quercus bicolor*), or species indicative of marsh. For purposes of this definition, "significant part of the growing season" means that period of the growing season when water is present long enough to support a plant community of predominantly hydrophytic vegetation.

Bogs are areas where standing or slowly running water is near the surface during a growing season, and/or where the surface is covered by 50% or more with *Sphagnum* moss, and/or where the vegetational community is made up of one or more of the following plant groups: blueberries and cranberries (*Vaccinium*), leatherleaf (*Chamaedaphne calyculata*), pitcher plant (*Sarracenia purpurea*), sundews (*Drosera*), orchids (*Orchidaceae*), white cedar (*Chamaecyparis thyoides*), red maple (*Acer rubrum*), black spruce (*Picea mariana*), bog aster (*Aster nemoralis*), larch (*Larix laricina*), bog rosemary (*Andromeda glaucophylla*), azaleas (*Rhododendron*), laurels (*Kalmia*), sedges (*Carex*), and bog cotton (*Eriophorum*).

An **emergent plant community** is a freshwater wetland characterized by erect, rooted, herbaceous hydrophytic vegetation that is present for most of the growing season in most years, and that may be persistent or non-persistent in nature.

A **submergent plant community** is a freshwater wetland characterized by plants that grow principally below the surface of the water for most of the growing season. Submergent plants are either attached to the substrate or float freely in the water.

Ponds are areas where open standing or slowly moving water shall be present for at least six (6) months a year. They may be natural or manmade. **Vernal Pools** are a type of ephemeral pond which dries out periodically. They are defined as depressional wetland basins that typically go dry in most years and may contain inlets or outlets, typically of intermittent flow. Vernal pools range in both size and depth depending upon landscape position and parent materials. Vernal pools usually support one (1) or more of the following obligate indicator species: wood frog (*Lithobates sylvaticus*), spotted salamander (*Ambystoma maculatum*),

marbled salamander (*Ambystoma opacum*), and fairy shrimp (*Eubranchipus* spp.) and typically precludes sustainable populations of predatory fish (see section 5.6.4 for further details).

The Rules also regulate activities in and around streams and open water bodies which include Buffers, Floodplains, Areas Subject to Storm Flowage ("ASSF"), and Areas Subject to Flooding ("ASF"). **Buffers or buffer zones** are areas of undeveloped vegetated land adjacent to a freshwater wetland. The width of buffer zones varies between river regions, based on conservation priority and level of development/urbanization.

5.6.1 Rivers and Streams

Streams are any flowing body of water or watercourse [other than a river] that flows long enough each year to develop and maintain a channel and that may carry groundwater discharge or surface runoff. Such watercourses may not have flowing water during extended dry periods but may contain isolated pools or standing water. **Rivers** are a type of stream which is designated as **perennial** by the United States Department of Interior Geologic Survey ("USGS") on 7.5-minute series topographic maps. A **perennial stream** maintains flow year-round. There are four (4) river / perennial stream crossings within the Project ROW, associated with Crookfall Brook, Angell Brook, Spring Brook and West River.

5.6.2 Floodplain

A floodplain is the land area adjacent to a river, stream or other body of flowing water which is, on average, likely to be covered with flood waters resulting from a 100-year frequency storm event as mapped by Federal Emergency Management Agency ("FEMA") (RIGIS 2017). There are three (3) areas of 100-year floodplain located within the Study Area, covering Zones A, AE and Regulated Floodway. Based on FEMA flood mapping (FIRMettes 44007C0157G [eff. 3/2/09], 44007C0308J [eff. 10/2/15] and 44007C0306H [eff. 10/2/15]), some areas of the Project ROW are located within floodplain, with an elevation range of approx. 228 – 229 feet, 24 – 32.6 feet, and 57.6 – 30 feet, respectively.

5.6.3 Area Subject to Storm Flowage

ASSFs are channel areas which carry storm, surface, groundwater discharge, or drainage waters out of, into, and/or connect freshwater wetlands or coastal wetlands. ASSFs are recognized by evidence of scouring and/or other marked changes in vegetative density and/or composition. There are 12 areas mapped ASSFs within the Study Area.

5.6.4 Special Aquatic Site – Vernal Pools

A vernal pool is a type of special aquatic site that is generally defined as a contained basin that generally lacks a permanent above-ground outlet. It fills with water between late fall and spring from rising groundwater, or with the meltwater and runoff of winter and spring snow and rain (RIDEM, 2016). Many vernal pools are regulated by the RIDEM as special aquatic sites. A special aquatic site is defined in the RIDEM Freshwater Wetlands Rules and Regulations as a body of open standing water, either natural or artificial, which does not meet the definition of pond, but which is capable of supporting and providing habitat for aquatic life forms, as documented by the: 1) presence of standing water during most years, as documented on site or by aerial photographs; and 2) presence of habitat features necessary to support aquatic life forms of obligate wildlife species, or the presence of evidence of, or use by aquatic life forms of obligate wildlife species (excluding biting flies).

Most vernal pools contain water for a few months in the spring and early summer and are dry by mid-summer. Because they lack a permanent water source and dry periodically, vernal pools lack a permanent fish population. Vernal pools provide breeding habitat for species, particularly amphibians, which depend upon pool drying and the absence of fish for breeding success and survival (obligate vernal pool species). Some wetlands and water bodies may provide breeding habitat for amphibians but lack the specific criteria

to meet the definition of a vernal pool (e.g., provide habitat to facultative vernal pool species only, or contain evidence of breeding obligate vernal pool species occurring together with fish populations); these wetlands and water bodies have been designated as "amphibian breeding habitats." No impacts to vernal pools will occur because of Project activities.

5.7 Wildlife

As previously described, the Study Area includes a variety of aquatic and terrestrial habitats. The wildlife assemblages present within the Study Area vary according to habitat characteristics. A list of amphibians, reptiles, birds, and mammals expected to occur within a given habitat are provided in Table 5-8. It should be noted that individual species may not occur in any one particular area but may be found throughout the general Study Area. This information is based on geographical distribution and habitat preferences as described in *New England Wildlife: Habitat, Natural History and Distribution* (DeGraaf and Yamasaki 2001).

5.7.1 Fisheries

There are no Designated Trout Waters. There are three cold-water fisheries within the Study Area, including the Crookfall Brook, tributary to Crookfall Brook, and tributary to Moshassuck River.

TABLE 5-8: EXPECTED WILDLIFE SPECIES WITHIN THE STUDY AREA

Terrestrial Habitats						**Aquatic Habitats**					
	Oak / pine forest	**White pine / Northern red oak / red maple forest**	**Old field community†**	**Upland low shrubland community†**		**Pond**	**Shallow marsh†**	**Shrub swamp**	**Forested wetland†**	**River**	**Stream†**
Amphibians & Reptiles											
American Bullfrog						X	X	X		X	X
American Toad	X	X	X	X		X	X	X	X		
Black Rat Snake	X	X	X	X					X		
Blanding's Turtle			X	X							
Blue-spotted Salamander	X	X				X	X	X	X		
Common Garter Snake	X	X	X	X		X	X	X	X		X
Common Musk Turtle			X			X	X	X		X	X
Common Snapping Turtle	X	X	X	X		X	X	X		X	X
Eastern Box Turtle	X	X	X	X			X	X	X		
Eastern Hognose Snake	X	X	X	X			X		X		
Eastern Milk Snake	X	X	X	X					X		
Eastern Smooth Green Snake	X	X	X	X			X	X	X		
Eastern Worm Snake	X	X	X	X							
Four-toed Salamander	X	X					X	X	X		X
Fowler's Toad	X	X	X	X		X	X	X	X		
Green Frog						X	X	X	X	X	X
Gray Treefrog	X	X				X	X	X	X		
Marbled Salamander	X	X				X		X	X		
Northern Black Racer	X	X	X	X			X	X	X		

Terrestrial Habitats						Aquatic Habitats					
	Oak / pine forest	**White pine / Northern red oak / red maple forest**	**Old field community†**	**Upland low shrubland community†**		**Pond**	**Shallow marsh†**	**Shrub swamp**	**Forested wetland†**	**River**	**Stream†**
Northern Brown Snake	X	X	X	X			X	X	X		
Northern Dusky Salamander	X	X							X		X
Northern Redback Salamander	X	X					X		X		
Northern Redbelly Snake	X	X	X	X				X	X		
Northern Ringneck Snake	X	X							X		
Northern Spring Peeper	X	X				X	X	X	X		
Northern Two-lined Salamander	X	X							X		X
Northern Water Snake						X	X	X		X	X
Painted Turtle			X	X							
Pickerel Frog						X	X		X		X
Red-spotted Newt	X	X				X	X	X	X		X
Ribbon Snake	X	X				X	X	X	X		X
Spotted Salamander	X	X				X	X	X	X		
Spotted Turtle	X	X	X	X		X	X	X	X		
Wood Frog	X	X					X	X	X		
Wood Turtle	X	X	X	X		X	X	X	X	X	X
Birds											
American Black Duck						X	X	X	X	X	X
Acadian Flycatcher	X	X							X		
American Crow	X	X	X	X					X		
American Goldfinch	X	X	X	X			X	X	X		
American Kestrel	X	X	X	X			X		X		

Terrestrial Habitats						Aquatic Habitats					
	Oak / pine forest	**White pine / Northern red oak / red maple forest**	**Old field community†**	**Upland low shrubland community†**		**Pond**	**Shallow marsh†**	**Shrub swamp**	**Forested wetland†**	**River**	**Stream†**
American Redstart	X	X							X		
American Robin*	X	X	X					X	X		
American Tree Sparrow	X	X	X	X			X	X	X		
American Woodcock	X	X	X	X				X	X		
Baltimore Oriole	X	X	X					X	X		
Bank Swallow	X	X	X	X		X	X		X	X	X
Barn Owl											
Barn Swallow	X	X	X	X		X	X		X	X	X
Barred Owl	X	X	X	X					X		
Belted Kingfisher						X				X	X
Black & White Warbler	X	X							X		
Black-billed Cuckoo			X	X					X		
Black-capped Chickadee	X	X	X	X				X	X		
Black-throated Green Warbler	X	X							X		
Blue-gray Gnatcatcher	X	X	X	X				X	X		
Blue-headed Vireo	X	X							X		
Blue Jay	X	X	X						X		
Blue-winged Warbler	X	X	X	X				X	X		
Bobolink							X				
Broad-winged Hawk	X	X							X		
Brown Creeper	X	X							X		
Brown Thrasher	X	X	X	X					X		

Terrestrial Habitats						Aquatic Habitats					
	Oak / pine forest	**White pine / Northern red oak / red maple forest**	**Old field community†**	**Upland low shrubland community†**		**Pond**	**Shallow marsh†**	**Shrub swamp**	**Forested wetland†**	**River**	**Stream†**
Brown-headed Cowbird	X	X	X	X			X		X		
Bufflehead										X	X
Canada Goose						X	X			X	X
Canada Warbler	X	X						X	X		
Carolina Wren	X	X	X	X					X		
Cedar Waxwing	X	X	X	X				X	X		
Chestnut-sided Warbler			X	X				X	X		
Chimney Swift			X	X							
Chipping Sparrow	X	X							X		
Common Nighthawk	X	X	X	X					X		
Common Grackle	X	X					X	X	X		
Common Merganser	X	X				X			X	X	X
Common Redpoll	X	X	X	X			X	X			
Common Yellowthroat	X	X	X	X		X	X	X	X		
Cooper’s Hawk	X	X	X	X					X		
Dark-eyed Junco	X	X	X	X					X		
Downy Woodpecker	X	X	X						X		
Eastern Bluebird	X	X	X	X				X	X		
Eastern Kingbird	X	X	X	X			X	X	X	X	
Eastern Meadowlark						X					
Eastern Phoebe	X	X	X					X	X		
Eastern Screech Owl	X	X	X	X			X		X		

Terrestrial Habitats						Aquatic Habitats					
	Oak / pine forest	**White pine / Northern red oak / red maple forest**	**Old field community†**	**Upland low shrubland community†**		**Pond**	**Shallow marsh†**	**Shrub swamp**	**Forested wetland†**	**River**	**Stream†**
Eastern Towhee	X	X	X	X					X		
Eastern Wood-Pewee	X	X	X					X	X		
European Starling	X	X	X						X		
Evening Grosbeak	X	X							X		
Field Sparrow	X	X	X	X					X		
Fish Crow						X	X			X	X
Fox Sparrow	X	X	X	X					X		
Grasshopper Sparrow											
Golden-crowned Kinglet	X	X						X	X		
Golden-winged Warbler	X	X	X	X					X		
Gray Catbird	X	X	X	X				X	X		
Great Black-backed Gull											
Great Blue Heron	X	X				X	X	X	X	X	X
Great Crested Flycatcher	X	X	X						X		
Great Horned Owl	X	X	X	X			X	X	X		
Green Heron	X	X				X	X	X	X	X	X
Hairy Woodpecker	X	X							X		
Hermit Thrush	X	X	X	X				X	X		
Herring Gull										X	
Hoary Redpoll			X	X			X	X	X		
Hooded Merganser	X	X				X			X	X	X
Hooded Warbler	X	X	X	X				X	X		

Terrestrial Habitats						Aquatic Habitats					
	Oak / pine forest	**White pine / Northern red oak / red maple forest**	**Old field community†**	**Upland low shrubland community†**		**Pond**	**Shallow marsh†**	**Shrub swamp**	**Forested wetland†**	**River**	**Stream†**
Horned Lark											
House Wren	X	X	X	X				X	X		
House Finch	X	X									
House Sparrow											
Indigo Bunting	X	X	X	X					X		
Killdeer											
Lapland Longspur											
Least Bittern							X				
Least Flycatcher	X	X							X		
Louisiana Waterthrush	X	X							X		X
Mallard						X	X	X		X	X
Mourning Dove	X	X	X	X					X		
Mute Swan						X	X	X		X	X
Nashville Warbler	X	X						X	X		
Northern Bobwhite	X	X	X	X							
Northern Cardinal	X	X	X	X				X	X		
Northern Flicker	X	X	X						X		
Northern Goshawk	X	X	X	X					X		
Northern Mockingbird	X	X	X	X				X	X		
Northern Rough-winged Swallow	X	X	X	X		X	X		X		X
Northern Saw-whet Owl	X	X							X		
Northern Shrike	X	X	X	X			X		X		

Terrestrial Habitats						Aquatic Habitats					
	Oak / pine forest	**White pine / Northern red oak / red maple forest**	**Old field community†**	**Upland low shrubland community†**		**Pond**	**Shallow marsh†**	**Shrub swamp**	**Forested wetland†**	**River**	**Stream†**
Northern Waterthrush	X	X						X	X		
Orchard Oriole	X	X							X		
Ovenbird	X	X							X		
Pine Grosbeak	X	X							X		
Pine Siskin	X	X	X	X				X	X		
Pine Warbler	X	X									
Prairie Warbler	X	X	X	X							
Purple Finch	X	X	X	X					X		
Purple Martin			X	X		X	X		X		
Red-bellied Woodpecker	X	X							X	X	X
Red-breasted Nuthatch	X	X									
Red-eyed Vireo	X	X							X		
Red-shouldered Hawk	X	X						X	X		
Red-tailed Hawk	X	X	X	X				X	X		
Ring-necked Pheasant			X	X				X			
Rose-breasted Grosbeak	X	X	X	X				X	X		
Red-winged Blackbird						X	X		X		
Rock Dove								X			
Rough-legged Hawk			X	X			X				
Ruby-crowned Kinglet	X	X									
Ruby-throated Hummingbird	X	X	X	X					X		
Ruffed Grouse	X	X	X	X					X		

Terrestrial Habitats						Aquatic Habitats					
	Oak / pine forest	**White pine / Northern red oak / red maple forest**	**Old field community†**	**Upland low shrubland community†**		**Pond**	**Shallow marsh†**	**Shrub swamp**	**Forested wetland†**	**River**	**Stream†**
Rusty Blackbird									X		
Savannah Sparrow							X				
Scarlet Tanager	X	X							X		
Sharp-shinned Hawk	X	X							X	X	
Snow Bunting							X				
Solitary Sandpiper							X	X			
Song Sparrow	X	X	X	X			X	X	X		
Sora Rail						X	X				
Spotted Sandpiper						X		X		X	X
Swamp Sparrow						X	X	X	X		
Tree Swallow	X	X	X	X		X	X	X	X	X	X
Tufted Titmouse	X	X	X					X	X		
Turkey Vulture	X	X	X			X		X	X		
Veery	X	X							X		
Virginia Rail							X				
Warbling Vireo	X	X	X								
Whip-poor-will	X	X	X	X					X		
White-breasted Nuthatch	X	X	X						X		
White-eyed Vireo	X	X	X	X				X	X		
White-throated Sparrow	X	X	X	X					X		
Wild Turkey	X	X	X	X					X		
Willow Flycatcher	X	X	X	X					X		

Terrestrial Habitats						Aquatic Habitats					
	Oak / pine forest	**White pine / Northern red oak / red maple forest**	**Old field community†**	**Upland low shrubland community†**		**Pond**	**Shallow marsh†**	**Shrub swamp**	**Forested wetland†**	**River**	**Stream†**
Wilson's (Common) Snipe			X				X	X			
Winter Wren	X	X						X	X		
Wood Duck	X	X				X	X	X	X	X	X
Wood Thrush	X	X							X		
Worm-eating Warbler	X	X									
Yellow-bellied Sapsucker	X	X							X		
Yellow-billed Cuckoo	X	X	X	X				X	X		
Yellow-throated Vireo	X	X							X		
Yellow Warbler	X	X	X	X				X	X		
Mammals											
Beaver	X	X				X	X	X	X	X	X
Big Brown Bat	X	X	X	X		X	X	X	X	X	X
Black Bear	X	X	X	X		X	X	X	X	X	X
Bobcat	X	X	X	X				X	X		
Coyote	X	X	X	X			X	X	X		X
Deer Mouse	X	X	X	X					X		
Eastern Chipmunk	X	X	X	X					X		
Eastern Cottontail	X	X	X	X			X	X	X		X
Eastern Mole	X	X	X	X					X		
Eastern Pipistrelle	X	X	X	X		X	X	X	X	X	X
Ermine	X	X	X	X			X	X	X		X
Fisher	X	X	X	X					X		

Terrestrial Habitats						Aquatic Habitats					
	Oak / pine forest	**White pine / Northern red oak / red maple forest**	**Old field community†**	**Upland low shrubland community†**		**Pond**	**Shallow marsh†**	**Shrub swamp**	**Forested wetland†**	**River**	**Stream†**
Gray Fox	X	X	X	X			X	X	X		X
Gray Squirrel	X	X							X		X
Hairy-tailed Mole	X	X	X	X					X		
Hoary Bat	X	X	X	X		X	X	X	X	X	X
House Mouse			X	X							
Little Brown Myotis	X	X	X	X		X	X	X	X	X	X
Long-tailed Weasel	X	X	X	X			X	X	X		X
Meadow Jumping Mouse	X	X	X	X			X	X	X		X
Meadow Vole	X	X	X	X			X	X	X		X
Masked Shrew	X	X	X	X			X	X	X		X
Mink	X	X				X	X	X	X	X	X
Muskrat						X	X	X		X	X
New England Cottontail	X	X	X	X			X	X	X		X
Northern Flying Squirrel	X	X									
Northern Myotis	X	X	X	X		X	X	X	X	X	X
Northern Short-tailed Shrew	X	X	X	X			X	X	X		X
Norway Rat			X	X							
Porcupine	X	X	X	X					X		
Raccoon	X	X	X	X			X	X	X		X
Red Bat	X	X	X	X		X	X	X	X	X	X
Southern Flying Squirrel	X	X							X		
Red Fox	X	X	X	X			X	X	X		X

Terrestrial Habitats						Aquatic Habitats					
	Oak / pine forest	**White pine / Northern red oak / red maple forest**	**Old field community†**	**Upland low shrubland community†**		**Pond**	**Shallow marsh†**	**Shrub swamp**	**Forested wetland†**	**River**	**Stream†**
Red Squirrel	X	X							X		
River Otter	X	X				X	X	X	X	X	X
Silver-haired Bat	X	X	X	X		X	X	X	X	X	X
Smoky Shrew	X	X						X	X		X
Snowshoe Hare	X	X	X	X			X		X		
Southern Bog Lemming	X	X	X	X			X		X		X
Southern Red-backed Vole	X	X	X	X					X		X
Star-nosed Mole						X	X	X	X	X	X
Striped Skunk	X	X	X	X			X	X	X		X
Virginia Opossum	X	X	X	X			X	X	X		X
Water Shrew	X	X				X	X	X	X	X	X
White-footed mouse	X	X	X	X				X	X		X
White-tailed Deer	X	X	X	X			X	X	X		X
Woodchuck	X	X	X	X					X		
Woodland Vole	X	X	X	X				X	X		

Legend: X = Expected Source: DeGraaf and Yamasaki 2001. † Habitat type crossed by Project ROW

5.7.2 Rare and Endangered Species

Correspondence regarding Federal and Rhode Island state-listed species is included in **Appendix B**, Agency Correspondence.

5.7.2.1 State-Listed Species

Based on correspondence with the RIDEM, BSC Group completed field surveys in September 2023 for state-listed rare plant species previously identified in proximity to Project ROW. BSC found that no wood lily or any other rare plant species were observed within the targeted survey area.

5.7.2.2 Federal-Listed Species

To assess the potential for state or federal endangered, threatened, and/or special concern plant and/or animal species to be present along the Project route, BSC reviewed the RIDEM, 2023 Natural Heritage data layers, solicited database information from RIDEM, and followed the U.S. Fish and Wildlife Service ("USFWS") Information for Planning and Consultation ("IPaC") tool available on the USFWS website.

Results of the IPaC review indicated that the federally listed Northern Long-Eared Bat ("NLEB") (Myotis septentrionalis), and the federally proposed Tricolored Bat (*Perimyotis subflavus*) and Monarch Butterfly (*Danaus plexippus*) may be present within the Project area. No state listed species were identified using the information available from RIDEM. Additionally, minimal tree removal and trimming is proposed for the Project. However, no known hibernaculum, maternity roost trees are located within the Project area. No federally designated Critical Habitat occurs in the Project ROW. In accordance with 4(d) Rule for Non-Federal activities, a permit is not required for the Project. Permitting requirements and status for each of these species is described below.

5.7.2.2.1 Northern Long-Eared Bat

The NLEB is a medium-sized bat in the Family Vespertilionid with distinguishing long ears. Their body lengths range from 3.0 to 3.7 inches with a wingspan of 9.0 to 10 inches. Fur color ranges from medium to dark brown on the back and tawny to pale-brown on the underside. The NLEB has both a winter and summer habitat. During winter, these bats hibernate in natural caves and abandoned mines (known as hibernacula) which have high humidity, constant temperatures, and no air currents (Natural Heritage Endangered Species Program ("NHESP"), 2019). NLEB will share caves and mines with other wildlife species but hibernate singly or in small groups within deep crevices or cracks of the caves and mines. Rhode Island does not have any natural caves or abandoned mines so most bats that spend the summer in Rhode Island must leave the state and travel elsewhere to hibernate (RIDEM, 2023 and U.S. Fish and Wildlife, 2015). During the summer, NLEB prefer forests where the bats roost in colonies or singly in cavities of both live and dead trees, as well as underneath tree bark. Females give birth to a single pup each season. The estimated maximum lifespan of the NLEB is up to 18.5 years. NLEB feed at dusk and eat a variety of insects such as flies, leafhoppers, caddisflies, beetles, and moths. The greatest threat to the NLEB is white-nose syndrome, which is spreading from the Northeast to the Midwest and Southeast United States. The NLEB is federally listed as a threatened species under the Endangered Species Act ("ESA") (U.S. Fish & Wildlife, 2015).

In accordance with the final 4(d) Rule for the NLEB, a verification letter for the Project was submitted to the US Fish & Wildlife Service on November 26, 2024. Based upon the IPaC submission, a "no effect" determination was made for NLEB. The verification letter from US Fish & Wildlife Service verifies that the Programmatic Biological Opinion ("PBO") satisfies and concludes responsibilities for the Action under ESA Section 7(a)(2) with respect to NLEB.

5.7.2.2.2 Tricolored Bat

The tricolored bat is a small, insect-eating species known for its distinctive tricolored fur, which ranges from yellowish to nearly orange. Once abundant, this species has a broad distribution across the eastern and central U.S., parts of southern Canada, Mexico, and Central America. In winter, tricolored bats typically roost in caves and abandoned mines, although in the southern U.S., where caves are less common, they often use road-associated culverts, where they experience shorter periods of torpor and forage during warmer nights. In the spring, summer, and fall, they roost in forested areas, typically in the leaves of live or recently dead deciduous trees, but may also be found in Spanish moss, pine trees, or even human-made structures. The species is facing extinction, primarily due to the widespread impact of white-nose syndrome, a fatal disease that affects cave-dwelling bats across North America. White-nose syndrome has led to an estimated decline of over 90% in tricolored bat colonies throughout most of their range. In response to this growing threat, the U.S. Fish and Wildlife Service is leading the White-nose Syndrome National Response Team, a coordinated effort involving more than 150 non-governmental organizations, institutions, Tribes, and state and federal agencies.

Under section 7(a)(2) of the Endangered Species Act ("ESA"), federal agencies must consult with the U.S. Fish and Wildlife Service if an action may impact a listed species. While the tricolored bat is proposed for listing as endangered under the ESA, it is not yet officially listed. For actions that may affect a proposed species, agencies are not required to consult but may confer with the Service under section 7(a)(4) of the ESA.

5.7.2.2.3 Monarch butterfly

Adult monarch butterflies are large and easily noticeable, with vibrant orange wings outlined in black and marked with black veins. Two rows of white specks on the upper side of the wings are set against the black border. Monarchs are sexually dimorphic; males have unique smell patches and thinner wing veins. Predators are alerted by their vivid coloring that eating them may be dangerous because of their toxicity. Monarch butterflies lay their eggs on milkweed (mostly Asclepias spp.) during the breeding season, and the larvae hatch in two to five days. Over the course of nine to eighteen days, the larvae go through five instars, or stages in between molts, during which they consume milkweed and store deadly chemicals called cardenolides to ward off predators. After six to 14 days, the larvae pupate into chrysalis and emerge as adult butterflies. Each breeding season produces several generations of monarchs, the majority of which live for two to five weeks. Adults who spend six to nine months overwintering go through a reproductive diapause, which is a pause in reproduction.

Additionally, in regions where monarchs are found, they breed throughout the year. In temperate climates like eastern and western North America, monarchs undergo long-distance migration, living much longer than non-migratory populations. In the fall, monarchs begin migrating to their overwintering sites, traveling over 3,000 km and taking more than two months. In early spring (February-March), surviving monarchs break diapause, mate at their overwintering sites, and then disperse. The same monarchs that migrated south return to the breeding grounds, where their offspring continue the cycle of migration (Pelham, 2008).

Consultation with U.S. Fish and Wildlife Service under Section 7 of the Endangered Species Act is not required for candidate species, like the monarch.

6 DESCRIPTION OF AFFECTED SOCIAL ENVIRONMENT

Per the EFSB Rules, this section provides a detailed description of all environmental characteristics of the proposed site including the physical and social environment on and off site.

6.1 Land Use

This section describes existing and future land use within the Study Area. The scope of this discussion will address those features which might be affected by the Project. Land use within the Study Area is predominantly deciduous forest (33.6%), followed by medium density residential (11.2%), high density residential (8.4%), commercial (8.3%), medium/high density residential (7.2%), industrial (4.1%), and mixed forest (3.5%). Other land uses which occupy more than 1% of the Study Area include power lines, institutional, transitional areas, pasture, wetland/water, roads, and developed recreation. Land uses within the Study Area are depicted in Figure 6-1.

6.1.1 Open Space and Recreation

Open space, characterized by brushland/areas of reforestation, hardwood and softwood forest, recreation land, transitional areas, vacant land, water, and wetlands comprises approximately 43.6% of the Study Area. Most of the open space within the Study Area is dominated by undeveloped forest land.

6.1.2 Residential

Residential development is the second-most dominant land use type within the Study Area (27.9% when high and medium density residential are combined). Of the 2,058 acres dedicated to residential development within the Study Area, approximately 828.8 acres as Medium density (0.25 – 1 acre lots), approximately 617 acres are classified as High density (<0.125 acre lots), approximately 530 acres as Medium-High density (0.125 – 0.25 acre lots), 60.40 acres as Medium-Low density (1 – 2 acre lots), and 21.56 acres as Low density (>2 acre lots).

Residential neighborhoods are located throughout the Study Area but are particularly dominant in the south and east portions of the Study Area associated with Pawtucket, Providence, and North Providence, RI.

6.1.3 Commercial Business

Commercial business within the Project Study Area are characterized by commercial and industrial mixed development. Commercial development within the Study Area is predominantly located in the northeast of the Study Area, along Route 146A. This includes buildings associated with grocery stores, restaurants, gyms, and beauty salons.

6.1.4 Institutions

Institutional land use identified as churches, municipal buildings (e.g., Schools, fire stations), and hospitals exists within the Study Area. This includes the North Smithfield Police Department (to the northeast of the Study Area), a childcare center, and a church.

6.1.5 Agricultural

Agricultural land use within the Study Area includes 90 acres of pasture (agricultural land not suitable for tillage), and 33 acres of tillable cropland.

6.1.6 Future Land Use

A zoning analysis was completed to assess future land use in the Study Area. Typically, towns and cities manage future growth through zoning regulations. According to the Town of North Smithfield Comprehensive Plan (2019), the majority of the Study Area in North Smithfield is Zoned for Rural Agriculture, along with Residential – Suburban, Residential – Urban, and Rural Estate Agriculture. While there is no specific mention of the need to upgrade the electric transmission or distribution system in the Town Comprehensive Plan, the plan does mention the need to reduce energy consumption and improve energy efficiency of residential and Town buildings, and the need for embracing renewable energy and supporting renewable energy projects. In the Town of Lincoln, the Study Area is zoned for Manufacturing General, Manufacturing Limited, Residential Agricultural, and Residential Single Family. Within the Town of North Providence, most land use is zoned for Residential and Commercial uses. The Comprehensive Community Plan (2013) supports the State's goal of obtaining 20% of its energy from renewable sources in the future and will support public and private initiatives to take advantage of this small-scale energy generation potential. In addition, the Town is committed to reducing energy consumption in Town facilities. In the City of Providence, the Study Area is within OS - Open Space, C-3 Heavy Commercial District and R-4 Residential District. As part of the City's Comprehensive Plan, weatherization, energy efficiency, electrification, and renewable energy investments will continue to remain in alignment with the City's Green Building Ordinance.

6.2 Visual Resources

Most of the Project Route traverses predominantly deciduous forest 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 Figure 5-1. Tree removals and trimming are required to complete this Project. Therefore, existing vegetation will provide some screening.

The Project is within an existing maintained ROW. Although the Project will require a height increase for structures, the height increase does not represent a dramatic change in the visual appearance of the transmission line facilities. On average, the steel structures replacing the wood structures will be taller than current conditions due to the switch from the horizontal alignment to the vertical alignment (existing height range is 50 – 80 feet., and the proposed range is 51 – 121 feet.). The range of change in structure heights is - 1 to +41 feet. Although structures will be slightly taller, the difference in appearance when viewed from the ground will be negligible.

Visual renderings were prepared from these observation points. **Appendix C** depicts existing and simulated future conditions at these representative locations along the Project ROW. Overall, the potential for visual impact along the Project Route has been minimized through use of existing ROWs associated with the lines. These ROWs are located primarily in undeveloped and forested areas with relatively few residential or commercial abutters.

6.3 Cultural and Historic Resources

This section presents the findings of a cultural resources due diligence review conducted by TNEC's cultural resource consultant, PAL, in May 2024. The purpose of this review was to identify historic architectural properties, archaeological sites, and other cultural resources within the vicinity of the Project, and to make recommendations regarding consultation with the Rhode Island Historic Preservation and Heritage Commission ("RIHPHC"), or additional cultural resource investigations. Properties were identified through a search of the RIHPHC's archaeological, National Register of Historic Places ("NRHP") and architectural survey files, and consultation with interested stakeholders during previous projects.

The study areas established for the purposes of the identification effort were broadly defined to provide information about the types of resources located within the vicinity of the Project. For archaeological resources, the study area encompassed 0.5 mile on either side of the Project centerline for a total width of

one mile. For historic architectural properties, the study area was established at 0.25 mile on either side of the Project centerline ("Study Area"). The area of potential effects ("APE") for archaeological sites is defined as any areas of ground disturbances that may occur as a result of implementing planned improvements, including the relocation or replacement of existing structures, access roads, and staging areas. The APE for historic architectural properties includes the construction area and areas adjacent to the ROW where visual impacts may occur.

A total of 194 resources were identified within the Project's defined Study Area: 30 archaeological sites and 164 aboveground resources. Sixty (60) of the individual properties are currently listed in the National Register, most as contributing resources to the Wanskuck Historic District. The Wanskuck Historic District in Providence encompasses two historic mill complexes, two churches, the old community hall, and over sixty residences. There are 20 pre-contact and ten post-contact archaeological sites within the Study Area. The pre-contact sites include campsites, lithic workshops, artifact scatters, and isolated find spots. The post-contact sites include eighteenth- and nineteenth-century residences and farmsteads, as well as eighteenth- and nineteenth-century mill sites, a twentieth century streetcar line, a historic roadway, and a potential isolated and fragmented gravestone.

6.4 Transportation

The Study Area is served by a limited network of state and local roads and highways. The major east/west route in the area is Route 146 and Interstate 295 (I-295) (which the Line crosses between Structures 46 and 47), and the major north/south route is Route 146 (which the Line crosses between Structures 112 and 113).

6.5 Electric and Magnetic Fields

EMF is a term used to describe electric and magnetic fields that are created by the voltage (electric field) and the current (magnetic field) on electric conductors. The Company, like all North American electric utilities, supplies electricity at a frequency of 60 Hertz ("Hz"). Therefore, the electric utility system and the equipment and conductors connected to it produce 60-Hz (power-frequency) EMF. These fields can be either measured using instruments or calculated using models.

Power-frequency EMFs are present wherever electricity is used. This includes utility transmission lines, distribution lines, and substations. It also includes electrical wiring in homes, offices, and schools. Appliances and machinery that use electricity will also generate electric and magnetic fields.

Electric fields exist whenever voltages are present on transmission conductors and are not directly dependent on the magnitude of current flow. The magnitude of the electric field from a transmission line is primarily a function of the configuration and operating voltage of the line and decreases with the distance from the source. The electric field may be shielded (i.e., the strength may be reduced) by any grounded conducting object, such as trees, fences, walls, buildings, and most common structures. The strength of an electric field is measured in volts per meter ("V/m") or kilovolts per meter ("kV/m"), where 1 kV = 1,000 volts ("V").

Magnetic fields are present whenever current flows in a conductor and are not directly dependent on the voltage present on the conductor. The magnetic field strength from a transmission line is a function of both the current flow on the conductor and the configuration of the transmission line. The strength of magnetic fields also decreases with distance from the source. Since the flow of electric current (expressed in units of Amperes), or load on a transmission line varies based on the need for electric power in the region, the magnetic field associated with electric transmission lines also varies throughout the day and with seasonal changes in electric demand. Unlike electric fields, however, most common materials have little shielding effect on magnetic fields.

Magnetic fields are measured as magnetic flux density in in units called Gauss ("G"). For the low levels normally encountered during daily activities, the field strength is expressed in a much smaller unit, the

milligauss ("mG"), where 1,000 mG = 1 G. Magnetic-fields created along transmission lines are measured. Table 6-1 lists common household devices and typical magnetic field levels measured at the distances indicated from the source.

TABLE 6-1: COMMON SOURCES OF MAGNETIC FIELDS

Sources*	Distance From Source	
	6 inches ("mG")	24 inches ("mG")
Microwave Ovens	100-300	1-30
Dishwashers	10-100	2-7
Refrigerators	Ambient - 40	Ambient – 10
Fluorescent Lights	20-100	Ambient – 8
Copy Machines	4-200	1-13
Drills	100-200	3-6
Power Saws	50-1,000	1-40

Note: * Different makes and models of appliances, tools, or fixtures will produce different levels of magnetic fields. Source: Adapted from National Institute of Environmental Health Sciences (2002).

The federal government has implemented no regulations or guidelines for EMF from transmission lines or electric utility infrastructure. In addition, the state of Rhode Island has no requirements for EMF within their jurisdiction.

Since there are no federal or Rhode Island guidelines, EMF levels from the Project were assessed using standards and guidelines developed by two international health and scientific organizations that have evaluated the relevant research related to EMF. The guidance levels, referred to as reference levels recommended by the International Committee on Electromagnetic Safety ("ICES"), a committee of the Institute of Electrical and Electronics Engineers, and the International Commission on Non-Ionizing Radiation Protection ("ICNIRP") are summarized in Table 6-2. It is important to note that these reference values are not exposure limits per se because exposure to higher EMF levels comply with the standards if the underlying basic restrictions on fields in the human-body are not exceeded.

TABLE 6-2: REFERENCE LEVELS FOR WHOLE BODY EXPOSURE TO 60-HZ EMF

Agency Providing Guideline	Magnetic Field	Electric Field
International Commission on Non-Ionizing Radiation Protection ("ICNIRP") (general public, whole body continuous exposure)	2,000 mG	4.2 kV/m
International Committee on Electromagnetic Safety ("ICES") (general public, whole body, continuous exposure)	9,040 mG	10 kV/m[a] 5.0 kV/m

[a] This is an exception for persons within transmission line ROWs.

References: Institute of Electrical and Electronics Engineers (IEEE), 2019, 2021; International Commission on Non-Ionizing Radiation Protection (ICNIRP), 2010.

6.6 Noise

Environmental sound levels are quantified using a variety of parameters and metrics. This section introduces general concepts and terminology related to acoustics and environmental noise.

Sound energy is physically characterized by amplitude and frequency. Sound amplitude is measured in decibels ("dB") as the logarithmic ratio of a sound pressure to a reference sound pressure which corresponds to the typical threshold of human hearing. Generally, the average listener considers a 1.0 dB change in a constant broadband noise "imperceptible" and a 3.0 dB change "just barely perceptible." Similarly, a 5.0 dB change is generally considered "clearly noticeable", and a 10 dB change is generally considered a doubling (or halving) of the apparent loudness. Frequency is measured in Hz, which is the number of cycles per second. The typical human ear can hear frequencies ranging from approximately 20 Hz to 20,000 Hz. Typically, the human ear is most sensitive to sounds in the middle frequencies (1,000 Hz to 8,000 Hz) and

is less sensitive to sounds in the low and high frequencies. As such, the A-weighted scale was developed to simulate the frequency response of the human ear to sounds at typical environmental levels. The A-weighted scale emphasizes sounds in the middle frequencies and de-emphasizes sounds in the low and high frequencies. Any sound level to which the A-weighted scale has been applied is expressed in A- weighted dB, dBA. For reference, the A-weighted sound pressure levels associated with some common noise sources are shown in Table 6-3 below:

TABLE 6-3: TYPICAL SOUND PRESSURE LEVELS ASSOCIATED WITH COMMON NOISE SOURCES

Sound Pressure Level ("dBA")	Subjective Evaluation	Environment	
		Outdoor	Indoor
140	Deafening	Jet aircraft takeoff at 75 feet	
130	Threshold of pain	Jet aircraft takeoff at 300 feet	
120	Threshold of feeling	Elevated train	Rock band concert
110	Extremely loud	Jet flyover at 1,000 feet	Inside propeller plane
100	Very loud	Motorcycle at 25 feet, auto horn at 10 feet, crowd noise at football game	
90	Very loud	Propeller plane flyover at 1,000 feet, noisy urban street	Full symphony or band, food blender, noisy factory
80	Moderately loud	Diesel truck (40 mph) at 50 feet	Inside auto at high speed, garbage disposal, dishwasher
70	Loud	B-757 cabin during flight	Close conversation, vacuum cleaner, electric typewriter
60	Moderate	Air-conditioner condenser at 15 feet, near highway traffic	General office
50	Quiet		Private office
40	Quiet	Farm field with light breeze, birdcalls, soft stereo music in residence	Bedroom, average residence (without television and stereo)
30	Very quiet	Quiet residential neighborhood	
20	Very quiet	Rustling leaves	Quiet theater, whisper
10	Just audible		Human breathing
0	Threshold of hearing		

Source: Adapted from Architectural Acoustics, M. David Egan 1988 and Architectural Graphic Standards, Ramsey and Sleeper 1994, as referenced in the Environmental Noise Assessment prepared for the Southern Rhode Island Transmission Project by Black & Veatch Corporation.

Within North Smithfield and Lincoln, the Study Area encompasses the Route 146 and Interstate 295 corridors and George Washington highway, and State highway 146 but is predominantly within quiet forest areas. Ambient sound levels are influenced by diverse factors such as vehicular traffic, commercial and industrial activities, and outdoor activities typical of both rural and developed environments. Noise receptors include residences, hospitals and designated recreational areas.

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7 IMPACT ANALYSIS

This section presents an analysis of the potential impacts of the Project on the existing natural and social environments within the Study Area. As with any construction project, potential adverse impacts can be associated with the construction, operation, or maintenance of an electric transmission line. These impacts will be minimized to the greatest extent feasible through thoughtful design and construction, operation and maintenance practices.

Potential impacts to the natural and social environments associated with the Project can be categorized based on construction-related (temporary) impacts and operational-related (permanent) impacts. Examples of potential temporary construction-related impacts include traffic impacts, temporary use of areas to stage construction equipment and supplies, and short-term construction noise associated with the operation of heavy equipment.

The Project will be constructed in a manner that minimizes the potential for adverse environmental impacts. A monitoring program will be conducted by TNEC to verify that the Project is constructed in compliance with all relevant licenses and permits and all applicable federal, state, and local laws and regulations. Design and construction mitigation measures will be implemented so that construction-related environmental impacts are minimized.

7.1 Summary of Environmental Effects and Mitigation

The Project will occur within the existing ROW, thereby minimizing adverse environmental impacts. No long-term impacts to 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 equipment access mats (construction mats) to protect wetland soils, vegetation root stock, and streams. Minor, temporary disturbances of wildlife may result from equipment travel and construction crews working in the Project corridor. Any wildlife displacement will be negligible and temporary, and no permanent alteration of the existing habitat is proposed. As part of the Project, an environmental monitor will be part of the Project team to ensure compliance with all applicable regulatory programs and permit conditions, and to oversee the proper installation and maintenance of the soil erosion and sediment control BMPs.

7.2 Summary of Social Effects and Mitigation

The Project involves the refurbishment of an existing transmission line within an existing ROW. No long-term impacts to residential, commercial, or industrial land uses will occur as a result of the Project. Any construction noise impacts are expected to be brief and localized. Minimal visual impacts will result from the Project (associated with the slight increase in height of transmission line structures). The Project will improve the reliability of the electric supply and as such will have a positive effect for the area. Traffic controls plans will be employed as necessary, and as required at the ROW access points off local and state roads. The Project will not adversely impact the social and economic conditions in the Project area.

7.3 Soils

Construction activities which expose unprotected soils have the potential to increase soil erosion and sedimentation rates. Soil compaction and decreased infiltration rates may result from equipment operations. Standard construction techniques and BMPs will be employed to minimize any short- or long-term impacts due to construction activity. These include the installation of straw bales, siltation fencing, water bars, diversion channels, the use of dust control measures, and the re-establishment of vegetation post-construction. Sediment and erosion control devices will be inspected by TNEC's environmental monitor frequently during construction and repaired or replaced if necessary. The Applicant will develop and

implement a Soil Erosion and Sediment Control Plan ("SESC" Plan), which will detail BMPs and inspection protocols.

Highly erodible soils are encountered within the Study Area. On all slopes greater than eight percent, which are above sensitive areas, impacted soils will be stabilized with straw or chipped brush mulch to prevent the migration of sediments.

Soil erosion and sediment control measures will be selected to minimize the potential for soil erosion and sedimentation in areas where soil is impacted. TNEC will adhere to its ROW Access, Maintenance, and Construction BMPs ("EG-303").

Temporary soil erosion controls listed below may be placed in the following types of areas, in accordance with site-specific field determinations.

- Across or along portions of cleared ROW, at intervals dictated by slope, soil erodibility, amount of vegetative cover remaining, and down-slope environmental resources.
- Along access ways within the transmission line ROW.
- Across areas of impacted soils on slopes leading to streams and wetlands.
- Around portions of construction work sites that must unavoidably be located in wetlands.

The temporary soil erosion controls will be maintained, as necessary, throughout the period of active construction until restoration has been deemed successful, as determined by standard criteria for storm water pollution control/prevention and soil erosion control. In addition to silt fence or straw bales, temporary soil erosion controls may include the use of mulch, jute netting (or equivalent), soil erosion control blankets, reseeding to establish a temporary vegetative cover, temporary or permanent diversion berms (if warranted), and/or other equivalent structural or vegetative measures. After the completion of construction activities in any area, permanent stabilization measures (e.g., seeding and/or mulching) will be performed as necessary.

During periodic post-construction inspections, TNEC will determine the appropriate time frame for removing these temporary soil erosion controls. This determination will be made based on the effectiveness of restoration measures, such as percent re-vegetative cover achieved, in accordance with applicable permit and certificate requirements.

7.4 Surface Water Resources

Any impact of the Project upon surface waters will be minor and temporary. Rivers and streams within the Project ROW are spanned by existing transmission lines. Construction activities temporarily increase risks for soil erosion and sedimentation that may temporarily degrade existing water quality; however, appropriate BMPs will be implemented and maintained to effectively control sediment. In addition, construction equipment will not cross the stream along the construction corridor without the use of temporary swamp mat bridges. Emphasis has been placed on using existing gravel roadways within the Project ROW and seeking access points that avoid crossing wetlands and surface waters to the extent possible.

There are several surface water features within the Study Area. Temporary swamp mats will be used to access structure locations within or adjacent to surface water features as conditions warrant. Access to most structure locations adjacent to these watercourses will be provided without impacting the channels either by using alternate upland access on the Project ROW or by spanning the areas using temporary swamp mats during construction. Sedimentation and turbidity within these watercourses will be minimized through the implementation of BMPs prior to construction activities.

Potential impacts to surface waters if sediment transport is not controlled include temporary increased turbidity and sedimentation (locally and downstream) and subsequent alterations of benthic substrates, decreases in primary production and dissolved oxygen concentrations, releases of toxic substances and/or nutrients from sediments, and destruction of benthic invertebrates. Soil erosion and sediment controls are intended to effectively minimize the potential for this situation to occur. The implementation and maintenance of stringent soil erosion and sediment control BMPs will limit the levels of Project related sedimentation and will minimize adverse impacts to surface waters.

7.4.1 Water Quality

The primary potential impact to water quality from any construction project is the increase in turbidity of surface waters in the vicinity of construction resulting from soil erosion and sedimentation from the impacted site. A second potential impact is the spillage of petroleum, hydraulic fluid, or other products near waterways. Impacts to previously undisturbed areas on the ROW will be minimized using existing access roads. Further, equipment (with exceptions for equipment that is not readily mobile) will not be refueled or maintained near wetlands or surface water resources. The contractors will respond to an inadvertent release or spill of soil or other hazardous materials in accordance with Rhode Island State and TNEC requirements. Pre-construction environmental training of contractors will reinforce this obligation. TNEC has company procedures to minimize risks and provide procedural requirements to be followed in the event of an inadvertent release. Therefore, it is anticipated that any adverse impacts to water resources resulting from construction of the Project will be negligible.

7.4.2 Hydrology

Some minor, temporary impacts to surface drainage can be expected during construction on the transmission lines. These impacts will be associated with access road and work pad improvements. TNEC will employ soil erosion and sediment controls prior to the initiation of soil disturbing activities to protect adjacent surface waters where necessary. Following construction, temporarily disturbed areas will be restored to pre-construction conditions to the extent practicable. Features that will permanently remain on the Project ROW (such as improved access roads), will be stabilized.

The hydrology of surface waters will not be significantly affected during or after construction since temporary wooden mat bridges will be constructed across stream channels to allow for the staging of equipment without disturbing the stream or its channel substrate.

7.4.3 Floodplain

Project activities located within Floodplain are limited to the replacement of structures, temporary access roads (off row) and construction matting. No other impacts are proposed within Floodplain.

7.5 Groundwater Resources

Potential impacts to groundwater resources within the Project ROW as a result of construction activity on the transmission line facilities will be negligible. Equipment used for construction will be properly inspected, 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., absorbent pads, clean up rags, five-gallon containers, and absorbent material) and fueling of equipment will occur in upland areas where practicable. In addition, maintenance equipment and replacement parts for construction equipment will be on hand to repair failures and stop spills in the event of equipment malfunction. Following construction, the normal operation and maintenance of the transmission line facilities will have no impact on groundwater resources.

7.6 Vegetation

TNEC's vegetation management program maintains safe access to transmission line facilities and promotes the growth of vegetative communities along ROWs that are compatible with transmission line operation and in accordance with federal and state standards. TNEC has conducted vegetation management within its ROWs as a matter of good utility practice since the late 1980s. TNEC's vegetation management program is designed to allow the safe operation of transmission lines by preventing the growth of incompatible vegetation that may interfere with the transmission facilities or access along its ROW. As a result, the vegetation within the maintained portions of the TNEC ROW typically consists of low-growing shrubs, herbaceous species, and other low-growing species. Portions of the ROW that are not proximate to an existing line may support taller vegetation, if it will not conflict with the construction or operation of the lines.

To stabilize impacted sites after the work on the transmission facilities, TNEC will seed and mulch impacted areas with appropriate grass-type mixes and straw mulch. Vegetative species compatible with the use of the ROW for transmission line purposes are expected to regenerate naturally. TNEC will promote the re-growth of desirable species by implementing vegetative maintenance practices to control tall-growing trees and undesirable invasive species that conflict with line clearances, thereby enabling native plants to dominate. Tree removals and trimming (on or off-ROW) is required for the Project.

7.7 Wetlands

Construction of the Project will result in temporary and permanent impacts to wetland resources. The following section describes the impacts associated with construction of the Project. Table 7-1 summarizes the potential impacts of the Project on wetlands, based on preliminary design data.

TABLE 7-1: SUMMARY OF POTENTIAL IMPACTS ON WETLANDS AND WATERCOURSES

Impacts	Approximate Impact Area
TEMPORARY - Swamp Mats for Access and Work Pads	541,523.34 -sf (12.4 acres)
PERMANENT – Fill for structures requiring caisson foundations	222.26-sf

All temporary matting used for access and work pads in wetlands and over watercourses will be removed after the completion of the Project.

7.8 Wildlife

Minor, temporary disturbances of wildlife may result from equipment travel and construction crews working in the Project corridor. During construction, displacement of wildlife may occur due to disturbance associated with ROW mowing and the operation of construction equipment. Wildlife currently utilizing the forested edge of the cleared ROW may be affected by the construction of the Project.

Larger, more mobile species, such as eastern white-tailed deer or red fox, will leave the construction area. Individuals of some bird species will also be temporarily displaced. Depending on the time of year of these operations, this displacement could impact breeding and nesting activities. Smaller and less mobile animals such as small mammals, reptiles, and amphibians may be affected during vegetation mowing and the transmission line construction. The species impacted during the reconductoring of the transmission line are expected to be limited in number. Effects will be localized to the immediate area of construction around structure locations and along existing access roads. However, this is anticipated to be a temporary effect as it is expected that existing wildlife use patterns will resume, and population sizes will recover, once work activities are completed. Any wildlife displacement will be negligible and temporary, since no permanent

alteration of the existing habitat is proposed. No long-term impacts to wildlife are expected to result from the Project.

7.9 Social and Economic

Based on the proposed location of the Project, the greatest potential for social impact is the interaction of construction and future maintenance activities on current and future land uses abutting the Project ROW.

7.9.1 Social Impacts

The Project will not adversely impact the overall social and economic condition of the Project area. The Project does not require, nor will it lead, to long-term residential or business disruption. Temporary construction impacts, primarily related to construction traffic and equipment operation, are expected to be minor. As described in Section 3.0, the proposed work will be located entirely within an existing cleared transmission line.

7.10 Land Use

The following section addresses the compatibility of the Project with various land uses along the proposed route. Because the Project will occupy areas dedicated to use for electrical facilities, it will not displace any existing residential uses, nor will it affect any future development proposals that meet local zoning requirements. Short-term land use impacts may occur during the construction phase of the Project. Impacts associated with the construction phase of the Project will be temporary, and most present land uses within the existing ROW could resume following construction.

The construction of the Project in the ROW will be consistent with the established land use and therefore, will not present long-term land use impacts. Generally, existing land uses within and adjacent to the Project ROW will be allowed to continue following construction. The encroachment, installation or construction of buildings, pools or other non-transmission related facilities is not allowed with the transmission line easement.

7.10.1 Residential

Several residential areas are in proximity to the Project ROW. Tree removals and trimming is necessary to complete the Project. Only trees that present a hazard or prohibit access for rebuild will be removed. The existing vegetative visual buffers will continue to provide visual screening of the facilities from residences.

7.10.2 Agriculture

The Project will not impact agricultural land use within the ROW or wider Study Area.

7.10.3 Institutions

The Project is not anticipated to impact the institutions located within the Study Area.

7.10.4 Recreation

No existing recreational uses or trails will be displaced in the long-term by the Project. Impacts to existing parks and recreational areas from the construction of the Project will be minimal and short-term. Since the Project is located within existing maintained ROW, potential long-term impacts will be avoided.

7.11 Visual Resources

The Project involves replacing conductors and upgrades to existing structures, which will involve a slight increase in structure heights (with ranges of -21 to +56 feet). The structures will be replaced along the same

alignment and in roughly the same location. No significant impacts to visual resources are anticipated because of the Project.

7.12 Cultural and Historic Resources

Section 106 of the National Historic Preservation Act of 1966 requires federal agencies to review federally funded or permitted projects for their potential impacts to historic and cultural resources. Potential resources addressed under this review include known and unknown properties that are listed or are determined eligible for listing on the NRHP. Once a review has been initiated, the agency, in consultation with the RIHPHC, office of the State Historic Preservation Officer ("SHPO") and appropriate Tribal authorities, must identify historic properties, assess whether effects to the properties will be adverse, and then work to minimize, resolve, or mitigate those adverse effects.

Eligibility for inclusion on the NRHP is based on four criteria, at least one of which must be met (36 Code of Federal Regulations ("CFR") Part 60). In order to be eligible, cultural resources must:

- be "associated with events that have made a significant contribution to the broad patterns of our history,"
- be "associated with the lives of persons significant in our past,"
- "embody the distinctive characteristics of a type, period, or method of construction, or … represent a master, or … possess high artistic values, or … represent a significant and distinguishable entity whose components may lack individual distinction," or
- "have yielded, or may be likely to yield, information important in prehistory or history[.]"

In addition to meeting at least one of these four criteria, an eligible property must retain integrity in its location, design, setting, materials, workmanship, feeling, and/or association. Resources can include both above-ground/architectural resources and archaeological sites; NRHP criteria and standards of integrity are applied to both types of resources. In Rhode Island, the state review process follows that of Section 106 and is conducted by the SHPO at the RIHPHC pursuant to the Antiquities Act of Rhode Island as per R.I.G.L. 42-45 et seq.

TNEC's cultural resource consultant, PAL, previously conducted archaeological survey along the Lines from the Woonsocket Substation in North Smithfield south to Providence. PAL assessed areas of moderate and high archaeological sensitivity along the ROW and secured a State Archaeologist's Permit from the RIHPHC to perform a Phase I archaeological survey. PAL commenced the Phase I archaeological survey fieldwork in June 2024 and completed the survey in July 2024. PAL is planning to submit a report on the Phase I archaeological survey to the RIHPHC and the Narragansett Indian Tribe, the Mashpee Wampanoag Tribe, and the Wampanoag Tribe of Gay Head (Aquinnah) in October 2024. PAL is developing an archaeological avoidance and protection plans to mitigate any effects construction will have to archaeological resources and will submit it with the Phase I archaeological survey report. TNEC plans to implement the ASAPPs before, during, and after construction, and commits to implementing measures to avoid, minimize, and mitigate significant cultural resources.

7.13 Noise

Noise impacts are expected to be negligible. Temporary, minor construction noise may be generated by the Project that will occur predominantly during normal daytime working hours. Proper mufflers will be required to control noise levels generated by construction equipment. Noise impacts are expected to be negligible.

7.14 Transportation

The construction-related traffic increase will be small relative to total traffic volume on public roads in the area. In addition, it will be intermittent and temporary, and construction related traffic will cease once the Project is completed. These limited periods of traffic are not expected to result in any additional congestion or a change in operating conditions on any of the roadways along the ROW. TNEC will coordinate closely with RIDOT to develop acceptable traffic management plans for work within state highway ROWs. At all locations where access to the ROW intersects a public way, the contractor will follow a pre-approved work zone traffic control plan. Although traffic entering and exiting the ROW at these locations is expected to be small, vehicles entering and exiting the site will do so safely and with minimal disruption to traffic along the public way. Following construction, traffic activity will be minimal and will occur only when the ROW or transmission lines require maintenance. As a result, the construction and operation of the transmission line will have minimal impact on the traffic of the surrounding area roadways. No long-term impacts to traffic flow or roadways are expected.

7.15 Safety and Public Health

Trespassing on the ROW will be discouraged using existing gates and/or barriers at entrances from public roads.

7.16 Electric and Magnetic Fields

Exponent performed an independent assessment of the electric and magnetic field ("EMF") levels associated with the proposed TNEC Q143S-R144 Woonsocket Substation to Admiral Street Substation Rebuild, involving the replacement of the 115-kV overhead Q143S-R144 line. The 11.5 mile Project was divided into 13 different cross sections based upon the physical configuration of the Q143S and R144 Lines. Exponent analyzed the cross sections and determined that several could be conservatively combined together into eight modeling cross sections for the purpose of EMF modeling because they differ only in the placement of structure centerlines to relative to the ROW edges.

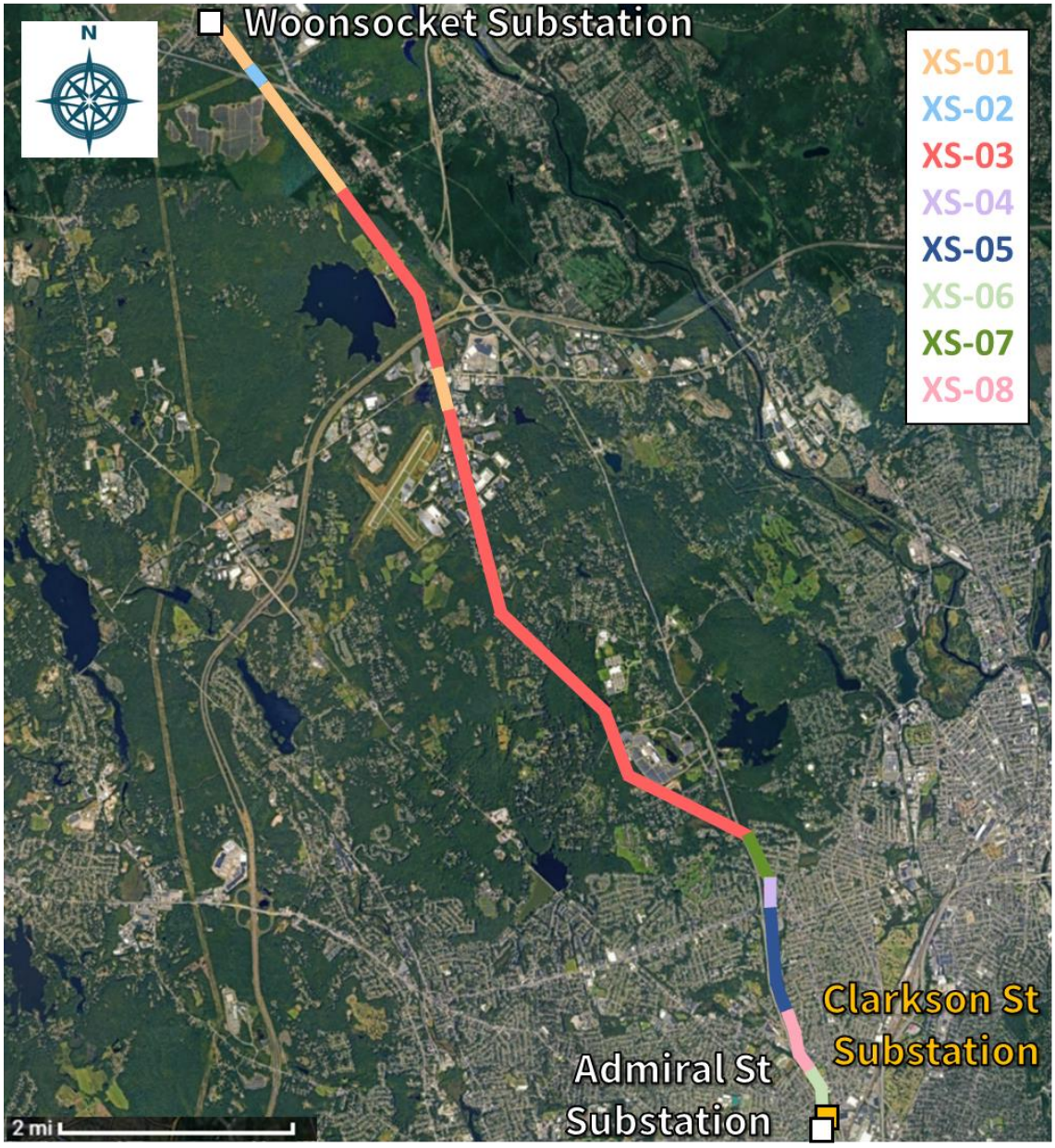
TNEC has proposed up to 13 cross sections for 60-Hertz ("HZ") EMF modeling. Exponent has analyzed the proposed cross sections and determined that an efficiency gain may be achieved by conservatively combining several similar configurations that differ only in the relative placement of structure centerlines relative to the ROW edges but with phase spacing of individual circuits not differing from one to the next. Thus, Exponent instead proposes to model a total of eight cross-sections as shown in Table 7-2 below.

TABLE 7-2: TNEC PROPOSED CROSS-SECTION AND EXPONENT MERGED CROSS SECTIONS

TNEC proposed cross section (XS) number[1]	Exponent merged cross section (XS) number
1, 4	1
2	2
3, 5, 6, 7, 8	3
10	4
11	5
13	6
9	7
12	8

Please refer to Cross Section Details in Figure 7-1 and the location of each of the eight modeled cross sections in Figure 7-2, below.

FIGURE 7-2. MODELED CROSS-SECTIONS*



*Note: Project route between Woonsocket Substation and the Clarkson Street Substation showing the locations of representative cross sections XS-01 to XS-08. All modeled XS have a view facing South.

For this assessment, EMF modeling was conducted at a height of one meter (3.28 feet) above ground along a transect perpendicular to the transmission line's centerline, following the guidelines of IEEE Standard 644-2019 (IEEE, 2019). Pre-Project and post-Project EMF levels for all Project configurations of the transmission lines (including on the ROW, directly beneath the transmission lines) and at the edge of the ROW and beyond are far below reference levels for the general public published by ICNIRP and ICES.

EMF levels at the Project right-of-way (ROW) edges were calculated to decrease or not significantly change as a result of the Project rebuild. Magnetic-field levels were calculated at the ROW edges to either decrease or not increase by more than 0.6 mG along the entire Project route at average loading. Similarly, ROW-edge electric-field levels were calculated to decrease from a maximum of 0.7 kV/m to 0.1 kV/m or less as a result of the Project.

7.16.1 Electric Fields

The pre-Project ("existing") and post-Project ("rebuilt") modeled electric field values for the four cross sections (XS-01 to XS-08) at the ROW edges are well below ICNIRP and ICES health-based guidelines of 4.2 kV/m and 5 kV/m, respectively for all modeled cases. The highest ROW-edge electric-field levels were calculated to decrease from a maximum of 0.7 kV/m to 0.1 kV/m or less as a result of the Project. The modeling analysis indicates that the Project will generally decrease as a result of the Project.

The calculations of the electric field levels at the edge of the ROW are summarized in Table 7-3 below.

TABLE 7-3: ELECTRIC-FIELD LEVELS ("KV/M") FOR THE EXISTING AND PROPOSED LINES

Cross Section	Configuration	-ROW Edge	+ROW Edge
XS-01	Existing	0.3	< 0.1
	Post Construction	0.1	< 0.1
	Post Construction + 5 years	0.1	< 0.1
XS-02	Existing	< 0.1	< 0.1
	Post Construction	< 0.1	< 0.1
	Post Construction + 5 years	< 0.1	< 0.1
XS-03	Existing	0.2	< 0.1
	Post Construction	< 0.1	< 0.1
	Post Construction + 5 years	< 0.1	< 0.1
XS-04	Existing	< 0.1	0.5
	Post Construction	< 0.1	< 0.1
	Post Construction + 5 years	< 0.1	< 0.1
XS-05	Existing	0.2	0.7
	Post Construction	0.1	< 0.1
	Post Construction + 5 years	0.1	< 0.1
XS-06	Existing	0.1	0.3
	Post Construction	< 0.1	< 0.1
	Post Construction + 5 years	< 0.1	< 0.1
XS-07	Existing	0.3	0.7
	Post Construction	0.1	< 0.1
	Post Construction + 5 years	0.1	< 0.1
XS-08	Existing	0.2	< 0.1
	Post Construction	< 0.1	< 0.1
	Post Construction + 5 years	< 0.1	< 0.1

7.16.2 Magnetic Fields

The modeled cross sections represent portions of the route located between the Woonsocket Substation and the Clarkson Street Substation, where Line R144 is energized and Line Q143S is energized to 115 kV but terminated near the Clarkson Street Substation by an open circuit-breaker switch. Thus, Line Q143S will not carry load under typical operating conditions, but would only carry load if the Line R144 were out of service.

Magnetic-field levels were calculated for two loading scenarios: expected annual average and annual peak loading. Calculations were performed for the existing configuration as well as the rebuilt configuration including calculations at the in-service date in addition to calculations based on projected loading five years after Project completion. Magnetic field levels were calculated to generally decrease as a result of the Project due to the rebuilding of the exiting H-frame Project transmission lines on double-circuit vertical monopole structures with optimal phasing.

Existing magnetic-field levels were calculated to be less than 11 mG on the western ROW edge and 1.5 mG or lower on the eastern ROW edge, under average loading conditions. These average magnetic-field levels were calculated to decrease by as much as 8.4 mG at the western ROW edge and to increase by no more than 0.5 mG at the eastern ROW edge immediately post-construction as a result of the proposed Project. Magnetic field levels for projected +5-year loading either remained the same as proposed or increased by no more than an additional 0.1 mG at the ROW edges (a maximum total increase of 0.6 mG compared to existing levels). Magnetic-field levels post-construction at average loading were calculated to be approximately 1.9 mG or less at the ROW edges and 15 mG or less across the entire width of the ROW along the Project route, which is less than 1% of the ICNIRP Reference Level of 2,000 mG and the ICES Exposure Reference Level of 9,040 mG for the general public. Under peak loading conditions, which is expected to occur for limited periods of a few hours or days each year, the maximum magnetic field anywhere along the Project route is calculated to be 39 mG (less than 2% of the ICNIRP Reference Level) and at the ROW-edges after the Project are expected to be 3.3 mG or less.

Calculated magnetic-field values for all sections are summarized in Table 7-4 and Table 7-5 below.

TABLE 7-4: MAGNETIC-FIELD LEVEL ("MG") AT AVERAGE LOADING

Cross-section	Configuration	Distance from Centerline of ROW	
		-ROW Edge	+ROW Edge
XS-01	Existing	1.0	0.7
	Post Construction	1.2	0.2
	Post Construction + 5 years	1.3	0.2
XS-02	Existing	0.2	0.2
	Post Construction	0.2	0.1
	Post Construction + 5 years	0.2	0.1
XS-03	Existing	0.9	0.7
	Post Construction	1.4	0.2
	Post Construction + 5 years	1.5	0.3
XS-04	Existing	0.3	10
	Post Construction	0.3	1.8
	Post Construction + 5 years	0.3	1.9
XS-05	Existing	1.0	9.3
	Post Construction	1.1	1.6
	Post Construction + 5 years	1.2	1.7
XS-06	Existing	0.3	2.6
	Post Construction	0.7	0.3
	Post Construction + 5 years	0.8	0.3
XS-07	Existing	0.9	10
	Post Construction	1.3	1.6
	Post Construction + 5 years	1.4	1.7
XS-08	Existing	0.9	0.7
	Post Construction	1.3	0.2
	Post Construction + 5 years	1.4	0.3

TABLE 7-5: MAGNETIC-FIELD LEVEL ("MG") AT PEAK LOADING

Cross-section	Configuration	Distance from Centerline of ROW	
		-ROW Edge	+ROW Edge
XS-01	Existing	2.1	1.4
	Post Construction	2.2	0.4
	Post Construction + 5 years	2.1	0.4
XS-02	Existing	0.5	0.5
	Post Construction	0.4	0.2
	Post Construction + 5 years	0.4	0.2
XS-03	Existing	1.9	1.4
	Post Construction	2.7	0.4
	Post Construction + 5 years	2.5	0.4
XS-04	Existing	0.5	22
	Post Construction	0.5	3.3
	Post Construction + 5 years	0.5	3.2
XS-05	Existing	2.0	20
	Post Construction	2.0	3.0
	Post Construction + 5 years	1.9	2.8
XS-06	Existing	0.7	5.5
	Post Construction	1.4	0.6
	Post Construction + 5 years	1.3	0.6
XS-07	Existing	1.9	22
	Post Construction	2.4	3.0
	Post Construction + 5 years	2.3	2.8
XS-08	Existing	1.9	1.4
	Post Construction	2.4	0.4
	Post Construction + 5 years	2.2	0.4

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8 MITIGATION MEASURES

The Project is not anticipated to have any long-term impact to the natural or social environment of the Study Area. Mitigation measures for this Project will be used to reduce the impact of the work on the natural and social environment. The Project consists of structure replacements and the reconductoring of the existing Q143S and R144 Line in an existing ROW. As described in Chapter 6.0, there are no long-term impacts to mitigate because of the Project. Therefore, mitigation efforts are focused on the construction phase.

8.1 Construction Phase

Construction for this Project will require only minor temporary disturbances to the surrounding natural environment. Mitigation measures will be implemented during construction to effectively minimize Project impacts on the natural and social environments. These mitigation measures include the use of existing access roads and structure pads where possible to minimize disturbed areas, installation of erosion and sedimentation controls, and supervision and inspection of construction activities within resource areas by an environmental monitor. The following section details various mitigation measures which will be implemented to minimize construction related impacts.

8.1.1 Mitigation of Natural Resource Impacts

When the existing transmission lines were constructed, access roads were established within most portions of the ROW. During construction of the Project, vehicles will utilize these existing access roads where practical to minimize disturbance within the ROW. Access through wetlands to the existing structure locations will be provided using swamp mats from the existing maintained portion of the ROW. Construction access will be limited to the existing structure locations and proposed access routes, which will be bordered by erosion and sedimentation control BMPs, where needed. Following overhead reconductoring and thermal upgrade activities along the lines, all disturbed areas will be stabilized and restored.

Vegetation management operations will be confined to the existing ROW. Vegetation mowing adjacent to wetland areas is of particular concern due to the potential for erosion, and therefore, specific mitigation measures will be implemented to minimize this potential where needed. These measures will include the installation of straw wattle or compost mulch tube diversion berms across the slope, to intercept storm water runoff, which will be directed through straw wattle or silt fence to remove suspended sediment. These structures will be maintained until vegetative cover is reestablished. In addition, straw wattle and/or erosion control blankets will be installed across disturbed slopes adjacent to wetland areas in accordance with an erosion and sediment control plan. Excavated soils will be stockpiled and spread in approved soil areas well outside all biological wetland areas in such a manner that general drainage patterns will not be affected.

Where possible, existing vegetation will be retained at all road crossings and areas subject to public view to maintain a visual buffer to the ROW. Stream crossings will be located perpendicular to the channel to the extent possible to reduce the crossing length and reduce the potential for disturbance to the water body. Design and implementation of all stream crossing structures (i.e., temporary mat bridges) will comply with standards and specifications as outlined in the *Rhode Island Soil Erosion and Sediment Control Handbook* and TNEC's EG303. Temporary access is used where the substrate is sufficiently firm or level to support equipment without creating a disturbance to the soil substrate.

8.1.2 Erosion and Sedimentation Control

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 soil stockpiles and other disturbed soil areas are confined and do not result in downslope sedimentation of sensitive areas. Low growing tree species, shrubs and grasses will only be mowed along access roads and at pole locations. Construction

crews will be responsible for conducting daily inspections and identifying erosion controls that must be maintained or replaced as necessary. Erosion and sedimentation controls will be installed and maintained in accordance with the *Rhode Island Soil Erosion and Sediment Control Handbook* and TNEC's Environmental Guidance Policies for ROW Access, Maintenance and Construction BMPs for New England ("EG-303").

8.1.3 Supervision and Monitoring

Throughout the entire construction process, TNEC will retain the services of an environmental monitor who will oversee the implementation and maintenance of BMPs and soil erosion and sediment controls on a routine basis to ensure compliance with all federal and state permit requirements and TNEC environmental guidance and policy. The environmental monitor will be a trained environmental scientist, who will be responsible for supervising construction activities relative to environmental issues. The environmental monitor will be experienced in soil erosion and sediment control management and the Project's environmental resources.

During periods of prolonged precipitation, the monitor will inspect all locations to confirm environmental controls are functioning properly. In addition to retaining the services of an environmental monitor, TNEC 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. Additionally, all construction personnel will be briefed on Project environmental compliance issues and obligations prior to the start of construction. Regular construction progress meetings will provide the opportunity to reinforce the contractor's awareness of these issues and make corrective actions.

8.1.4 Mitigation of Social Resource Impacts

TNEC will minimize social resource impacts during construction by incorporating several standard mitigation measures. By use of an established transmission line ROW rather than creating a new ROW, the potential for disruption due to construction activities will be limited to an area already dedicated to transmission line uses. There are two potential sources of air quality impacts associated with the Project – dust and vehicle emissions – neither of which are expected to be significant. During earth disturbing activities, the contractor will deploy dust mitigation measures as described in TNEC's EG-303. Exposed soils will be wetted and stabilized as necessary to suppress dust generation, and crushed stone aprons will be used at all access road entrances to public roadways. Consequently, fugitive dust emissions are anticipated to be low.

TNEC requires the use of ultra-low sulfur diesel fuel exclusively in its contractor's diesel-powered construction equipment. Vehicle idling is to be minimized during the construction phase of the Project, in compliance with the Rhode Island Diesel Engine Anti-Idling Program, Air Pollution Control Regulation No. 45, authorized pursuant to R.I.G.L.s § 31-16.1 and § 23-23-29. Vehicle idling for diesel and non-diesel-powered vehicles is limited to five minutes except for powering auxiliary equipment, for heating/defrosting purposes in cold weather, and for cooling purposes in hot weather. The contractor is responsible for complying with the state regulatory requirements along with the TNEC's Environmental Guidance EP-8; Air Emissions Management ("EG-802").

Construction generated noise will be limited to the use of mufflers on all construction equipment and by limiting construction activities to the hours specified in the local ordinances. Dust will be controlled by wetting and stabilizing access road surfaces, as necessary, and by maintaining crushed stone aprons at the intersections of access roads with paved roads and street sweeping. TNEC will minimize the potential for disturbance from the construction by notifying the Town of planned construction activities before and during construction of the line. Some short-term impacts are unavoidable, even though they have been minimized. By carrying out the reconductoring of the line in a timely fashion, TNEC will keep these impacts

to a minimum. TNEC will prepare a traffic management plan for approval by the RIDOT, which will minimize impacts associated with increased construction traffic on local roadways.

8.2 Post-Construction Phase

Following the completion of construction, TNEC uses standard mitigation measures on all transmission line construction projects to minimize the impacts of projects on the natural and social 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. TNEC will implement the following standard and site-specific mitigation measures for the Project.

8.2.1 Mitigation of Natural Resource Impacts

Restoration efforts, including final grading and installation of permanent erosion control devices, and seeding of disturbed areas, will be completed following construction. Construction debris will be removed from the Project area and disposed of at an appropriate landfill. Pre-existing drainage patterns, ditches, roads, fences, and stone walls will be restored to their former condition, where appropriate. Permanent slope breakers and erosion control devices will be installed in areas where the disturbed soil has the potential to impact wetland resource areas.

Vegetation maintenance of the ROW will be accomplished with methods identical to those currently used in maintaining the existing ROW. TNEC's ROW vegetation maintenance practices encourage the growth of low-growing shrubs and other vegetation, which do not interfere with utility line safety or maintenance, but help inhibit soil erosion, and provide habitat for certain wildlife species.

8.2.2 Mitigation of Social Resource Impacts

Where possible, TNEC will limit access to the ROW by locking permanent gates and placing barriers where access roads enter the ROW from public ways.

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TABLE OF CONTENTS

Q143S/R144 LINES REBUILD PROJECT

Rhode Island Energy Facility Siting Board

Siting Report

APPENDIX A

Q143S/R144 LINES REBUILD PROJECT

Rhode Island Energy Facility Siting Board

Siting Report

EXPONENT, INC.'S STATUS OF RESEARCH ON EXTREMELY LOW FREQUENCY ELECTRIC AND MAGNETIC FIELDS AND HEALTH, JANUARY 2022 THROUGH APRIL 2024 DATED MARCH 19, 2025

Exponent®

Status of Research on Extremely Low Frequency Electric and Magnetic Fields and Health, January 2022 through April 2024

Status of Research on Extremely Low Frequency Electric and Magnetic Fields and Health, January 2022 through April 2024

Prepared For:

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March 19, 2025

Contents

List of Figures

List of Tables

Limitations

At the request of the Narragansett Electric Company, a subsidiary of PPL Electric Utilities, Exponent prepared a summary report on the status of research related to extremely low frequency electric- and magnetic-field exposure and health. Exponent reserves the right to supplement this report and to expand or modify opinions based on review of additional material as it becomes available, through any additional work, or review of additional work performed by others.

The scope of services performed for this report may not adequately address the needs of other users of this report beyond the permitting of the projects for which it was prepared, and any re-use of this report or its findings, conclusions, or recommendations presented herein are at the sole risk of the user. The findings, opinions and comments formulated during this assessment are based on observations and information available at the time of the report writing and are made to a reasonable degree of scientific certainty. No guarantee or warranty as to future life or performance of any reviewed condition is expressed or implied.

1 Introduction

Questions about electric and magnetic fields (EMF) and health are sometimes raised during the permitting of transmission lines. Numerous national and international scientific and health agencies have reviewed the research and evaluated potential health risks of exposure to extremely low frequency (ELF) EMF, which include the frequencies stemming from the delivery of electricity at 60 Hertz (Hz) in North America (50 Hz in Europe and other countries). A weight-of-evidence review of ELF EMF and health was released in 2015 by the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), in which the Committee did not conclude that the available scientific evidence confirms a causal link between any adverse health effects (including both cancer and non-cancer health outcomes) and EMF exposure. The conclusions of the 2015 SCENIHR report are consistent with those of other agencies that have reviewed the research, most notably the comprehensive review of ELF EMF research published by the World Health Organization (WHO) in 2007, in which the WHO's Task Group critically reviewed the cumulative epidemiologic and laboratory research through 2005. SCENIHR's findings in their 2015 report were also maintained in the organization's 2024 report providing an update on the potential health effects of exposure to electromagnetic fields in the 1 Hz to 100 kHz range (SCHEER, 2024).

The Narragansett Electric Company, a subsidiary of PPL Electric Utilities, requested that Exponent, Inc. (Exponent) provide an easily-referenced guide to the current status of EMF health research that updates a report previously prepared for the Narragansett Electric Company (Exponent, 2022). Exponent (2022) systematically evaluated peer-reviewed research and reviews by scientific panels published through December 2021. This current report extends this earlier report with a systematic evaluation of peer-reviewed research and reviews by scientific panels published from January 2022 through April 2024, and describes if and how these recent results affect conclusions reached by SCENIHR in 2015, the WHO in 2007, and other reviewing agencies.

Nature of extremely low frequency electric and magnetic fields

Electricity is transmitted as current from generating sources to high-voltage transmission lines, substations, distribution lines, and then finally to our homes and workplaces for consumption. The vast majority of electricity in North America is transmitted as alternating current (AC), which changes direction 60 times per second (i.e., a frequency of 60 Hz).

Everything that is connected to our electrical system (i.e., power lines, wiring, appliances, and electronics) produces ELF EMF (*see* Figure 1). Both electric fields and magnetic fields are properties of the space near these electrical sources. Forces are experienced by objects capable of interacting with these fields; electric charges are subject to a force in an electric field created by

voltage differences, and moving charges (e.g., electric current) experience a force in a magnetic field. The strengths of both electric and magnetic fields decline rapidly with distance.

- **Electric fields** are the result of voltage applied to electrical conductors and equipment. The electric field is expressed in measurement units of volts per meter (V/m) or kilovolts per meter (kV/m); 1 kV/m is equal to 1,000 V/m. Grounded conducting objects including fences, buildings, and our own skin and muscle easily block electric fields. Therefore, certain appliances and electronics within homes and workplaces are the major source of electric fields indoors, while transmission and distribution lines are the major source of electric fields outdoors.
    - **Magnetic fields** are produced by the flow of electric currents; however, unlike electric fields, most materials do not readily block magnetic fields. The strength of a magnetic field is expressed as magnetic flux density in units of gauss (G) or milligauss (mG), where 1 G=1,000 mG.[1] The strength of the magnetic field at any point depends on characteristics of the source. In the case of power lines, magnetic-field strength is dependent on the arrangement of conductors, the amount of current flow, and distance from the conductors.

[1] Scientists also refer to magnetic flux density at these levels in units of microtesla. Magnetic flux density in units of mG can be converted to microtesla by dividing by 10 (i.e., 1 mG = 0.1 microtesla).

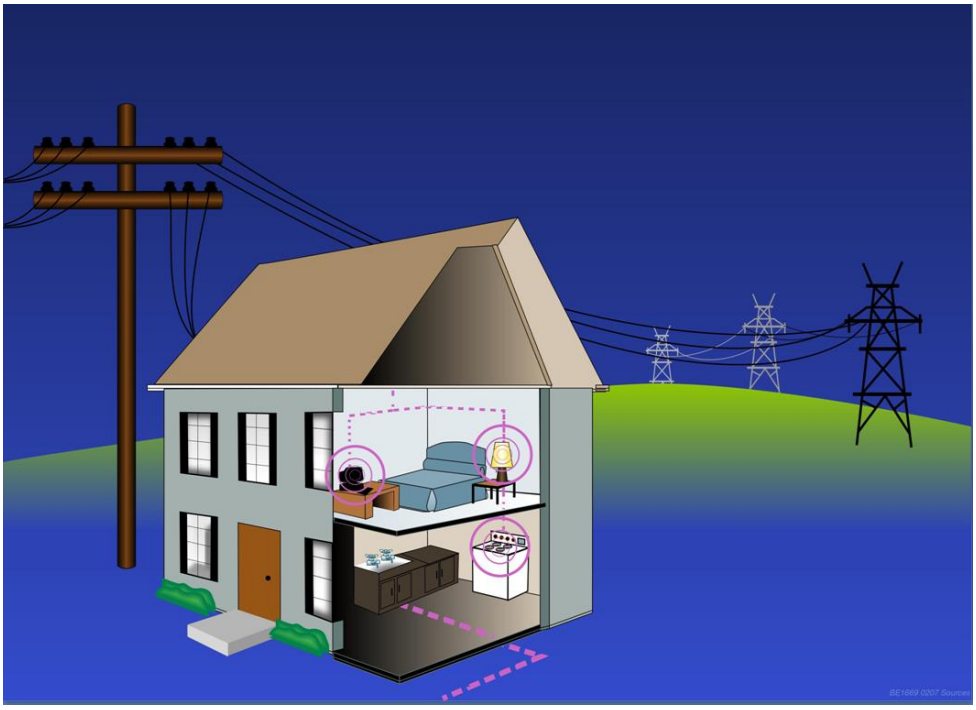

Figure 1. Numerous sources of ELF EMF in our homes (appliances, wiring, currents running on water pipes, and nearby distribution and transmission lines).

Sources and exposure

The intensity of both electric fields and magnetic fields diminishes with increasing distance from the source. Electric fields and magnetic fields from transmission lines generally decrease with distance from the conductors in proportion to the square of the distance, described as creating a bell-shaped curve of field strength around the lines.

Since electricity is such an integral part of our infrastructure and everyday life (e.g., in transportation systems and in homes and businesses), people living in modern communities are surrounded by these fields. Figure 2 describes typical EMF levels measured in residential and occupational environments, compared to levels measured on or at the edge of transmission-line rights-of-way (ROW). While EMF levels decrease with distance from the source, any home, school, or office tends to have a background EMF level as a result of the combined effect of the numerous EMF sources. In general, the background magnetic-field level in a house away from appliances is typically less than 20 mG, while levels can be hundreds of mG in close proximity to appliances. Background levels of electric fields range from 10 V/m to 20 V/m, while appliances produce levels up to several tens of V/m (WHO, 2007a).

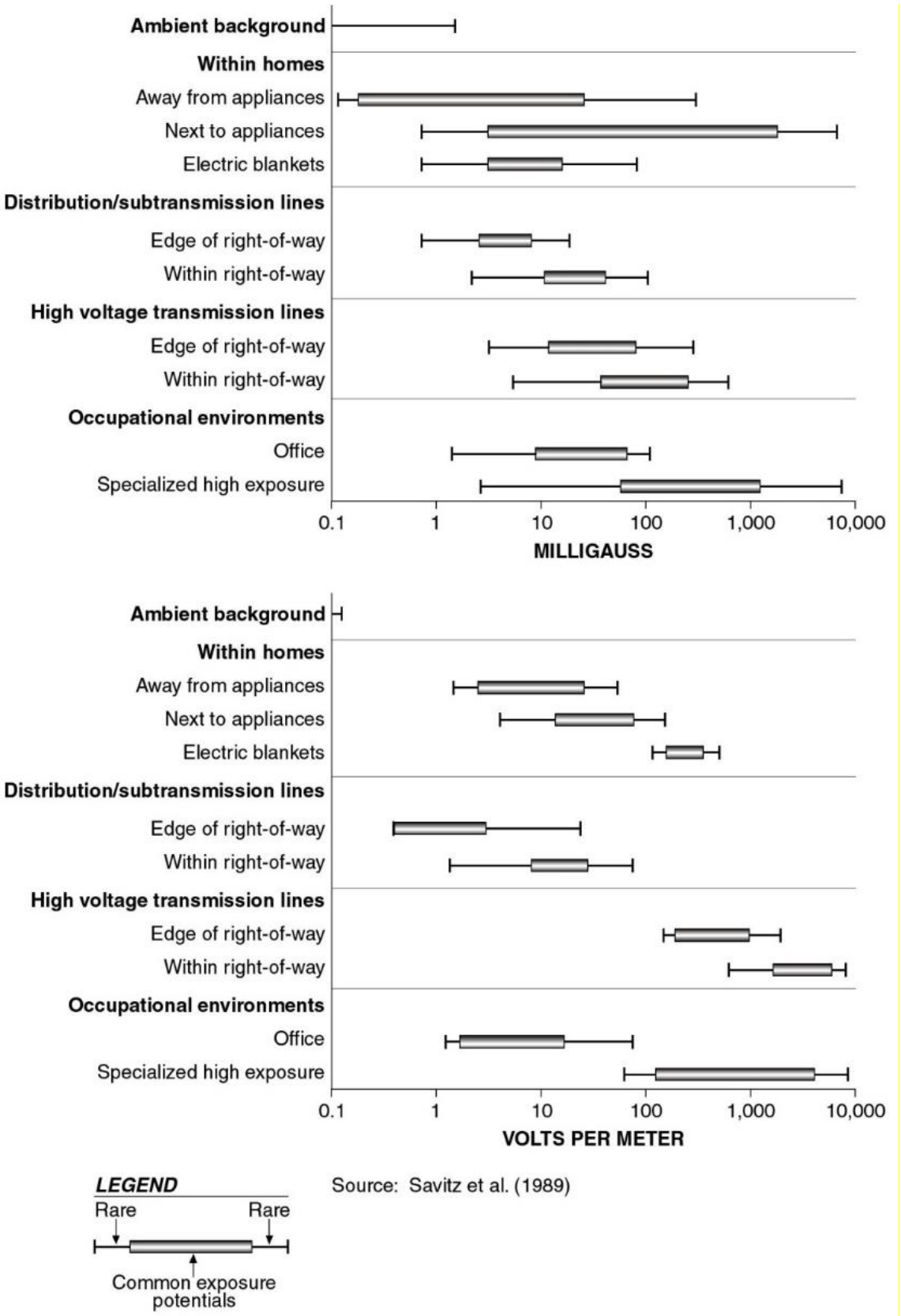

Figure 2. Electric- and magnetic-field strengths in the environment.

Experiments have yet to show which aspect of ELF EMF exposure, if any, may be relevant to biological systems. As short-term ELF EMF exposures are not known to produce adverse effects at common environmental levels and shielding by buildings blocks electric fields from outdoor power lines from entering buildings, little scientific or regulatory attention has been given to assessing public exposure to electric fields. In contrast, exposure and health research has focused on magnetic fields, particularly long-term, average personal exposure, which is the average of all exposures to the varied electrical sources encountered in the many places we live, work, eat, and shop. As expected, this exposure is difficult to approximate, and exposure assessment is a major source of uncertainty in studies of ELF EMF and health (WHO, 2007a).

Considerable research has been done to characterize the general public's exposure to magnetic fields, although some basic conclusions are available from the literature:

- *Personal magnetic-field exposure:*
    - The vast majority of persons in the United States have a time-weighted average (TWA) exposure to magnetic fields of less than 2 mG (Zaffanella and Kalton, 1998).[2]
    - In general, personal magnetic-field exposure is greatest at work and during travel (Zaffanella and Kalton, 1998).
- *Residential magnetic-field exposure:*
    - The highest magnetic-field levels are typically found directly next to appliances (Zaffanella, 1993). For example, Gauger (1985) reported the maximum ELF magnetic field at 3 centimeters from a sampling of appliances as 3,000 mG (can opener); 2,000 mG (hair dryer); 5 mG (electric oven); and 0.7 mG (refrigerator).
    - Several parameters affect the level and distribution of personal magnetic-field exposures at home: residence type, residence size, type of water line, and proximity to overhead power lines. Persons living in small homes, apartments, homes with metal piping, and homes close to three-phase electric power distribution and transmission lines tend to have higher at-home magnetic-field levels (Zaffanella and Kalton, 1998).
    - Residential magnetic-field levels are caused by currents from nearby transmission and distribution systems, pipes or other conductive paths, and electrical appliances (Zaffanella, 1993).
- *Workplace magnetic-field exposure*

[2] TWA is the average exposure to a chemical or physical agent over a specified period (e.g., an 8-hour workday or 24 hours). The average is determined by sampling the exposure of interest throughout the selected period.

- Some occupations (e.g., electric utility workers, welders, telecommunications workers) have higher exposures due to work near equipment with high magnetic-field levels (NIEHS, 2002).

- *Power line magnetic-field exposure*

  - The magnetic-field levels associated with transmission and distribution lines vary substantially depending on their configuration, amount of current flow (load), and distance from conductors, among other parameters. At distances of a few hundred feet from overhead transmission lines and during average electricity demand, the magnetic-field levels from many transmission lines are often similar to the background levels found in most homes, as illustrated in Figure 2 above, and as discussed in a National Institute of Environmental Health Sciences (NIEHS) booklet on EMF (NIEHS, 2002).

Known effects

Similar to virtually any exposure, adverse effects can be expected from exposure to very high levels of ELF EMF. In the presence of an extremely strong electric or magnetic field, stimulation of muscles and nerves is possible (ICNIRP, 2010). Additionally, strong electric fields can induce voltages and currents in nearby objects (e.g., fences, vehicles, buildings, etc.) that can, if contacted by a person under particular conditions, may lead to small shocks (i.e., micro shocks).[3] These acute effects cause no long-term damage or health consequences. Limits for the general public and workplace have been set to prevent these effects, but there are no real-life situations where these levels are exceeded on a regular basis. Standards and guidelines are discussed in more detail in Section 6.

[3] Under some conditions higher voltage transmission lines can induce voltages and currents in nearby objects (e.g., fences, vehicles, buildings, etc.). to produce secondary shocks. Depending on the size and proximity of the object, as well as the strength of the electric field, it is possible for persons to experience small shocks (i.e., micro shocks) or continuous currents. Such micro-shocks are acute effects that cause no long-term damage or health consequences. Adherence to standards for transmission lines in the National Electrical Safety Code (NESC) are designed to prevent stronger shocks or continuous currents.

2 Methods for Evaluating Scientific Research

Science follows a method of obtaining information and of reasoning to ensure that the information and conclusions are accurate and correctly describe physical and biological phenomena. Often misconceptions occur when people casually interpret their observations and experience. Therefore, scientists use systematic methods to conduct and evaluate research and assess the potential impact of a specific agent (e.g., ELF EMF) on human health. This process is designed to ensure that more weight is given to studies of better quality, and to ensure studies with a given result are not selectively chosen from available studies to advocate or suppress a preconceived idea of an adverse effect. Scientists, scientific agencies, and health organizations use these standard methods to draw conclusions about the many exposures in our environment.

Weight-of evidence reviews

The scientific process entails looking at *all* the evidence on a particular issue in a systematic and thorough manner to evaluate if the overall data present a logically coherent and consistent picture. This is often referred to as a weight-of-evidence review in which all studies are considered together, giving more weight to studies of higher quality, and using an established analytic framework to arrive at a conclusion about a possible causal relationship. Weight-of-evidence reviews typically are conducted within the larger framework of health risk assessments or evaluations of particular exposures or exposure circumstances that qualitatively and quantitatively define health risks.

Several agencies have described weight-of-evidence and health risk assessment methods, including the International Agency for Research on Cancer (IARC), which routinely evaluates substances such as drugs, chemicals, and physical agents for their ability to cause cancer; the WHO International Programme for Chemical Safety; the U.S. Environmental Protection Agency (U.S. EPA), which sets guidance for public exposures; SCENIHR for the European Union; and the U.S. National Toxicology Program (NTP) (U.S. EPA, 1993, 1996; World Health Organization (WHO), 1994; SCENIHR, 2012; NTP, 2015a).

Two steps precede a weight-of-evidence evaluation: 1) a systematic review to identify the relevant literature, and 2) an evaluation of each relevant study to determine its strengths and weaknesses. A systematic review is a method to evaluate and synthesize evidence from a large body of scientific research on a topic to reach a conclusion (NTP, 2015b). By virtue of synthesizing insights from a multitude of scientific studies, systematic reviews arrive at a conclusion that is inherently more representative than one from a single study. This comprehensive approach can significantly mitigate the risk of bias or design flaws that might compromise the validity of a conclusion drawn from a solitary study.

The following sections discuss important considerations in the evaluation of human health studies of ELF EMF in a weight-of-evidence review, including exposure considerations, study

design, methods for estimating risk, bias, and the process of causal inference. The purpose of discussing these considerations here is to provide context for the later weight-of-evidence evaluations.

Exposure considerations

Methods to describe ELF EMF exposure vary widely and each have their own strengths and limitations (Kheifets and Oksuzyan, 2008). Methods include:

- Classifying residences based on the relative capacity of nearby power lines to produce magnetic fields (i.e., wire code categories) within selected distances.
- Assessing exposure based on occupational titles.
- Calculating magnetic-field levels based on job histories (i.e., a job-exposure matrix [JEM]).
- Determining distance of residences from nearby power lines.
- Taking spot measurements of magnetic-field levels inside or outside residences.
- Taking 24-hour and 48-hour measurements of magnetic fields in a particular location in a house (e.g., a child's bedroom).
- Calculating magnetic-field levels based on known design features of nearby power lines including line loading.
- Taking personal measurements of magnetic fields for a 24-hour or 48-hour period using a dosimeter.

Magnetic-field exposure is ubiquitous, but it varies for each individual over a lifetime because the locations where people spend time change and the ELF EMF sources at those locations also change. This lack of consistency makes valid estimates of personal magnetic-field exposure challenging. Furthermore, without a biological basis to define a relevant exposure metric (average exposure or peak exposure) and a defined critical period for exposure (e.g., *in utero*, shortly before diagnosis), relevant and valid assessments of exposure are problematic. Exposure misclassification is one of the most significant concerns in studies of ELF EMF.

In general, personal measurements are the metrics valued by epidemiologists because they record exposure from all sources but the sample of exposure covers at most a few days. More studies have estimated long-term exposure at residences from transmission lines from calculations based on the line design, distance to the residence, and historical measure or estimated of current flow on the lines that allows for estimation of long-term exposure in the past. Other methods to estimate exposure are generally weaker because they may not be strong predictors of long-term exposure. ELF EMF can be estimated indirectly by assigning an estimated amount of exposure to an individual based on the distance of the residence from a transmission line. Indirect measures are not as accurate as direct measurements because they do not contain information specific to

that person or the exposure situation For instance using distance from a transmission line to estimate homeowners' ELF EMF exposure would not provide information about the current flow on the line that is the source of the magnetic field or if the line is in service. .

Types of health research studies

Research studies can be broadly classified into three groups: 1) epidemiologic observations of people; 2) experimental laboratory studies of humans and animals (*in vivo*); and 3) experimental laboratory studies of cells and tissues (*in vitro*). Epidemiologic studies investigate how disease is distributed in populations and what factors influence or determine this disease distribution (Gordis, 2000), and attempt to identify potential causes for disease while observing people as they go about their daily lives. Such studies are designed to quantify and evaluate the associations between disease and reported exposures to environmental factors.

The most common types of epidemiologic studies in the ELF EMF literature are case-control and cohort studies. In case-control studies, people with and without the disease of interest are identified and the exposures of interest are evaluated. Often, people are interviewed or their personal records (e.g., medical records or employment records) are reviewed in order to establish the exposure history for each individual. The exposure histories are then compared between the diseased and non-diseased populations to determine whether any statistically significant differences in exposure histories exist. In cohort studies, on the other hand, individuals within a defined cohort of people (e.g., all persons working at a utility company) are classified as exposed or non-exposed and followed over time for the incidence of disease. Researchers then compare disease incidence in the exposed and non-exposed groups.

Experimental studies are designed to test specific hypotheses under controlled conditions and are vital to assess cause-and-effect relationships. An example of a human experimental studies relevant to this area of research would be ones that measure the impact of magnetic-field exposure on acute biological responses in humans, such as hormone levels. These studies are conducted in laboratories under controlled conditions. *In vivo* studies of animals and *in vitro* experimental studies also are conducted under controlled conditions in laboratories. *In vivo* studies expose laboratory animals to very high levels of a chemical or physical agent to determine whether exposed animals develop cancer or other effects at higher rates than unexposed animals, while attempting to control for other factors that could possibly affect disease rates (e.g., diet, genetics). *In vitro* studies of isolated cells and tissues are important because they can help scientists understand biological mechanisms that relate to the same exposure to the whole body of humans and animals. The responses of cells and tissues outside the body, however, may not reflect the response of those same cells if maintained in a living system, so their relevance cannot be assumed. Therefore, it is both necessary and desirable to assess whether a particular agent could cause adverse health effects using both epidemiologic and experimental studies, and both approaches have been used to evaluate whether exposure to ELF EMF has any adverse effects on human health. Epidemiologic studies are valuable because they are conducted in human populations, but they are limited by their non-experimental design.

In epidemiologic studies of magnetic fields, for example, researchers cannot control the amount of individual exposure, how exposure occurs over time, the contribution of different sources, or individual behavior other than factors such as diet that may affect disease risk. In valid risk assessments of ELF EMF, epidemiologic studies are considered alongside experimental studies of laboratory animals, while studies of isolated cells and tissues are generally considered as supplementary data.

Estimating risk

Epidemiologists measure statistical associations between exposures and disease in order to estimate risk. *The calculation of risk in this way does not, by itself, establish that the exposures are the cause of disease.* This brief summary is included to provide a foundation for understanding and interpreting statistical associations in epidemiologic studies as risk estimates.

Two common types of risk estimates are absolute risk and relative risk (RR). Absolute risk, also known as incidence, is the amount of new disease that occurs in a given period. For example, the absolute risk of childhood leukemia in children 0 to 19 years of age for 2021 was 4.8 per 100,000 children (NCI, 2024). An RR evaluates whether a particular exposure or inherent quality (e.g., genetics) is associated with a disease outcome and is calculated by looking at the absolute risk in one group relative to a comparison group. For example, “Non-Hispanic White” children 0 to 19 years of age had an estimated absolute risk of childhood cancer of 4.2 per 100,000 in 2021, and “Non-Hispanic Black” children in the same age range had an estimated age-adjusted absolute risk of 3.0 per 100,000 in the same year. By dividing the absolute risk of “Non-Hispanic White” children by the absolute risk of “Non-Hispanic Black” children, we obtain an RR of 1.40. This RR estimate can be interpreted to mean that white children have a risk of childhood cancer that is 40% greater than the risk of “Non-Hispanic Black” children . This RR estimate can be interpreted to mean that white children have a risk of childhood cancer that is 40% greater than the risk of “Non-Hispanic Black” children (NCI, 2024). Additional statistical analysis is needed to evaluate whether this association is statistically significant, as defined in the following sub-section.

Traditional cohort studies provide direct estimates of RR, and usually provide reliable estimates of the risk associated with a particular exposure.

Another type of epidemiology study is the case-control study. Whereas a cohort study follows a group of exposed and unexposed people to see who develops a health outcome, case-control studies start with people who either have a disease or not and evaluate who was exposed or unexposed. Case-control studies are more common than cohort studies, because they are less costly and more time efficient. Such case control studies are less reliable because they prone to biases such as recall bias which can distort the association between an exposure and health outcome.

Thus, the association between a particular disease and exposure is measured quantitatively in an epidemiologic study as either the RR (cohort studies) or OR (case-control studies) estimate. The general interpretation of a risk estimate equal to 1.0 is that the exposure is not associated with an increased incidence of the disease. If the risk estimate is greater than 1.0, the inference is that the exposure is associated with an increased incidence of the disease. On the other hand, if the risk estimate is less than 1.0, the inference is that the exposure is associated with a reduced incidence of the disease. The magnitude of the risk estimate is often referred to as its strength (i.e., strong versus weak). Stronger associations are given more weight because they are less susceptible to the effects of bias.

Statistical significance

Statistical significance testing provides an idea of whether or not a statistical association is a chance occurrence or whether the association is likely to be observed upon repeated testing. The term statistically significant is used in epidemiologic studies to describe the tendency of the level of exposure and the occurrence of disease to be linked, with chance as an unlikely explanation. Statistically significant associations, however, are not necessarily an indication of cause-and-effect because the interpretation of statistically significant associations depends on many other factors associated with the design and conduct of the study, including how the data were collected and the number of study participants.

Confidence intervals (CI), reported along with RR and OR values, indicate a range of values for an estimate of effect that has a specified probability (e.g., 95%) of including the true estimated effect. CIs evaluate statistical significance, but do not address the role of bias, described further below. A 95% CI indicates that if the study was conducted a very large number of times, 95% of the measured estimates would be within the upper and lower confidence limits.

The CI range is also important for interpreting estimated associations, including the precision and statistical significance of the association. A very wide CI indicates great uncertainty in the value of the true risk estimate. This is usually due to a small number of observations. A narrow CI provides more certainty about the true RR estimate. If the 95% CI does not include 1.0, the probability that an association is due to chance alone is 5% or lower, and the result is considered statistically significant, as discussed above.

Meta-analysis and pooled analysis

In scientific research, the results of smaller studies may be difficult to distinguish from normal, random variation. This is especially the case for sub-group analyses where few cases are estimated to have high exposure levels (e.g., in case-control studies of childhood leukemia and TWA magnetic-field exposure greater than 3 to 4 mG). Meta-analysis is an analytic technique that combines the published results from a group of studies into one summary result. A pooled analysis, on the other hand, combines the raw, individual-level data from the original studies and analyzes the data from the studies altogether. These methods are valuable because they increase

the number of individuals in the analysis, which allows for a more robust and stable estimate of association. Meta- and pooled analyses are important tools for qualitatively synthesizing the results of a large group of studies.

The disadvantage of meta- and pooled analyses is that they can convey a false sense of consistency across studies if *only* the combined estimate of effect is considered (Rothman and Greenland, 1998). These analyses typically combine data from studies with different study populations, methods for measuring and defining exposure, and disease definitions. This is particularly true for analyses that combine data from case-control studies, which often use very different methods for the selection of cases and controls and exposure assessment (Linet et al., 2003). Therefore, meta- and pooled analyses are used not only to synthesize or combine data, but also to understand which factors cause the results of the studies to vary (i.e., publication date, study design, possibility of selection bias), and how these factors affect the associations calculated from the data of all the studies combined (Rothman and Greenland, 1998).

Meta- and pooled analyses are a valuable technique in epidemiology; however, in addition to calculating a summary RR, they should follow standard techniques (Stroup et al., 2001) and analyze the factors that contribute to any heterogeneity between the studies.

Bias in epidemiologic studies

One key reason that the results of epidemiologic studies cannot directly provide evidence for cause-and-effect is the presence of bias. Bias is defined as "*any systematic error in the design, conduct or analysis of a study that results in a mistaken estimate of an exposure's effect on the risk of disease*" (Gordis, 2000, p. 204). In other words, sources of bias are factors or research situations that can mask a true association or cause an association that does not truly exist. As a result, the extent of bias, as well as its types and sources, is one of the most important considerations in the interpretation of epidemiologic studies. Since it is not possible to fully control human populations, perfectly measure their exposures, or control for the effects of all other risk factors, bias will exist in some form in all epidemiologic studies of human health. Laboratory studies, on the other hand, more effectively manage bias because of the tight control the researchers have over most study variables.

One important source of bias occurs in epidemiologic studies when a third variable confuses the relationship between the exposure and disease of interest because of its relationship to both. Consider an example of a researcher whose study finds that people who exercise have a lower risk of diabetes compared to people who do not exercise. It is known that people who exercise more also tend to consume healthier diets and healthier diets may lower the risk of diabetes. If the researcher has not controlled for the impact of diet, it is not possible to say with certainty that the lower risk of diabetes is due to exercise and not to a healthier diet. In this example, diet is called a confounding variable.

Cause versus association and evaluating evidence regarding causal associations

Epidemiologic studies can help suggest factors that may contribute to the risk of disease, but they are not used as the sole basis for drawing inferences about cause-and-effect relationships. Since epidemiologists do not have control over the many other factors to which people in their studies are exposed, and diseases can be caused by a complex interaction of many factors, the results of epidemiologic studies must be interpreted with caution. A single epidemiologic study is rarely unequivocally supportive or non-supportive of causation; rather, a weight is assigned to the study based on the validity of its methods and all relevant studies (epidemiology, *in vivo*, and *in vitro*) must be considered together in a weight-of-evidence review to arrive at a conclusion about possible causality between an exposure and disease.

In 1964, the U.S. Surgeon General published a landmark report on smoking-related diseases (HEW, 1964). As part of this report, the Surgeon General outlined nine criteria for evaluating epidemiologic studies (along with experimental data) for causality. In a more recent edition of this report, these criteria have been reorganized into seven criteria (HHS, 2004). Table 1 provides a list and brief description of each criterion.

Table 1. Criteria for evaluating whether an association is causal (HHS, 2004)

Criteria	Description
Consistency	Repeated observation of an association between exposure and disease in multiple studies of adequate statistical power, in different populations, and at different times.
Strength of the association	The larger (stronger) the magnitude and statistical strength of an association between exposure and disease, the less likely such an effect is the result of chance or unmeasured confounding.
Specificity	The exposure is the single cause or one of a few causes of disease.
Temporality	The exposure occurs prior to the onset of disease.
Coherence, plausibility, and analogy	The association cannot violate known scientific principles and the association must be consistent with experimentally demonstrated biologic mechanisms.
Biologic gradient	The observation that the stronger or greater the exposure, the stronger or greater the effect, also known as a dose-response relationship.
Experiment	Observations that result from situations in which natural conditions imitate experimental conditions. Also stated as a change in disease outcome in response to a non-experimental change in exposure patterns in populations.

These criteria were meant to be applied to statistically significant associations observed in the

cumulative epidemiologic literature (i.e., if no statistically significant association is observed for an exposure, then the criteria are not relevant). It is important to note that these criteria were not intended to serve as a checklist, but as guide to evaluate associations for causal inference. Theoretically, it is possible for an exposure to meet all seven criteria, but still not be deemed a causal factor. Also, no one criterion can provide indisputable evidence for causation, nor can any single criterion, except for temporality, rule out causation.

In summary, the judicious consideration of these criteria is useful in evaluating epidemiologic studies, but they cannot be used as the sole basis for drawing inferences about cause-and-effect relationships. In line with the criteria of coherence, plausibility, and analogy, epidemiologic studies are considered along with *in vivo* and *in vitro* studies in a comprehensive weight-of-evidence review. Epidemiologic support for causality is usually based on high-quality studies that report consistent results across many different populations and study designs and are supported by experimental data collected from *in vivo* and *in vitro* studies.

Biological response versus disease in human health

When interpreting research studies, it is important to distinguish between a reported biological response and an indicator of disease. This is relevant because exposure to ELF EMF may elicit a biological response that is simply a normal response to environmental conditions. This response, however, may not be a disease, cause a disease, or be otherwise harmful. There are many exposures or factors encountered in day-to-day life that elicit a biological response, but the response is neither harmful nor the cause of disease. For example, as a person walks from a dark room indoors to a sunny day outdoors, the pupils of the eye naturally constrict to limit the amount of light passing into the eye. This constriction of the pupil is a biological response to the change in light conditions. Pupil constriction, however, is neither a disease itself, nor is it known to cause disease.

3 Agency Reviews of ELF EMF and Health

Over the past several decades, a number of national and international scientific and health organizations have published reports or scientific statements with regard to the possible health effects of ELF EMF. These organizations assemble panels of experts with the knowledge and mandate to review relevant research and provide scientifically-grounded public health recommendations. Organizations that have reviewed the research on ELF EMF and health include those listed in Table 2. Overall, the conclusions of these agencies' reviews have been fairly consistent. After more than 45 years of research that includes thousands of peer-reviewed, scientific studies, none of these agencies has concluded that long-term exposure to ELF EMF at the levels commonly encountered in our environment is a confirmed cause of any adverse health effect. The reviews published by some of these agencies are further discussed below. Conclusions from recent agency reviews related to specific health outcomes, including child and adult cancers, are summarized in the relevant sub-sections of Section 4.

Table 2. Health and scientific agencies that conducted reviews of the ELF EMF scientific literature

Scientific Organization	Sponsor	Publication Dates
Federal-Provincial-Territorial Radiation Protection Committee (FPTRPC)	Canada	1998, 2005
International Commission on Non-Ionizing Radiation Protection (ICNIRP)	n/a (International Chartered non-profit)	1998, 2003, 2010, 2020
NIEHS	United States	1998, 1999
IARC	United Nations	2002
National Radiological Protection Board (NRPB)	United Kingdom	2004
Swedish Radiation Protection Authority (SSI) / Swedish Radiation Safety Authority (SSM)*	Sweden	2005, 2006, 2007, 2008, 2009, 2010, 2013, 2014, 2015, 2016, 2018, 2019, 2020, 2021, 2022, 2024a, 2024b
WHO	United Nations	2007
SCENIHR / Scientific Committee on Health, Environmental and Emerging Risks (SCHEER)†	European Commission	2007, 2009, 2015, 2024
Health Council of the Netherlands (HCN)	The Netherlands	2009, 2022a, 2022b
The European Health Risk Assessment Network on Electromagnetic Fields (EFHRAN)	European Commission	2010, 2012

*The SSI was renamed in 2008.
†SCENIHR was renamed SCHEER in 2016.

Although not included in Table 2 above, the recent *Report on Carcinogens* from the NTP did not list ELF EMF as either "*Known To Be Human Carcinogens*" or "*Reasonably Anticipated To Be Human Carcinogens*" (NTP, 2021).

International Agency for Research on Cancer

As an agency of the WHO, IARC routinely assembles international working groups of experts to critically and systematically review and evaluate human, animal, and mechanistic evidence on the carcinogenicity of various human exposures as the first step (hazard identification) in a carcinogen risk assessment (IARC, 2019). These evaluations are published as IARC Monographs. Monograph 80 reviewed non-ionizing ELF EMF (IARC, 2002).

IARC uses specific categories to classify the overall evaluation of carcinogenicity of an agent to humans (Figure 1). Categories include (from highest to lowest risk): *carcinogenic to humans* (Group 1); *probably carcinogenic to humans* (Group 2A); *possibly carcinogenic to humans* (Group 2B); and *not classifiable as to its carcinogenicity to humans* (Group 3). These categories are intentionally meant to err on the side of caution, giving more weight to the possibility that the exposure is truly carcinogenic and less weight to the possibility that the exposure is not carcinogenic. As of March 2025, IARC has reviewed more than 1,000 substances and exposure circumstances to evaluate their potential carcinogenicity; eighty percent of substances and exposures fall in the categories of possible carcinogen (31%) or not classifiable (48%). Throughout the history of the IARC, only one agent has been classified as probably not a carcinogen, which illustrates the conservatism of the evaluations and the difficulty in proving the absence of an effect beyond all doubt.[4]

[4] Note that in 2019, IARC removed the category *Probably not a Carcinogen* (Group 4), as only one chemical (caprolactam) had ever been assigned to that category; this chemical was re-categorized into Group 3 (IARC, 2019).

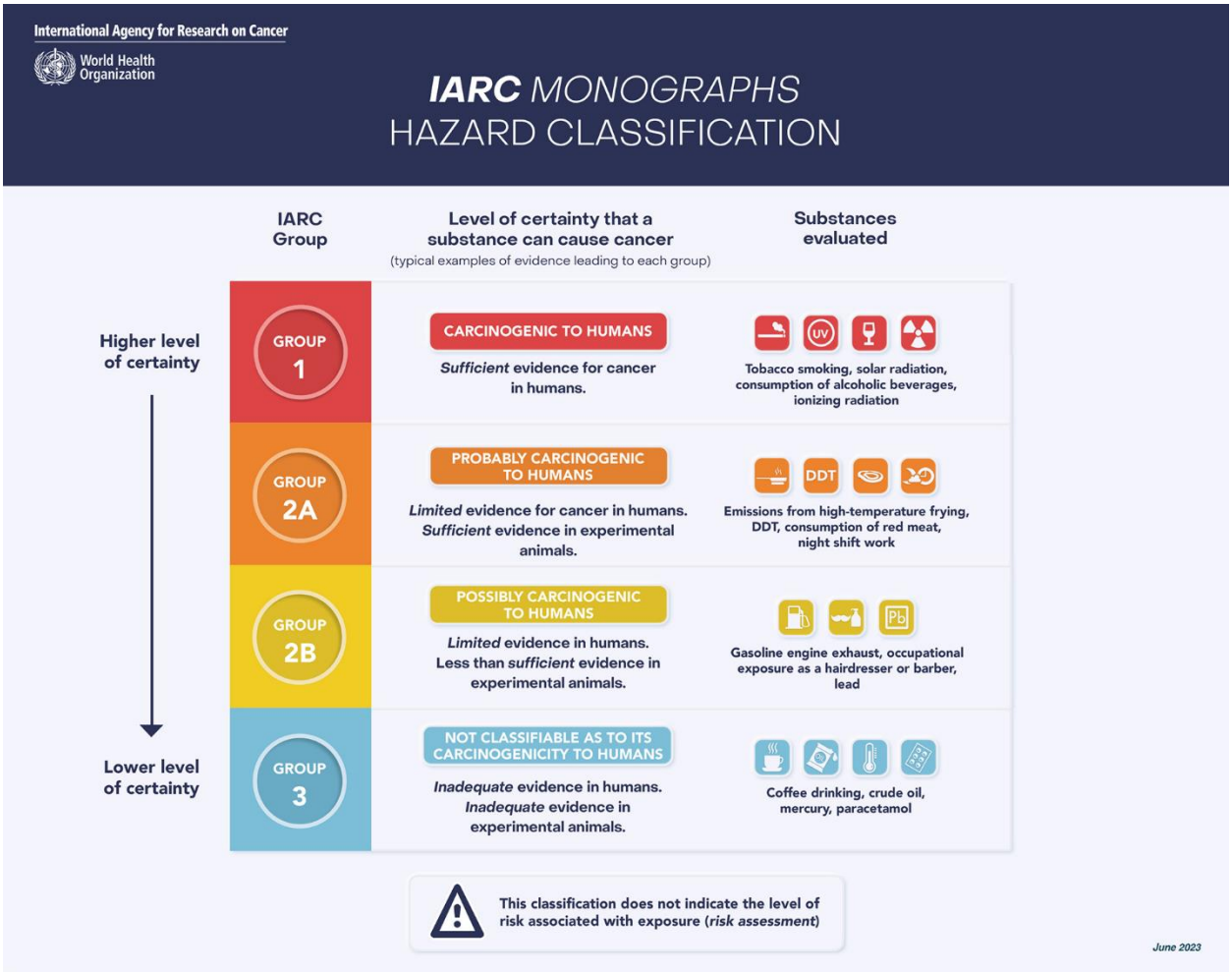

Figure 3. IARC Monographs Hazard Classification Chart.

(Source: IARC, 2023)[5] Not shown in Group 1 on the infographic are processed meats for which "An analysis of data from 10 studies estimated that every 50 gram portion of processed meat eaten daily increases the risk of colorectal cancer by about 18%."

After reviewing the scientific literature on ELF magnetic fields, IARC classified ELF magnetic fields as *possibly carcinogenic to humans (Group 2B)* (IARC, 2002). In the IARC classification system, a possible carcinogen denotes exposures for which there is limited evidence of carcinogenicity in studies of humans[6] and inadequate evidence of carcinogenicity in studies of

[5] WHO infographic available at https://www.iarc.who.int/infographics/iarc-monographs-classification/. Last updated June 16, 2023. Questions and answers on Cancer: Carcinogenicity of the consumption of red meat and processed meat. October 26, 2015. https://www.who.int/news-room/questions-and-answers/item/cancer-carcinogenicity-of-the-consumption-of-red-meat-and-processed-meat. Accessed March 19, 2025.

[6] *Limited evidence of carcinogenicity* from studies of humans describes a body of research where "A causal interpretation of the positive association observed in the body of evidence on exposure to the agent and cancer is credible, but chance, bias, or confounding could not be ruled out with reasonable confidence" (IARC, 2019, p. 31).

experimental animals[7]. For ELF magnetic fields, IARC concluded that there was *"limited evidence in humans for the carcinogenicity of extremely low frequency magnetic fields in relation to childhood leukaemia"* (IARC, 2002, p. 338). This classification was largely based on an association between childhood leukemia and a TWA magnetic-field exposure greater than 3 to 4 mG reported in two pooled analyses of epidemiologic studies (Ahlbom et al., 2000; Greenland et al., 2000). IARC further concluded that there was *"inadequate evidence in humans for the carcinogenicity of extremely low frequency magnetic fields in relation to all other cancers"* and *"inadequate evidence in experimental animals for the carcinogenicity of extremely low-frequency magnetic fields"* (IARC, 2002, p. 338). After reviewing the scientific literature on ELF electric fields, IARC classified ELF electric fields as "*not classifiable as to their carcinogenicity to humans (Group 3)"* (IARC, 2002, p. 338).

In March 2024, an Advisory Group of independent scientists assembled by IARC from 22 different countries met to recommend priorities for evaluations of carcinogenicity by the IARC *Monographs* program during the years from 2025 to 2029. The goal of the Advisory Group is to "ensure that the agents evaluated in the *Monographs* are selected on the basis of the latest scientific evidence relevant to carcinogenicity" (Berrington de Gonzalez et al., 2024, p. 1). In drawing their conclusions and developing their priority recommendations, the Advisory Group reviewed the evidence for each agent, regarding human exposure, cancer in humans, cancer in experimental animals, and carcinogen mechanisms. The IARC Advisory Group determined that for ELF magnetic fields, *"[e]xisting evidence does not appear to support a change in classification [of possibly carcinogenic to humans]"* (Berrington de Gonzalez et al., 2024, p. 2).

World Health Organization

The most comprehensive assessment of EMF was conducted by the WHO and published in June 2007 as their *Environmental Health Criteria (EHC) Monograph 238* (WHO, 2007a). The Task Group responsible for the report's overall conclusions consisted of 21 scientists from around the world with expertise in a wide range of scientific disciplines. Their review was conducted using standard scientific procedures, as outlined in its Preamble and described above in Section 2, and relied on the conclusions of previous reviews, where possible. The Task Group critically reviewed the cumulative epidemiologic and laboratory research through 2005, taking into account the strength and quality of the individual research studies, and mainly focused on evaluating studies published after the 2002 IARC review of ELF EMF and cancer. In their 2007 report, the WHO used the same terminology as IARC to describe the strength of evidence in support of causality between specific agents and cancer.

The WHO 2007a report provided the following overall conclusions:

[7] *Inadequate evidence of carcinogenicity* from studies in experimental animals describes a body of research in which "studies cannot be interpreted as showing either the presence or the absence of a carcinogenic effect because of major qualitative or quantitative limitations, or no data are available on cancer in experimental animals" (IARC, 2019, p. 33).

> *New human, animal, and in vitro studies published since the 2002 IARC Monograph, 2002 [sic] do not change the overall classification of ELF as a possible human carcinogen* (WHO, 2007a, p. 347).
>
> *Acute biological effects [i.e., short-term, transient health effects such as a small shock] have been established for exposure to ELF electric and magnetic fields 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 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, p. 355).

The current guidance from the WHO on its website states:

> *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 [WHO 2007a report], 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 … Science cannot provide a guarantee of absolute safety yet but the development of research is reassuring overall* (WHO, 2016).

Scientific Committee on Health, Environmental and Emerging Risks

The most recent weight-of-evidence review of EMF and health was released in 2024 by SCHEER. The Committee consists of independent scientific experts assembled to provide advice on public health and risk assessments to the Department of Health and Consumer Protection of the European Commission. The Committee addresses questions related to emerging or newly identified health and environmental risks and on broad, complex, or multidisciplinary issues requiring a comprehensive assessment of risks to consumer safety or public health. The 2024 report on the potential health effects of exposure to EMF serves as an update to the previous reviews published in 2015 (SCENIHR, 2015) and 2009 (SCENIHR, 2009). In performing its assessment of the literature, the Committee followed the scientific guidelines it had developed for the assessment of the quality and weight of the evidence of human health risks (SCENIHR, 2012; SCHEER, 2018).

The conclusions of the 2024 SCHEER review are consistent with earlier comprehensive reviews, including the previous 2015 SCENIHR report and the WHO 2007 review discussed above. SCHEER (2024) concluded that the available scientific evidence did not support a causal link between EMF exposure and any adverse health effects (including both cancer and non-cancer health outcomes). SCHEER's conclusions regarding the specific health outcomes reviewed in this report are summarized in the relevant subsections within Section 4 (*Current Scientific Consensus*). In addition to these outcomes, SCHEER (2024) also left unchanged the previous conclusions of the 2015 SCENIHR report that "*there was no convincing evidence for a causal relationship between ELF-MF exposure and self-reported symptoms*" (SCHEER, 2024, p. 2).

4 Current Scientific Consensus

The following sections identify and describe epidemiologic studies related to ELF EMF and health published between January 2022 and April 2024 in the research areas that have received the most attention—cancer, reproductive and developmental effects, neurodegenerative diseases, and cardiovascular disease. A summary of the conclusions of recent *in vivo* studies of carcinogenesis is also included. To provide additional context, the summaries for each health endpoint include an overall assessment of the research findings to-date and the conclusions of the most recent reports published by the scientific and health agencies listed in Section 3. Exponent summarized the epidemiolocal research through December 2021 in a previous report (Exponent, 2022), which includes more information on the earlier body of research.

A structured literature search was conducted using PubMed, a search engine provided by the National Library of Medicine and the National Institutes of Health that includes over 33 million up-to-date citations from MEDLINE and other life science journals for biomedical articles (http://www.pubmed.gov). A well-defined search strategy was used to identify English language literature indexed between January 2022 and April 2024.[8] All fields (e.g., title, abstract, keywords) were searched with various search strings that referenced the exposure and disease of interest.[9] A researcher with experience in this area reviewed the titles and abstracts of these publications for inclusion in this evaluation. The following specific inclusion criteria were applied:

1. **Outcome**. Epidemiologic studies evaluated cancer; reproductive or developmental effects; neurodegenerative diseases; or cardiovascular disease; *in vivo* studies evaluated carcinogenicity. Research on other outcomes was not included (e.g., psychological effects, behavioral effects, hypersensitivity).
2. **Exposure**. Studies evaluated ELF EMF at a frequency of 50 or 60-Hz.
3. **Exposure assessment methods**. Studies evaluated exposure beyond self-report of an activity or occupation, and estimated exposure through various methods including calculated EMF levels using distance from power lines, measured TWA exposure, and average exposure estimated from JEMs.
4. **Study design**. Study design included epidemiologic studies, meta-analyses, pooled analyses, human experimental studies, and *in vivo* studies of carcinogenicity. The review relies on the conclusions of the WHO with regard to *in vivo* studies in the areas of reproduction, development, neurology, and cardiology. Further, this report relies on the conclusions of the

[8] Since the literature search was performed in early May 2024, and there is sometimes a delay between the publication date of a study and the date it is indexed in PubMed, it is possible that some relevant studies published in or prior to April 2024 were not included in this update.

[9] EMF OR magnetic fields OR electric fields OR electromagnetic OR power frequency OR transmission line AND cancer (cancer OR leukemia OR lymphoma OR carcinogenesis) OR neurodegenerative disease (neurodegenerative disease OR Alzheimer's disease OR amyotrophic lateral sclerosis OR Lou Gehrig's disease) OR cardiovascular effects (cardiovascular OR heart rate) OR reproductive outcomes (miscarriage OR reproduction OR developmental effects).

WHO 2007 report (WHO, 2007a) regarding mechanistic data from *in vitro* studies since this field of study is less informative to the risk assessment process (IARC, 2002).

5. **Peer-review**. The study must have been peer-reviewed and published. Therefore, no conference proceedings, abstracts, or non-peer reviewed on-line materials were included.

Epidemiologic studies are evaluated below by outcome (childhood cancer; adult cancer; reproductive or developmental effects; neurodegenerative disease; and cardiovascular effects), followed by an evaluation of *in vivo* research on carcinogenesis.

Childhood health outcomes

Childhood leukemia

Overall Assessment

Childhood leukemia is the most prevalent form of cancer in children. Because of the statistical association between distance to power lines and line configuration e.g., Wertheimer and Leeper, 1979; Ahlbom et al., 2000; Greenland et al., 2000) summarized studies of measured and calculated magnetic fields and reported statistically significant association of childhood leukemia with estimated exposure above 3 or 4 mG. The strength of associations with estimated exposure has diminished over time with the publication of larger and higher quality studies. In particular, research in the past decade through April 2024 provides little new evidence for an association. The conclusion of the WHO (2007a) and other reviewing agencies has been that the scientific evidence does not confirm the existence of adverse health effects at exposures below scientifically established guideline values remains valid. The association between childhood leukemia and magnetic fields observed in the earlier studies remains unexplained and is unsupported by experimental *in vivo* studies.

Recent Conclusions of Agency Reviews

In their 2015 report, SCENIHR concluded that the epidemiologic data on childhood leukemia and EMF exposure reviewed for the report "*are consistent with earlier findings of an increased risk of childhood leukaemia with estimated daily average exposures above 0.3 to 0.4 μT [microtesla] [i.e., 3 to 4 mG]*" and noted that "*no mechanisms have been identified and no support is existing [sic] from experimental studies that could explain these findings, which, together with shortcomings of the epidemiological studies prevent a causal interpretation*" (SCENIHR, 2015, p. 164). In their 2024 report, SCHEER concluded that "*overall, there is weak evidence concerning the association of ELF-MF [magnetic field] exposure with childhood leukaemia*" (SCHEER, 2024, p. 9).

In their most recent review of the research, SSM concluded, "*[n]o new established causal relationships between EMF exposure and health risk have been identified. The studies presented in this report do not resolve whether the consistently observed association between ELF*

magnetic field (ELF-MF) exposure and childhood leukaemia in epidemiology is causal or not" (SSM, 2024b, p. 7).

In 2020, ICNIRP published a review of the research related to potential health effects of EMF exposure; the Commission's objective was to identify any data gaps in the body of literature on which they based their exposure guidelines (see Section 6) (ICNIRP, 2020a, 2020b). Regarding the research on childhood leukemia, ICNIRP did not recommend further epidemiologic studies on this topic, noting that any additional studies would be *"unlikely to advance the knowledge, as they will potentially be affected by the same types of biases as existing studies"* (ICNIRP, 2020a, p. 535). ICNIRP did recommend *"[f]urther studies on mechanisms and biological data from childhood leukemia experimental models"* while also stating, *"there is no support from animal experiments and there are no mechanistic data that can provide an explanation for any effect on biological structures at the exposure levels that have been identified in epidemiological studies"* (ICNIRP, 2020a, p. 536). The lack of evidence of a plausible biological mechanism between magnetic-field exposure and childhood leukemia development has been noted in other recent publications (e.g., Habash et al., 2019) and is discussed in the sub-section on *in vivo* studies related to carcinogenesis.

Summary of Childhood Leukemia Research (January 2022 – April 2024)

Amoon et al. (2022) prepared a pooled analysis of four studies of residential exposure to magnetic fields and childhood leukemia published following a 2010 pooled analysis by Kheifets et al. (2010a). The study by Amoon et al. (2022) compared the exposures of 24,994 children with leukemia to the exposures of 30,769 controls without leukemia in California, Denmark, Italy, and the United Kingdom. Exposure was assessed using residential measured or calculated magnetic fields. The exposure of these two groups to magnetic fields were found not to significantly differ. A decrease in the combined effect estimates in epidemiologic studies was observed over time, and the authors concluded that their findings, based on the most recent studies, "*do not rule out bias or confounding*" as possible explanations for the association and "*support conclusions of [the WHO and SCENIHR] that recent studies on magnetic fields and childhood leukaemia do not alter the previous assessment that magnetic fields are possibly carcinogenic to humans*" (Amoon et al., 2022, p. 1134).

Brabant et al. (2023) conducted a literature review and meta-analysis of studies of childhood leukemia and magnetic-field exposure that included 21 epidemiologic studies published from 1979 to 2020 in the overall analysis. The authors reported a statistically significant association, which they noted was "mainly explained by the studies conducted before 2000" (Brabant et al., 2023, p. 1). The authors reported a statistically significant association between childhood leukemia and measured or calculated magnetic-field exposures > 0.4 microtesla (μT) (> 4 mG); no statistically significant overall associations were reported between childhood leukemia and lower magnetic-field exposures (< 0.4 μT [< 4 mG]), or other surrogates for magnetic field exposure, including residential distance from power lines, or wire coding configuration. An association between childhood leukemia and electric blanket use was also reported. The overall

results were likely influenced by the inclusion of a large number of earlier studies; 10 of the 21 studies in the main analysis were published prior to 2000. Of the studies published prior to 2000, fewer studies were deemed to be of higher study quality, as determined by the authors, compared to studies published after 2000.

Crespi et al. (2024) evaluated the association between residential proximity to electricity transformers in multi-story residential buildings and childhood leukemia development in the international Transformer Exposure (TransExpo) study. Participants were required to live in an apartment building that contained a built-in transformer; exposure was estimated using the participants' apartment location relative to the transformer and categorized as high (located above or adjacent to the transformer), intermediate (located on the same floor as apartments in the high category), or unexposed (all other apartments). A registry-based pooled analysis with five countries' data included a total of 74 cases and 20,443 controls; 18 of the 74 cases were identified as intermediate or highly exposed. No significant associations were reported between proximity to residential transformers and childhood leukemia. Sensitivity analyses performed using the data from one of the five countries included (Finland), where a cohort study design was used, also reported no significant associations. The authors concluded that the evidence for an elevated risk of childhood leukemia from proximity to residential transformers was "*weak*."

Duarte-Rodríguez et al. (2024) conducted a population-based case-control study to examine the geographical distribution of childhood acute lymphoblastic leukemia (ALL) cases in Mexico City, Mexico. Cases and controls were recruited from public hospitals and matched by age and healthcare institution. Cases and controls were geolocated using the most recent residential address, and a spatial scan statistic was used to detect spatial clusters of cancer cases. The authors identified eight spatial clusters of cases, representing nearly 40% of all cases included in the study (n=1,054 cases). The accuracy and validity of this method for identifying clusters for a multifactorial disease were not evaluated by the authors. Furthermore, the size of some of these spatial cluster exceed 20 kilometers. The scales of these clusters are not informative to understand associations between local ELF EMF exposure and human health. The authors noted that six of the eight spatial clusters were located in proximity to high-voltage electric lines and high-voltage electric installations (distances not specified), and that the remaining two clusters were located near former petrochemical industrial facility sites. Since the study did not directly assess magnetic-field exposures and made no conclusions about magnetic-field exposure and cancer development, this study adds little value to the existing literature regarding a potential association between exposure to ELF EMF and childhood leukemia development.

Guo et al. (2023) reported conducting a systematic review and meta-analysis of studies published from 2015 to 2022 that evaluated associations between magnetic-field exposure and childhood leukemia development. Three meta-analyses were conducted to evaluate the relationship using different exposure metrics. In the first meta-analysis, magnetic-field levels ranging from 0.4 μT [4 mG] to 0.2 μT [2 mG] were associated with a statistically significant reduced risk of childhood leukemia development (i.e., a protective association). In the second analysis, exposure was based on wiring configuration codes, and the reported pooled relative risks estimates

demonstrated a statistically significant association with childhood leukemia. In the third meta-analysis, exposure was categorized into groupings of magnetic-field strength; no statistically significant associations with childhood leukemia were reported for any of the groupings, including for magnetic-field levels ≥ 0.4 μT [≥ 4 mG]. There are significant limitations of this study which prevent meaningful interpretations of the results. Most of the analyses of magnetic fields did not state whether measurements and calculations were included, and the authors provided no description of the methods used for their analyses nor any data tables to support their findings or even references to the number and type of studies included. In fact much of the article's introduction discusses ionization radiation, entirely unrelated to ELF EMF. The authors also did not report relevant metrics for evaluating meta-analyses such as study heterogeneity.

Malagoli et al. (2023) evaluated associations between exposure to magnetic fields from high-voltage power lines (≥ 132 kV) and childhood leukemia development in a case-control study of children in Italy. The study included 182 cases diagnosed with childhood leukemia between 1998 and 2019 and 726 controls matched based on age, sex, and Italian province. The authors assessed magnetic-field exposures by calculating the distance from each participant's residence to the nearest high-voltage power line and classifying that distance into one of three exposed categories (participants living < 100 meters, 100 to < 200 meters, or 200 to < 400 meters from the lines) or as unexposed (participants living ≥ 400 meters from the lines). The authors reported a non-statistically significant association between childhood leukemia and a residence distance of < 100 meters; no statistically significant associations were reported for any distance, including when stratified by age (< 5 or ≥ 5 years) or restricted to one subtype of leukemia, ALL.

Malavolti et al. (2024) examined the association between magnetic-field exposures from transformer stations and childhood leukemia in the same Italian study population as Malagoli et al. (2023). Magnetic-field exposures were estimated based on residential distance to the nearest transformer station, and participants were then categorized as exposed or unexposed using two different distance cut-points: 15 or 25 meters (i.e., exposed: residing within a radius of 15 or 25 meters from the transformer station; unexposed: residing ≥ 15 meters or exposed: ≥ 25 meters). No significant associations were reported for all leukemias or ALL specifically when either distance cut-point was used, and in fact no association at all (OR = 1.0) was observed when the more stringent cut-point of 15 meters was used. In sub-analyses that stratified by participant age (< 5 years vs. ≥ 5 years), no significant associations were reported for either age category.

Nguyen et al. (2022) investigated whether potential pesticide exposure from living in close proximity to commercial plant nurseries confounds the association between magnetic-field exposure and childhood leukemia development reported within the California study population that was previously analyzed in Crespi et al. (2016) and Kheifets et al. (2017). The authors of Nguyen et al. (2022) noted that while the association between childhood leukemia and magnetic-field exposure was "slightly attenuated" after adjusting for nursery proximity or when restricting to subjects living > 300 meters from nurseries, their results "*do not support plant nurseries as an explanation for observed childhood leukemia risks*." The authors further noted that close residential proximity to nurseries may be an independent risk factor for childhood leukemia. In

Nguyen et al. (2023), the authors extended their previous investigation (Nguyen et al., 2022) into whether pesticide exposure was an independent risk factor or confounder for childhood leukemia in the presence of magnetic-field exposure from high-voltage power lines by examining the potential impact of specific pesticide exposure factors (e.g., intended use, chemical class, active ingredient). The authors found no statistically significant associations between distance to high-voltage powerlines or magnetic-field exposure and childhood leukemia, including when adjusting for pesticide exposure. Several of the examined pesticides were determined by the authors to be potential independent risk factors for childhood leukemia.

Onyije et al. (2022) conducted an "*umbrella review*" (i.e., a review of systematic reviews, meta-analyses, and pooled analyses) of epidemiological studies published between 2003-2021 that evaluated environmental risk factors (including ELF-EMF) of childhood ALL, the most common type of childhood leukemia. Onyije et al. (2022) screened 1,486 publications and ultimately included 59 publications consisting of 42 systematic reviews and meta-analyses and 17 pooled analyses. Onyije et al. (2022) relied on A Measurement Tool to Assess Systematic Reviews (AMSTAR 2) to evaluate the quality of each systematic review.

None of the systematic reviews met criteria for a high quality of evidence rating and 7 of the 42 systematic received critically low-quality ratings and were excluded from the analysis. Two risk factors identified that were "convincingly associated with childhood ALL" were low doses of ionizing radiation in early childhood, and general pesticide exposure during maternal preconception/pregnancy. Eight studies included in the review evaluated ELF-EMF exposure. One study, Talibov et al. (2019) used occupational data (a JEM) to estimate paternal and maternal preconception as well as maternal pregnancy exposure to ELF-EMF and associations with childhood leukemia overall and by subtype in a case-control study of 9,723 childhood leukemia cases and 17,099 controls. ELF-EMF exposure was categorized as (≤ 0.1, > 0.1 to ≤ 0.2, and > 0.2 µT). Talibov et al. (2019) found no evidence of an association. Based on seven publications that evaluated ELF-EMF during childhood, Onyije et al. (2022) concluded there was "'some' evidence of ELF-EMF as a risk factor of childhood leukemia" largely due to all meta-analyses having RRs over 1.00. The studies, however, were inconsistent between reviews that relied on the same data. For instance, a pooled analysis of four studies by Amoon et al. (2022) found no association between ELF-EMF and ALL, but Seomun et al. (2021) which included the same four studies found positive associations. Onyije et al. (2022) provide a caveat about their findings by emphasizing the majority of the ELF-EMF studies are case-control studies known to be prone to selection and recall bias and 2) noting that while there have been decades of study on the epidemiological associations of ELF-EMF with childhood leukemia, concerns about bias as well as lack of biological plausibility have precluded discussions about causality. Inconsistency in epidemiologic studies has led to uncertainty regarding carcinogenicity of some of the risk factors for childhood leukemia as a result of information bias, participation and recall biases. Empirical associations were identified and no conclusion about causality were made.

Onyije et al. (2023) synthesized findings from systematic reviews and pooled analyses that evaluated environmental risk factors (including ELF-EMF) of childhood ALL. The studies

included in this brief review were not included in the Onyije et al. (2022) larger umbrella review, summarized above. Onyije et al. (2022) determined the strength of the evidence based on the magnitude of the association found in each study, the number of studies on a specific risk factor, and the heterogeneity between those studies. Evidence was classified as "*strong*," "*some*," "*little*," "*no*," or "*conflicting*," which was used when systematic reviews came to different conclusions. One new systematic review (Brabant et al., 2023) was included but it did not change the earlier evaluation by Onyije et al. (2022) of "some" evidence of an association between ELF-EMF and ALL.

Zagar et al. (2023) investigated the relationship between magnetic fields and childhood cancers, including childhood leukemia, in Slovenia. Cancer cases, including 194 cases of leukemia, were identified from the Slovenian Cancer Registry; cases were then classified into one of five calculated magnetic-field exposure levels (ranging from < 0.1 µT [1 mG] to ≥ 0.4 µT [4 mG]) based on residential distance to high-voltage transmission lines (e.g., 110 kV, 220 kV, and 400 kV). The authors reported that less than 1% of Slovenian children and adolescents lived in an area near high-voltage power lines. No statistically significant differences in the development of childhood cancers, including leukemia, brain tumors, or all cancers combined, were reported across the five exposure categories.

Childhood brain cancer

Overall Assessment

The results of one study identified during the period of this review evaluated below did not alter the classification of the epidemiologic data in this field as inadequate and the study did not report any convincing evidence for an association.

Recent Conclusions of Agency Reviews

In their 2015 report, SCENIHR concluded that "*no association has been observed for the risk of childhood brain tumours*" (SCENIHR, 2015, p. 158). The 2024 report by SCHEER did not provide specific conclusions on childhood brain cancer research but stated *"[a]s far as other neoplastic diseases [i.e., other than childhood leukemia] are concerned, the weight of evidence is uncertain, because of conflicting results from the lines of evidence (animal and human studies) examined"* (SCHEER, 2024, p. 27).

Summary of Childhood Brain Cancer Research (January 2022 – April 2024)

During the period of this review, one relevant epidemiologic study was identified. The study on childhood leukemia by Zagar et al. (2023) discussed in the previous section also investigated the association between brain tumor development and magnetic-field exposure. Similar to the report's results for childhood leukemia, among the 195 diagnosed cases of brain cancer in participants 0 to 29 years old, only one case occurred outside the lowest exposure category

(0.2 to 0.3 µT [2 to 3 mG]). None of the standardized incidence ratios the authors calculated were statistically significant. The authors concluded "*we cannot attribute … any tumor of the central nervous system up to 29 years … to the exposure to ELF MF [magnetic fields] near [high-voltage power lines]"* (Zagar et al., 2023, p. 67).

Onyije et al. (2024) carried out a systematic review and meta-analysis of epidemiological studies evaluating more than 60 modifiable risk factors (including ELF-EMF) of childhood brain tumors using data from cases diagnosed between 1953 and 2017. Eligible cohort and case-control studies reported effect estimates during either the preconception, or pregnancy, or postnatal period, or during more than one of these periods. Onyije et al. (2024) reviewed 4,044 publications and included 181 studies (85 case-control and 96 cohort) in their review. Eligible studies were evaluated for their methodological quality using the Joanna Briggs Institute (JBI) critical appraisal tool. Pooled effect sizes and corresponding 95% CI were calculated using random-effect models and case-control studies were evaluated separately from cohort studies.

Case control studies scored slightly higher on the JBI tool on average with 87.9%, compared to cohort studies with 80.7%. The analysis found that maternal exposure to x-rays during pregnancy (eight case control studies) and childhood x-ray exposure (seven case control and combined analysis studies) were not associated with childhood brain tumors. Childhood exposure to computed tomography (CT) scans did not show an association in three case control studies.

In contrast to the case control studies, cohort studies evaluating the association between CT scans and childhood brain tumors identified an association in six studies and in the combined analysis. Exposure to domestic radon and external background ionizing radiation in childhood "*were observed to have some support of an association*" in two cohort studies. Exposure to ultrasound and electric-heated waterbeds during pregnancy did not show an association (four case control studies), but an association was observed with maternal use of electric blankets during pregnancy (seven case control studies). Fifteen studies evaluated associations between ELF magnetic fields and childhood brain tumors. Nine of these studies evaluated ELF magnetic-field levels between ≤ 0.1 µT (≤ 1 mG) and ≤ 0.4 µT (≤ 4 mG) (three case control and six cohort studies), and three cohort studies evaluated associations when ELF magnetic fields were higher than ≥ 0.4 µT (≥ 4 mG). No association with childhood brain tumors was found separately or in combined analysis. Finally, three case-control studies evaluated exposure to powerlines (very low current configuration, ordinary high current configuration, and very high current configuration) and found no association with childhood brain tumors Based on these results, the authors did not include ELF-magnetic fields as a potential risk factor of childhood brain tumors

Adult health outcomes

Adult brain cancer

Overall Assessment

Epidemiologic studies on magnetic fields and adult brain cancer have overall limited value due to weaknesses in exposure assessment methodology and insufficient data on certain brain cancer subtypes. Recent research predominantly shows no consistent associations, which is supported by the conclusions of recent agency reviews regarding adult cancers.

Recent Conclusions of Agency Reviews

The 2015 report by SCENIHR concluded that *"adult cancers show no consistent associations"* (SCENIHR, 2015, p. 158). The 2024 report by SCHEER did not provide a specific update on adult brain cancer research but cited the review published by HCN in 2022 (HCN, 2022a), which is discussed in the next paragraph.

In their 2022a report, HCN investigated the relationship between exposure to magnetic fields and the risk of specific types of cancer in adults. Regarding adult brain cancer, the Committee concluded, "*[r]esearch in the residential environment shows no associations between living within 50 metres of a high-voltage power line and the risk of brain cancer. The research is limited in scale, however, and the Committee therefore feels that no statements can be made regarding a causal relationship. An association was indeed found in the case of occupational exposure to magnetic fields above the background level. The Committee sees this as an indication of a causal relationship between the risk of brain cancer and occupational exposure"* (HCN, 2022a, p. 30). Regarding studies of occupational exposure, the Committee noted, *"It is not possible to determine an exposure-effect relationship due to the nature of the studies"* but nonetheless, determined that *"[b]ased on the association found … the EPA classification 'indications of a causal relationship' … appl[ies] to the relationship between risk of brain cancer and occupational exposure to magnetic fields"* (HCN, 2022a, p. 31).

Summary of Adult Brain Cancer Research (January 2022 – April 2024)

Yoshikawa et al. (2023) conducted a systematic review and meta-analysis on modifiable risk factors for adult-onset glioblastoma, an aggressive and malignant type of brain tumor with a poor prognosis. The authors reviewed 1,045 publications and ultimately included 12 studies, comprising 7 case-control and 5 prospective cohort studies. Only 2 of the 12 studies evaluated exposure to magnetic fields and both were case-control studies (Thériault et al., 1994; Villeneuve et al., 2002). The rest of the studies evaluated either alcohol consumption, body mass index, Type II diabetes, or non-steroidal anti-inflammatory drugs use as risk factors for glioblastoma.

Villeneuve et al. (2002) conducted a case-control study using data from the Canadian National Enhanced Cancer Surveillance System to evaluate magnetic-field exposure as a risk factor for GBM. For the meta-analysis, ORs or hazard ratios (HR) were combined to calculate summary results and a fixed or random-effects model was employed based on study heterogeneity (measured via the Cochran Q test). In Villeneuve et al. (2002) a significant positive association between self-reported magnetic-field exposure and glioblastoma was only found when magnetic-field exposure was estimated to be ≥ 0.6 µT (≥ 6 mG) (OR 5.36; 95% CI 1.16–24.78). The CIs are very wide, suggesting a high degree of uncertainty in the OR of 5.36. Cases and controls were matched by age. In the second paper, Thérinault et al. (1994) conducted a case-control study of 65 controls and 18 glioblastoma cases drawn from three cohorts of male employees of electric utility companies. Cases and controls were matched by age. No significant association or dose response relationship between exposure to magnetic fields and glioblastoma were found. Yoshikawa concludes "*no significant association was found between exposure to magnetic fields and GBM [glioblastoma] risk*" due to the limited (self-report) nature of the exposure assessment in Villeneuve et al. (2002) and the lack of associations found in Thériault et al. (1994).

Breast cancer

Overall Assessment

In their 2007 review, the WHO concluded that the evidence did not support an association between ELF magnetic-field exposure and breast cancer development (WHO, 2007a). This conclusion has also been expressed by other reviewing agencies in more recent reviews (e.g., SSM, 2016, 2018). Since no new published studies were identified during the period covered in this report, the conclusion that there is no association remains valid.

Recent Conclusions of Agency Reviews

The SSM concluded in two of their more recent annual reports that with respect to female breast cancer, *"now it is fairly certain that there is no causal relation with exposure to ELF magnetic fields"* (SSM, 2016, p. 7), and with respect to male breast cancer, *"[t]o date, there is no established link between ELF-MF [magnetic field] exposure and breast cancer in men"* (SSM, 2018, p. 49). Reviews published by SSM since 2018 have not provided specific conclusions on adult breast cancer research.

In their 2022a report, HCN concluded, "*[o]verall, studies in the residential environment do not reveal any associations between exposure to magnetic fields and the risk of breast cancer. However, some individual studies suggest otherwise and the Committee therefore feels that no statements can be made regarding a causal relationship in the residential environment. An association was indeed found between exposure and disease in the case of occupational exposure to magnetic fields above the background level. This applies to both men and women. The Committee sees this as an indication of a causal relationship*" (p. 26). Of studies of occupational exposure and breast cancer in women or men, the Committee noted, *"It is not*

possible to determine an exposure-effect relationship due to the nature of the studies" (HCN, 2022a, p. 28).

Notably, the occupational environments often include exposures to multiple chemicals and physical agents which may or may not have been assessed in these studies.

Summary of Breast Cancer Research (January 2022 – April 2024)

No relevant epidemiologic studies on adult breast cancer were published during the period covered in this review.

Adult leukemia and lymphoma

Overall Assessment

The findings from the existing body of research on adult leukemia and ELF EMF have been inconsistent, and no pattern has been identified whereby studies of a particular design or quality are more likely to produce positive or negative associations. Results from recent studies have not altered the conclusions reached by the WHO that the evidence is "*inadequate*" to link magnetic fields to adult leukemia development. While some scientific uncertainty remains on a potential relationship between adult lymphohematopoietic malignancies and magnetic-field exposure because of continued deficiencies in study methods, the current database of studies provides inadequate evidence for an association.

Recent Conclusions of Agency Reviews

The 2015 report by SCENIHR concluded that *"adult cancers show no consistent associations"* (SCENIHR, 2015, p. 158). A similar conclusion was expressed by SCHEER (2024) after reviewing meta-analyses performed by HCN (HCN, 2022a), which SCHEER noted "*could not always find evidence of a statistically significant dose-response relationship*" (SCHEER, 2024, p. 25).

In their 2022a report, HCN concluded, *"[r]esearch in th[e] residential environment has identified an association between the proximity of high-voltage power lines and an increased risk of leukaemia in adults. An association has also been found between occupational exposure to magnetic fields above the background level and an increased risk of leukaemia. The Committee sees this as indications of a causal relationship*" (HCN, 2022a, p. 22).

Summary of Adult Leukemia and Lymphoma Research (January 2022 – April 2024)

Jalilian et al. (2022) examined the relationship between occupational magnetic fields and electric shock exposures and lymphoma within a large Nordic census-based cohort. The study included

cases of non-Hodgkin's lymphoma (n = 68,978), chronic lymphocytic leukemia (n = 20,615), and multiple myeloma (n = 17,736) diagnosed between 1961 and 2005 in Finland, Iceland, Norway, and Sweden. Cases were matched to controls by age, sex, and country. Occupational exposure to magnetic fields and electric shocks were assessed using JEMs. The authors reported no associations among workers exposed to magnetic fields or electric shocks for any of the cancers assessed; this included no associations among workers exposed to high levels (≥ 0.30 μT [≥ 3 mG]) of magnetic fields. The authors concluded that their results "*do not provide support for an association between occupational exposure to ELF [magnetic fields] and electric shocks and lymphoma risk*" and that further research into this area "*should not be a research priority*" (Jalilian et al., 2022, p. 1).

Odutola et al. (2023) examined whether occupational exposure to magnetic fields was associated with follicular lymphoma in an Australian case-control study that took place between 2011 and 2016. Cases (n=681) were 20-74 years old diagnosed with follicular lymphoma between 2011 and 2016 and controls were related (siblings) (n= 294) and unrelated (spouses/partners) (n= 179) participants of the same age. The authors estimated exposure using a self-administered questionnaire based on job titles. Briefly, job titles solicited from the questionnaire were mapped to the International Standard Classification of Occupations. Occupational exposure to ELF magnetic fields based on job title was then assigned using a previously published JEM (Bowman et al., 2007). Average intensity (μT), total duration (years), and lifetime cumulative exposure (μT-years) metrics were considered. Regression models were adjusted for the following confounders: age, sex, ethnicity, state, and smoking status. The authors found no significant associations between follicular lymphoma and occupational exposure to magnetic fields when using any of the exposure metrics. A strength of this study was its ability to confirm follicular lymphoma diagnosis from a linkage to a cancer-based registry. A limitation of the study was its reliance on a self-administered questionnaire, which is vulnerable to recall bias. The authors concluded "*[o]ur findings do not support an association between occupational ELF-MF exposure and FL [follicular lymphoma]*" and that "*[f]urther research using enhanced exposure assessments is warranted* …" (Odutola et al., 2023, p. 599).

Reproductive and developmental effects

Overall Assessment

Epidemiologic studies on reproductive or developmental effects and EMF exposure have historically suffered from limitations in study design, sample size, and exposure assessment method. Recent research has provided little, if any, new evidence for potential associations. Thus, the WHO's classification of the overall evidence in support of any causal inference as *inadequate* remains appropriate.

Recent Conclusions of Agency Reviews

The 2015 report by SCENIHR concluded, "*[r]ecent results do not show an effect of the ELF fields on the reproductive function in humans*" (SCENIHR, 2015, p. 185). In their 2024 report, SCHEER stated, "*[t]he available systematic reviews and meta-analyses have not shown an association between ELF-EMF exposure and pregnancy or reproductive outcomes"* (SCHEER, 2024, p. 2).

In their 2020 review, ICNIRP stated, *"[s]ubsequent [epidemiologic] studies [after 2010] do not support the hypothesis that ELF-MFs [magnetic fields] are related to adverse pregnancy outcomes, and the older laboratory studies did not find an association between ELF-MFs and reproduction and/or development … Overall, the evidence gathered so far does not indicate any data gaps that require research for guideline development"* (ICNIRP, 2020a, p. 534).

In their 2022a report, HCN concluded, *"[r]esearch in the residential environment shows no association between living in the vicinity of high-voltage power lines and the risk of testicular cancer. No associations were also found in the case of occupational exposure to magnetic fields above the background level. As research in the residential environment is limited and the results of the studies on occupational exposure vary, the Committee concludes that no statements can be made regarding a causal relationship"* (HCN, 2022a, p. 33).

Summary of Reproductive and Developmental Effects Research (January 2022 – April 2024)

Kashani et al. (2023) conducted a systematic review and meta-analysis to evaluate whether EMF exposure (of varying frequencies) is associated with fetal or childhood abnormalities. Fourteen studies were included in the systematic review and meta-analysis, with six of those studies evaluating ELF magnetic-field exposure (five studies examined maternal and childhood exposure to power lines and one study examined occupational exposure to 50-Hz fields). Associations between ELF magnetic fields and childhood and fetal abnormalities from these six studies were inconsistent, with three studies reporting standardized mean differences around the null (i.e., no effect observed). There were considerable limitations that may have affected the study's findings, including a small number of included studies, significant heterogeneity between studies, and evidence of significant publication bias. The authors noted that "*due to the limitations of the studies, … the effects of EMF on fetal and childhood abnormalities should be interpreted with caution*" (Kashani et al., 2023).

Zhou et al. (2023) carried out a systematic review and meta-analysis of ELF-EMF (1 Hz to 300 Hz) exposure and pregnancy outcomes. Seven studies evaluating miscarriage, stillbirth, birth defects, and preterm birth were included, with six of the seven studies labeled as high-quality following a quality assessment. The authors found that there was no significant increase in adverse pregnancy outcomes comparing pregnant women who lived closer to EMF sources compared to pregnant women who lived further from EMF sources (distances of near and far

were not defined in the study). The authors concluded that "*[n]o correlation has been found between maternal ELF-EMF exposure and miscarriage, stillbirth, neonatal birth defects and preterm delivery*" (Zhou et al., 2023, p. 5).

Neurodegenerative diseases

Summary of Neurodegenerative Disease Research (January 2022 – April 2024)

Chambers-Richards et al. (2023) conducted a systematic review and meta-analysis of studies that investigated the relationship of three "*environmental and occupational toxins*" (i.e., EMF, metals, and pesticides) to Parkinson's disease. The authors included 24 studies in their analysis, including 9 studies of occupational EMF exposure, ranging in publication date from 1998 to 2017; no evidence of heterogeneity or publication bias were noted among the 9 studies. No statistically significant association was reported between EMF exposure and Parkinson's disease , including when the lower quality studies were omitted from the analysis. The authors reported a statistically significant association between Parkinson's disease and pesticide exposure but not between Parkinson's disease and metals exposure. The authors concluded that their findings "*may suggest that the risk in the development of Parkinson's disease may be more markedly increased with the duration or frequency of exposure to pesticides, as opposed to exposure to metals and electromagnetic fields*" (Chambers-Richards et al., 2023, p. 81).

Duan et al. (2023) carried out a meta-summary of amyotrophic lateral sclerosis (ALS) and exposure to magnetic fields, which was one of 22 non-genetic risk factors evaluated across 67 studies for its association with ALS. Six of the 67 studies (including 5 case-control studies) looked at magnetic-field exposure and associations with ALS. Pooling results from these studies resulted in a significant increased odds of ALS among individuals with higher exposure to magnetic fields (exposure levels were not defined by the authors). However, the pooled OR for magnetic-field exposure (1.22) was below the minimum OR threshold of 1.3 set by the authors as the criterion for defining an exposure as an ALS risk factor. In addition, the authors identified "*substantial*" heterogeneity between studies evaluating magnetic-field exposure and ALS. Non-genetic significant risk factors with ORs over 1.3 from this meta-summary included heavy metals, pesticides, solvents, and previous head injury; several risk factors had statistically significant protective odds (OR < 0.7) against developing ALS including diabetes, kidney disease, and living in an urban setting. A strength of the study is that there was little evidence of publication bias for magnetic-field exposure studies. The authors concluded, "*we found no significant association between electromagnetic fields and the incidence of ALS, except the dose of exposure might affect the development of ALS*" (Duan et al., 2023, p. 8). The authors claim that the dose that might affect ALS development cannot be evaluated because details on what constitutes high and low exposure are not provided.

Goutman et al. (2023) evaluated occupational exposure, including "*electromagnetic radiation*," and associations with ALS in a case-control study of Michigan workers across various industries. All cases (n = 381) were patients at the University of Michigan's Pranger ALS clinic, while

controls (n = 272) were recruited from an online database for the University of Michigan. Participants enrolled from 2010 to 2020 and were asked to complete a written survey on their work history (up to their last four jobs) and occupational exposures they may have encountered at those jobs. Exposure to EMF was ascertained with a binary question, "[*were you] [e]xposed to power lines, transformation stations or other EM [sic]*?" In addition to EMF, the survey also asked participants to report on their exposure to particulate matter, volatile organic compounds, pesticides, metals, biologicals, combustion/diesel exhaust, radiation, and corrosion. Regression models were adjusted for age, sex, and military service. There was no observed association between EMF exposure and ALS, although the exposure assessment method (i.e., self-reported questionnaire data that did not ask separate questions for different frequencies of electromagnetic fields, such as mobile phone use) was a significant limitation of the study. The authors found occupational exposure to metals was significantly and positively associated with ALS, while corrosives were significantly and negatively associated. In a subsequent publication, Goutman et al. (2022) assessed the potential for EMF and other occupational exposures to be risk factors for ALS progression, including survival and onset segment (bulbar, cervical, lumbar), in the same study. EMF exposure was not significantly associated with ALS survival, but was significantly associated with cervical onset compared to lumbar. It is worth noting that the majority of exposures (seven of nine) were significantly associated with cervical onset compared to lumbar. The authors make no concluding statements on EMF and ALS but instead emphasized that occupational pesticide exposure and working in military operations were significantly associated with worse ALS survival.

Saucier et al. (2023) carried out three systematic reviews of studies that evaluated relationships between urbanization, air pollution, and water pollution and ALS development. The authors identified five studies that assessed whether EMF (of varying frequencies) and high-voltage infrastructure were significant urbanization risk factors for ALS, but they make no conclusion about magnetic-field exposure and ALS development based on these studies, therefore adding little value to the existing literature.

Sorahan and Nichols (2022) investigated magnetic-field exposure and mortality from motor neuron disease in a large cohort of employees of the former Central Electricity Generating Board of England and Wales. The study included nearly 38,000 employees first hired between 1942 and 1982 and still employed in 1987. Estimates of exposure magnitude, frequency, and duration were calculated using data from the power stations and the employees' job histories and were described in detail in a previous publication (Renew et al., 2003). Mortality from motor neuron disease in the total cohort was observed to be similar to national rates. No statistically significant dose-response trends were observed with lifetime, recent, or distant magnetic-field exposure; statistically significant associations were observed for some categories of recent exposure, but not for the highest exposure category. The authors concluded that their study "*does not indicate that occupational lifetime magnetic field exposures are a risk factor for MND [motor neuron disease] but the possible role of recent exposures would be worth investigating in the other available studies*" (Sorahan and Nichols, 2022, p. 188).

Vasta et al. (2023) investigated whether EMF exposure from power lines and repeater antennas affected ALS onset age and progression in a cohort of Italian ALS patients (n = 1,098) diagnosed between 2007 and 2014. Patients were geolocated at their time of diagnosis; data on the distribution of power lines and repeater antennas came from the Environmental Protection Agency of Piedmont. Power line exposure was determined using the patient's address at the center of circles of variable radii (ranging from 100 to 2,000 meters); for each radius, exposure was calculated as the length of the power lines included in the circle. Based on these calculations, patients were classified as either low or high exposure using the median exposure. There were no significant differences in the age of ALS onset or rate of ALS decline between participants living closer vs. farther away from power lines or repeater antennas. The authors concluded that "*[o]ur study suggests that exposure to electromagnetic fields could not be part of the prognostic factor…"* in ALS etiology (Vasta et al., 2023, p. 345).

Vitturi et al. (2023) conducted a systematic review and meta-analysis of case-control studies examining potential occupational risk factors related to multiple sclerosis, including solvents, mercury, pesticides, and low-frequency magnetic fields. The authors included 24 studies in their review but only one of the included studies investigated exposure to magnetic fields, thereby adding little new information to the existing body of research.

Overall Assessment

The overall evidence from recently published studies of EMF, electric shocks, and neurodegenerative diseases, which are of higher methodological quality compared to earlier studies in this area, do not alter the assessment that there is no consistent or convincing support for a causal association.

Recent Conclusions of Agency Reviews

In their 2015 report, SCENIHR concluded, *"[t]he reviewed studies] do not provide convincing evidence of an increased risk of neurodegenerative diseases, including dementia, related to ELF [magnetic field] exposure"* (SCENIHR, 2015, p. 186). In their 2024 report, SCHEER stated, *"[o]verall, there is moderate evidence (mainly from human studies) on the association between occupational exposure to ELF-EMF and amyotrophic lateral sclerosis, weak evidence for the association of occupational ELF-EMF exposure with Alzheimer's disease, and dementia, but only uncertain to weak evidence for residential exposure and these neurodegenerative diseases. No significant association can be established between EMF exposure and Parkinson's or multiple sclerosis disease"* (SCHEER, 2024, p. 2).

In their 2022b report on neurodegenerative diseases in adults, HCN had the following conclusions:

- Parkinson's disease: *"[w]ith regard to Parkinson's disease, the Committee considers a causal link between exposure to magnetic fields and the development of the disease to be unlikely"* (HCN, 2022b, p. 5).
- ALS and Alzheimer's disease: *"the Committee considers the results for the residential areas to be inadequate to infer a causal relationship between the proximity of power lines and the risk of developing either disease. The Committee considers the associations identified by the occupational studies to be suggestive of a causal relationship. The few data available from experimental studies do not provide further support for a causal link"* (HCN, 2022b, p. 5).
- Multiple sclerosis: *"… no association was found in either the residential or occupational studies. However, in both environments, the number of studies was too limited to make definitive statements about whether or not there is a causal link between exposure to magnetic fields and development of the disease"* (HCN, 2022b, p. 5).

Cardiovascular disease

Overall Assessment

In their 2007 review, the WHO concluded that the existing evidence does not support an association between magnetic fields and cardiovascular disease. Relevant epidemiologic studies published during the period since the WHO's review have not provided evidence to alter the WHO's conclusion. Some research suggests the existence of potential therapeutic benefits of EMF exposure for cardiovascular disease.

Recent Conclusions of Agency Reviews

Regarding research on cardiovascular outcomes, ICNIRP concluded in their 2020 review of potential research gaps that *"the research available at the time the ICNIRP 2010 Guidelines were drafted provided convincing null findings, which suggest there are no data gaps in this area that require research"* (ICNIRP, 2020b, p. 534).

Summary of Cardiovascular Disease Research (January 2022 – April 2024)

No relevant epidemiologic studies on cardiovascular disease were published during the period of this review. A recent review article by Wang et al. (2023) discussed the potential therapeutic benefits of EMF exposure, including at 60 Hz, in cardiovascular disease treatment.

In vivo studies related to carcinogenesis

Human health risk assessments are not based exclusively on epidemiological studies; experimental studies in animals and humans also play a key role (USEPA, 2002, 2005; NTP, 2015a). The importance of *in vivo* experimental studies is particularly great in assessing the

potential role of magnetic fields in carcinogenic processes (IARC, 1992, 2022).

The impetus for reviews of *in vivo* research by WHO and IARC was summarized by SCENIHR (2015) with its conclusion:

> *Motivated by the observed increased leukaemia risk in children, experimental studies have investigated the carcinogenic potential of magnetic fields using animals. These studies have tended to use traditional rodent models and do not support the epidemiological findings . ... Previously SCENIHR (2009) concluded that animal studies did not provide evidence that exposure to magnetic fields alone caused tumours or enhanced the growth of implanted tumours. The inclusion of more recent studies does not alter that assessment. In addition, these studies do not provide further insight into how magnetic fields could contribute to an increased risk of childhood leukaemia. (p. 161).*

A substantial body of *in vivo* research has been added to the literature since then and has been previously reviewed by Exponent. Below is a brief overview of the status of this research up to 2022, after which new research from January 2022 to April 2024 is reviewed.

Chronic bioassays

In chronic bioassays animals are exposed to high levels of magnetic fields over the course of the animals' entire lifetime and tissue evaluations are performed to assess the incidence of tumors in many organs. In its evaluation of four large chronic bioassay studies, the WHO (2007a) concluded "*[o]verall, there is no evidence that ELF exposure alone causes tumours*" (p. 322). Subsequent studies reported by the Ramazzini Institute, although of lesser quality, support this conclusion (Soffritti et al., 2015, 2016a, 2016b; Bua et al., 2018).

Tumor promotion studies

Other studies have looked for evidence that ELF field exposure can enhance tumor development in combination with known carcinogens. The WHO stated that "*evidence that ELF field exposure can enhance tumour development in combination with carcinogens is inadequate*" (WHO, 2007a, p. 322). More recently, as part of its evaluation of *in vivo* studies, SCENIHR (2015) concluded that "*inclusion of more recent studies does not alter that assessment. In addition, these studies do not provide further insight into how magnetic fields could contribute to an increased risk of childhood leukaemia*" (SCENIHR, 2015, p. 161). More recently, SHEER (2024) reviewed the studies by the Ramazzini Institute that reported interactions between magnetic fields and exposure to ionizing radiation (Soffritti et al., 2015, 2016a) and formaldehyde (Soffritti et al., 2016b), but criticized the results because of "*missing*" and "*selective*" tumor data. SCHEER also cited criticisms of these studies by the Swedish Radiation Safety Authority (Swedish Radiation Safety Authority (SSM), 2018, 2019).

Magnetic-field effects on *in vivo* cellular processes potentially relevant to cancer

Some experimental studies reviewed by the WHO reported an increase in genotoxic effects among exposed animals (e.g., DNA strand breaks in the brains of mice [Lai and Singh, 2004]), although the results have not been replicated (e.g., McNamee et al., 2005). More recent studies in which animals were exposed to higher levels of magnetic fields for longer exposure periods reported no increase in damage to DNA (Korr et al., 2014; Saha et al., 2014).

Alcaraz et al. (2014) reported an increase in micronuclei in erythrocytes of mice following exposure to a 2,000 mG, 50-Hz magnetic field, which had not been reported by others at lower levels of magnetic fields. Wilson et al. (2015) reported that magnetic fields up to 3,000 mG did not increase mutations in blood cells of mice or a dose-related increase in testes. A follow up study reported magnetic fields exposure before and after exposure to 100 mGy X-rays did not increase the amount of DNA breaks or have an effect on the repair of DNA damage (Woodbine et al., 2015).

Scientists are constantly investigating indicators of biological processes that might lead to DNA damage, including short-term effects on indicators of oxidation in tissues. Some investigators have reported some effects of magnetic fields on indicators of oxidative stress at very high levels of 80,000 to 200,000 mG (e.g., Li et al., 2015; Luo et al., 2016). Effects at lower, but still high levels (1,000 mG), are inconsistent, and longer exposures do not result in greater responses (Akdag et al., 2013; Glinka et al., 2013; Hassan and Abdelkawi, 2014; Manikonda et al., 2014).

Magnetic- and electric-field treatments on tumor growth

Studies have investigated the therapeutic potential of magnetic-field and electric-field exposures in the treatment of experimentally-induced tumors in animals. One reported that following the injection of breast cancer cells and a 40,000 mG magnetic field alone, tumor volume declined (Yadamani et al., 2018). Two other studies involving injection of Ehrlich carcinoma tumor cells + a 50,000 mG magnetic field (Rageh et al., 2020) or Walker-256 carcinosarcoma cells + a 2 kV/m, 50-Hz electric field (Orel et al., 2021) reported greater reductions in tumor size with EMF + concurrent chemical treatment than only chemical treatment.

Occupational biomarker studies

In recent years a number of cross-sectional epidemiology studies have compared markers for DNA and oxidative stress in blood samples from workers at electric generating plants with higher and lower exposures to EMF (Bagheri Hosseinabadi et al., 2019, 2020, 2021; Zendehdel et al., 2019, 2020; Touitou et al., 2020). Besides the cross section design, which precludes drawing conclusions about cause and effect relationships,[10] the small number of participants and

[10] In a cross-sectional study, the investigators determine the study subjects' exposure and outcome status at the same time; thus, these types of studies are not suitable to draw any conclusion on a potential causal association.

multiple methodological limitations in these studies are problematic. None of the DNA analyses in these studies met the criteria required to confirm a clear positive response (OECD, 2015).

Recent *in vivo* studies of carcinogenesis (January 2022 through April 2024)

No new cancer bioassays or tumor promotion studies were identified in the most recent evaluation period. Moreover, experimental studies of EMF on cellular processes in living animals and humans potentially relevant to cancer were not identified either in this period.

Occupational biomarker studies

A single new cross-sectional epidemiology study by Vemula et al. (2023) met the criteria for inclusion in this section. Vemula et al. (2023) analyzed blood samples of 342 women working night shifts in hospitals and business call centers in Hyderabad State, India (i.e., the exposed group) and 150 women not in that work (i.e., the control group) with ages between 19 and 45. While the title, abstract, and text of the paper alleged that the women in the first group had exposure to EMF and light at night, they presented neither evidence for this allegation nor for the absence or reduced levels of these exposures in the work experience of the women in the control group. The age, diet, and history of recent infection were used as selection criteria. The participants provided self-assessed information about nonspecific "*subjective symptoms related to EMFs exposure*" including headaches, dizziness, and tinnitus, among others. The blood samples were analyzed for DNA damage by the alkaline comet assay, and micronuclei in buccal epithelial cells, which involved assessments by technicians using light microscopy. Melatonin, a neurohormone, was quantified by a radioimmunoassay and expression of RNA genes by real time polymerase chain reaction (RT-PCR). The study used the length of employment as an indicator of the duration of alleged exposure (121 women, 1-6 days; 114 women, 1-4 weeks; 107 women,1-6 months).

The mean levels of DNA damage, micronuclei, and gene expression were reported to be significantly greater in the exposed group than the control group; the levels of melatonin were significantly lower in the exposed group than the control group. However, within the exposed group of women, the duration of employment had no or very little effect on the parameters measured and these data were not subjected to statistical analysis. The authors did not indicate whether they asked the participants if they took melatonin supplements, which would affect measured levels of melatonin. Neither did the authors ask if participants chewed betel leaves or tobacco, or smoked tobacco, which would contribute to buccal cell DNA damage. Even though the authors assumed that EMF and light at night would reduce melatonin levels, they did not investigate the relationship between melatonin levels and DNA damage within individuals in their data. We do not know, for example, if participants with high levels of melatonin also had high levels of DNA damage or buccal cell micronuclei, or the reverse. The authors offered no interpretation or details of the RT-PCR testing. As the authors did not report coding of the samples prior to analysis, the analyses of DNA damage and buccal cell micronuclei were not conducted in a blinded fashion, so were potentially susceptible to expectation bias. Overall, the

authors stated that "*[o]ur results warrant more epidemiological studies considering the confounding factors*." In addition, the design and methodological inadequacies of this study allowed confounding factors to prevent any clear interpretation of the results presented.

Assessment

Overall, the single *in vivo* study of EMF published since the last update does not alter the WHO's conclusion that the overall evidence from *in vivo* studies does not support the role of EMF exposure in either direct or indirect genotoxic effects arising from oxidative stress. The literature continues to show that there is inadequate evidence to suggest carcinogenic effects in animals or humans due to EMF exposure. This assessment is consistent with SHEER (2023), which states, "*[i]n conclusion, there is weak evidence regarding the involvement of interaction mechanisms (oxidative stress, genetic/epigenetic effects) on health risks from ELF-MF observed in epidemiological and in vivo studies*" (p. 19). The poor quality of the new study reviewed and of most previous studies, however, leaves much to be improved, so the recommendation that "*further studies on mechanisms and biological data from childhood leukemia experimental models are recommended*" is appropriate (ICNIRP, 2020, p. 535).

5 Standards and Guidelines

Following a thorough review of the research, scientific agencies establish exposure standards to protect against recognized health effects. The primary objective of a weight-of-evidence review is to identify the lowest exposure level below which no health hazards have been found (i.e., a threshold). Exposure limits or guidelines are then set well below the threshold level to account for any individual variability or sensitivities that may exist.

Several scientific organizations have published guidelines for exposure to ELF EMF based on acute health effects that can occur at very high field levels; guidelines for magnetic field exposures for workers and the general public are presented in Table 3. ICNIRP reviewed the epidemiologic and experimental evidence and concluded that there was insufficient evidence to warrant the development of standards or guidelines on the basis of hypothesized long-term adverse health effects such as cancer; rather, the guidelines put forth in their 2010 document set limits to protect against acute health effects (i.e., the stimulation of nerves and muscles) that occur at much higher field levels. ICNIRP recommends a residential screening value of 2,000 mG and an occupational exposure screening value of 10,000 mG (ICNIRP, 2010). If exposure exceeds these screening values, then additional dosimetry evaluations are needed to determine whether basic restrictions on induced internal electric field densities are exceeded. For reference, in a national survey conducted by Zaffanella and Kalton (1998) for the NIEHS's EMF Research and Public Information Dissemination program, only about 1.6% of the general public in the United States experienced exposure to magnetic fields of at least 1,000 mG during a 24-hour period.

The International Committee on Electromagnetic Safety (ICES) also recommends limiting high levels of magnetic-fields because of the risk of acute effects, although their guidelines are higher than ICNIRP's guidelines. ICES recommends a residential exposure limit (i.e., exposure reference level) of 9,040 mG and an occupational exposure limit of 27,100 mG for 60-Hz magnetic fields (ICES, 2019, 2020). Both guidelines incorporate large safety factors.

Table 3. Screening guidelines for Magnetic Field exposure

Organization	Exposure (60 Hz)	Magnetic field guideline
ICNIRP	Occupational	10,000 mG
	General Public	2,000 mG
ICES	Occupational	27,100 mG
	General Public	9,040 mG

Source: ICNIRP, 2010; ICES, 2019, 2020.

The ICNIRP and ICES guidelines provide guidance to national agencies and only become legally binding if a country adopts them into legislation. The WHO recommends that member countries

adopt the ICNIRP or IEEE ICES guidelines or use a scientifically sound framework for formulating any new guidelines (WHO, 2007a, 2007b).

There are no national or state standards in the United States limiting exposure to ELF EMF based on health effects. The State of Rhode Island also has not implemented any standards or guidelines related to ELF EMF. While both Florida and New York have enacted standards to limit magnetic fields at the edge of transmission line rights-of-way, these limits were not based on health considerations, but are to maintain the status quo so fields from new transmission lines are no higher than those from existing transmission lines (NYPSC, 1978, 1990; FDEP, 1989, 1996).

6 Summary

Over the past few decades, a number of national and international scientific organizations have published reports or scientific statements with regard to the possible health effects of ELF EMF. These include weight-of-evidence reviews published by SCENIHR in 2015 and the WHO in 2007. The conclusions of these reports are generally consistent; none of these agencies have concluded that exposure to ELF EMF at the levels we encounter in our everyday environment cause or contribute to adverse health effects. The current guidance from the WHO on its website states that "*[d]espite extensive research, to date there is no evidence to conclude that exposure to low level electromagnetic fields is harmful to human health*" (WHO, 2016).

Recent studies published on ELF EMF and health have not provided sufficient evidence to alter these basic conclusions of SCENIHR, the WHO, and other agencies. The weak statistical association between high, average magnetic fields and childhood leukemia reported in two pooled analyses in 2000 (Ahlbom et al., 2000; Greenland et al., 2000) has not been appreciably strengthened by subsequent research. To the contrary, the strength of the association has diminished over time, which is consistent with the findings of SCHEER in their most recent 2024 report, which concluded that "*overall, there is weak evidence concerning the association of ELF-MF [magnetic field] exposure with childhood leukaemia*" (SCHEER, 2024, p. 2). The previously reported association in some studies remains unexplained and unsupported by experimental studies. The recent *in vivo* experimental studies confirm the lack of experimental data for genotoxic effects of ELF EMF that would support a leukemogenic or other cancer.

Research reviewed on other cancer and non-cancer outcomes provided no substantial new information to alter the previous conclusions that the evidence is inadequate to conclude that ELF EMF exposure is harmful at typical environmental levels. While the large body of existing research does not confirm any likely harm associated with ELF EMF exposure at low levels, research on this topic likely will continue to reduce remaining uncertainty.

In conclusion, when recent studies are considered in the context of previous research, they do not provide evidence to alter the conclusion that ELF EMF exposure at the levels we encounter in our everyday environment is not a cause of cancer or any other disease process.

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APPENDIX B

Q143S/R144 LINES REBUILD PROJECT

Rhode Island Energy Facility Siting Board
Siting Report

AGENCY CORRESPONDENCE

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Ecological Services Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5094
Phone: (603) 223-2541 Fax: (603) 223-0104

In Reply Refer To: 11/25/2024 19:22:02 UTC
Project Code: 2023-0119466
Project Name: Q143/R144 Transmission Line Rebuild

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

Updated 4/12/2023 - Please review this letter each time you request an Official Species List, we will continue to update it with additional information and links to websites may change.

About Official Species Lists

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Federal and non-Federal project proponents have responsibilities under the Act to consider effects on listed species.

The enclosed species list identifies threatened, endangered, proposed, and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. The Service recommends that verification be completed by visiting the IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested by returning to an existing project's page in IPaC.

Endangered Species Act Project Review

Please visit the "**New England Field Office Endangered Species Project Review and Consultation**" website for step-by-step instructions on how to consider effects on listed

species and prepare and submit a project review package if necessary:

https://www.fws.gov/office/new-england-ecological-services/endangered-species-project-review

NOTE Please do not use the **Consultation Package Builder** tool in IPaC except in specific situations following coordination with our office. Please follow the project review guidance on our website instead and reference your **Project Code** in all correspondence.

Northern Long-eared Bat - (**Updated 4/12/2023**) The Service published a final rule to reclassify the northern long-eared bat (NLEB) as endangered on November 30, 2022. The final rule went into effect on March 31, 2023. You may utilize the **Northern Long-eared Bat Rangewide Determination Key** available in IPaC. More information about this Determination Key and the Interim Consultation Framework are available on the northern long-eared bat species page:

https://www.fws.gov/species/northern-long-eared-bat-myotis-septentrionalis

For projects that previously utilized the 4(d) Determination Key, the change in the species' status may trigger the need to re-initiate consultation for any actions that are not completed and for which the Federal action agency retains discretion once the new listing determination becomes effective. If your project was not completed by March 31, 2023, and may result in incidental take of NLEB, please reach out to our office at newengland@fws.gov to see if reinitiation is necessary.

Additional Info About Section 7 of the Act
Under section 7(a)(2) of the Act and its implementing regulations (50 CFR 402 et seq.), Federal agencies are required to determine whether projects may affect threatened and endangered species and/or designated critical habitat. If a Federal agency, or its non-Federal representative, determines that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Federal agency also may need to consider proposed species and proposed critical habitat in the consultation. 50 CFR 402.14(c)(1) specifies the information required for consultation under the Act regardless of the format of the evaluation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

https://www.fws.gov/service/section-7-consultations

In addition to consultation requirements under Section 7(a)(2) of the ESA, please note that under sections 7(a)(1) of the Act and its implementing regulations (50 CFR 402 et seq.), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species. Please contact NEFO if you would like more information.

Candidate species that appear on the enclosed species list have no current protections under the ESA. The species' occurrence on an official species list does not convey a requirement to

consider impacts to this species as you would a proposed, threatened, or endangered species. The ESA does not provide for interagency consultations on candidate species under section 7, however, the Service recommends that all project proponents incorporate measures into projects to benefit candidate species and their habitats wherever possible.

Migratory Birds

In addition to responsibilities to protect threatened and endangered species under the Endangered Species Act (ESA), there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts see:

https://www.fws.gov/program/migratory-bird-permit

https://www.fws.gov/library/collections/bald-and-golden-eagle-management

Please feel free to contact us at **newengland@fws.gov** with your **Project Code** in the subject line if you need more information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat.

Attachment(s): Official Species List

Attachment(s):

- Official Species List

OFFICIAL SPECIES LIST

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

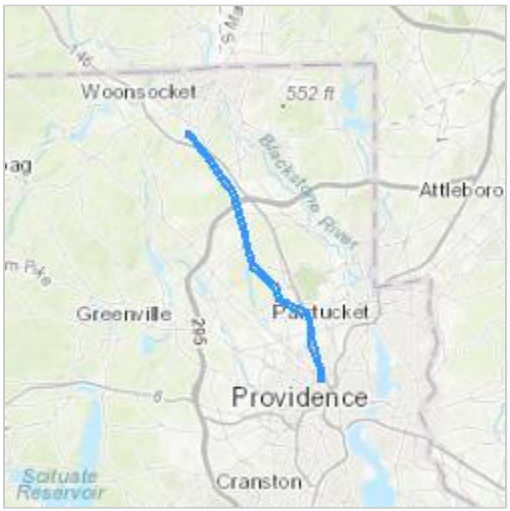
This species list is provided by:

New England Ecological Services Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5094
(603) 223-2541

PROJECT SUMMARY

Project Code: 2023-0119466
Project Name: Q143/R144 Transmission Line Rebuild
Project Type: Transmission Line - Maintenance/Modification - Above Ground
Project Description: Overhead transmission line maintenance.
Project Location:

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@41.9104564,-71.4758497300802,14z



Counties: Providence County, Rhode Island

ENDANGERED SPECIES ACT SPECIES

There is a total of 3 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

MAMMALS

NAME	STATUS
Northern Long-eared Bat *Myotis septentrionalis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9045	Endangered
Tricolored Bat *Perimyotis subflavus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/10515	Proposed Endangered

INSECTS

NAME	STATUS
Monarch Butterfly *Danaus plexippus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9743	Candidate

CRITICAL HABITATS

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

YOU ARE STILL REQUIRED TO DETERMINE IF YOUR PROJECT(S) MAY HAVE EFFECTS ON ALL ABOVE LISTED SPECIES.

IPAC USER CONTACT INFORMATION

Agency: BSC Group
Name: Alison Milliman
Address: 1 Mercantile Street Suite 610
City: Worcester
State: MA
Zip: 01608
Email amilliman@bscgroup.com
Phone: 6178964532

LEAD AGENCY CONTACT INFORMATION

Lead Agency: Army Corps of Engineers

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Ecological Services Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5094
Phone: (603) 223-2541 Fax: (603) 223-0104

In Reply Refer To: 11/26/2024 15:45:56 UTC
Project code: 2023-0119466
Project Name: Q143/R144 Transmission Line Rebuild

Federal Nexus: yes
Federal Action Agency (if applicable): Army Corps of Engineers

Subject: Technical assistance for 'Q143/R144 Transmission Line Rebuild'

Dear Alison Milliman:

This letter records your determination using the Information for Planning and Consultation (IPaC) system provided to the U.S. Fish and Wildlife Service (Service) on November 26, 2024, for 'Q143/R144 Transmission Line Rebuild' (here forward, Project). This project has been assigned Project Code 2023-0119466 and all future correspondence should clearly reference this number. **Please carefully review this letter. Your Endangered Species Act (Act) requirements are not complete.**

Ensuring Accurate Determinations When Using IPaC

The Service developed the IPaC system and associated species' determination keys in accordance with the Endangered Species Act of 1973 (ESA; 87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.) and based on a standing analysis. All information submitted by the Project proponent into IPaC must accurately represent the full scope and details of the Project. **Failure to accurately represent or implement the Project as detailed in IPaC or the Northern Long-eared Bat and Tricolored Bat Range-wide Determination Key (Dkey), invalidates this letter.**

Determination for the Northern Long-Eared Bat and Tricolored Bat

Based on your IPaC submission and a standing analysis completed by the Service, you determined the proposed Project will have the following effect determinations:

Species	Listing Status	Determination
Northern Long-eared Bat (*Myotis septentrionalis*)	Endangered	May affect
Tricolored Bat (*Perimyotis subflavus*)	Proposed Endangered	May affect

Other Species and Critical Habitat that May be Present in the Action Area

The IPaC-assisted determination key for the northern long-eared bat and tricolored bat does not apply to the following ESA-protected species and/or critical habitat that also may occur in your Action area:

- Monarch Butterfly *Danaus plexippus* Candidate

You may coordinate with our Office to determine whether the Action may cause prohibited take of the species listed above.

Conclusion

Consultation with the Service is not complete. Further consultation or coordination with the Service is necessary for those species or designated critical habitats with a determination of "May Affect." A "May Affect" determination in this key indicates that the project, as entered, is not consistent with the questions in the key. Not all projects that reach a "May Affect" determination are anticipated to result in adverse impacts to listed species. These projects may result in a "No Effect", "May Affect, Not Likely to Adversely Affect", or "May Affect, Likely to Adversely Affect" determination depending on the details of the project. Please contact our New England Ecological Services Field Office to discuss methods to avoid or minimize potential adverse effects to those species or designated critical habitats.

Federal agencies must consult with U.S. Fish and Wildlife Service under section 7(a)(2) of the Endangered Species Act (ESA) when an action *may affect* a listed species. Tricolored bat is proposed for listing as endangered under the ESA, but not yet listed. For actions that may affect a proposed species, agencies cannot consult, but they can *confer* under the authority of section 7(a)(4) of the ESA. Such conferences can follow the procedures for a consultation and be adopted as such if and when the proposed species is listed. Should the tricolored bat be listed, agencies must review projects that are not yet complete, or projects with ongoing effects within the tricolored bat range that previously received a NE or NLAA determination from the key to confirm that the determination is still accurate. Projects that receive a may affect determination for tricolored bat through the key, should contact the appropriate Ecological Services Field Office if they want to conference on this species.

Action Description
You provided to IPaC the following name and description for the subject Action.

1. Name

Q143/R144 Transmission Line Rebuild

2. Description

The following description was provided for the project 'Q143/R144 Transmission Line Rebuild':

> Overhead transmission line maintenance.

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@41.9104564,-71.4758497300802,14z

DETERMINATION KEY RESULT

Based on the answers provided, the proposed Action is consistent with a determination of “may affect” for a least one species covered by this determination key.

QUALIFICATION INTERVIEW

1. Does the proposed project include, or is it reasonably certain to cause, intentional take of listed bats or any other listed species?

   Note: Intentional take is defined as take that is the intended result of a project. Intentional take could refer to research, direct species management, surveys, and/or studies that include intentional handling/encountering, harassment, collection, or capturing of any individual of a federally listed threatened, endangered or proposed species?

   No

2. Is the action area wholly within Zone 2 of the year-round active area for northern long-eared bat and/or tricolored bat?

   Automatically answered
   No

3. Does the action area intersect Zone 1 of the year-round active area for northern long-eared bat and/or tricolored bat?

   Automatically answered
   No

4. Does any component of the action involve leasing, construction or operation of wind turbines? Answer 'yes' if the activities considered are conducted with the intention of gathering survey information to inform the leasing, construction, or operation of wind turbines.

   Note: For federal actions, answer ‘yes’ if the construction or operation of wind power facilities is either (1) part of the federal action or (2) would not occur but for a federal agency action (federal permit, funding, etc.).

   No

5. Is the proposed action authorized, permitted, licensed, funded, or being carried out by a Federal agency in whole or in part?

   Yes

6. Is the Federal Highway Administration (FHWA), Federal Railroad Administration (FRA), or Federal Transit Administration (FTA) funding or authorizing the proposed action, in whole or in part?

   No

7. Are you an employee of the federal action agency or have you been officially designated in writing by the agency as its designated non-federal representative for the purposes of Endangered Species Act Section 7 informal consultation per 50 CFR § 402.08?

   Note: This key may be used for federal actions and for non-federal actions to facilitate section 7 consultation and to help determine whether an incidental take permit may be needed, respectively. This question is for information purposes only.

   Yes

8. Is the lead federal action agency the Environmental Protection Agency (EPA) or Federal Communications Commission (FCC)? Is the Environmental Protection Agency (EPA) or Federal Communications Commission (FCC) funding or authorizing the proposed action, in whole or in part?

   No

9. Is the lead federal action agency the Federal Energy Regulatory Commission (FERC)?

   No

10. [Semantic] Is the action area located within 0.5 miles of a known bat hibernaculum?

    Note: The map queried for this question contains proprietary information and cannot be displayed. If you need additional information, please contact your State wildlife agency.

    Automatically answered
    No

11. Does the action area contain any winter roosts or caves (or associated sinkholes, fissures, or other karst features), mines, rocky outcroppings, or tunnels that could provide habitat for hibernating bats?

    No

12. Does the action area contain (1) talus or (2) anthropogenic or naturally formed rock shelters or crevices in rocky outcrops, rock faces or cliffs?

    No

13. Will the action cause effects to a bridge?

    Note: Covered bridges should be considered as bridges in this question.

    No

14. Will the action result in effects to a culvert or tunnel at any time of year?

    No

15. Are trees present within 1000 feet of the action area?

    Note: If there are trees within the action area that are of a sufficient size to be potential roosts for bats answer "Yes". If unsure, additional information defining suitable summer habitat for the northern long-eared bat and tricolored bat can be found in Appendix A of the USFWS' Range-wide Indiana Bat and Northern long-eared bat Survey Guidelines at: https://www.fws.gov/media/range-wide-indiana-bat-and-northern-long-eared-bat-survey-guidelines.

    Yes

16. Does the action include the intentional exclusion of bats from a building or structure?

    Note: Exclusion is conducted to deny bats' entry or reentry into a building. To be effective and to avoid harming bats, it should be done according to established standards. If your action includes bat exclusion and you are unsure whether northern long-eared bats or tricolored bats are present, answer "Yes." Answer "No" if there are no signs of bat use in the building/structure. If unsure, contact your local Ecological Services Field Office to help assess whether northern long-eared bats or tricolored bats may be present. Contact a Nuisance Wildlife Control Operator (NWCO) for help in how to exclude bats from a structure safely without causing harm to the bats (to find a NWCO certified in bat standards, search the Internet using the search term "National Wildlife Control Operators Association bats"). Also see the White-Nose Syndrome Response Team's guide for bat control in structures.

    No

17. Does the action involve removal, modification, or maintenance of a human-made structure (barn, house, or other building) **known or suspected to contain roosting bats?**

    No

18. Will the action cause construction of one or more new roads open to the public?

    For federal actions, answer 'yes' when the construction or operation of these facilities is either (1) part of the federal action or (2) would not occur but for an action taken by a federal agency (federal permit, funding, etc.).

    No

19. Will the action include or cause any construction or other activity that is reasonably certain to increase average daily traffic permanently or temporarily on one or more existing roads?

    Note: For federal actions, answer 'yes' when the construction or operation of these facilities is either (1) part of the federal action or (2) would not occur but for an action taken by a federal agency (federal permit, funding, etc.). .

    No

20. Will the action include or cause any construction or other activity that is reasonably certain to increase the number of travel lanes on an existing thoroughfare?

    For federal actions, answer ‘yes’ when the construction or operation of these facilities is either (1) part of the federal action or (2) would not occur but for an action taken by a federal agency (federal permit, funding, etc.).

    No

21. Will the proposed Action involve the creation of a new water-borne contaminant source (e.g., leachate pond, pits containing chemicals that are not NSF/ANSI 60 compliant)?

    Note: For information regarding NSF/ANSI 60 please visit https://www.nsf.org/knowledge-library/nsf-ansi-standard-60-drinking-water-treatment-chemicals-health-effects

    No

22. Will the proposed action involve the creation of a new point source discharge from a facility other than a water treatment plant or storm water system?

    No

23. Will the action include drilling or blasting?

    Yes

24. Will the drilling or blasting produce noise or vibrations above existing background levels that will affect suitable summer habitat for northern long-eared bats and/or tricolored bats?

    Note: Additional information defining suitable suitable summer habitat for the northern long-eared bat and/or tricolored bat, can be found in Appendix A in the USFWS' Range-wide Indiana Bat and Northern long-eared Bat Survey Guidelines at: https://www.fws.gov/media/range-wide-indiana-bat-and-northern-long-eared-bat-survey-guidelines

    Yes

25. Will the action involve military training (e.g., smoke operations, obscurant operations, exploding munitions, artillery fire, range use, helicopter or fixed wing aircraft use)?

    No

26. Will the proposed action involve the use of herbicides or other pesticides other than herbicides (e.g., fungicides, insecticides, or rodenticides)?

    No

27. Will the action include or cause activities that are reasonably certain to cause chronic or intense nighttime noise (above current levels of ambient noise in the area) in suitable summer habitat for the northern long-eared bat or tricolored bat during the active season?

    Chronic noise is noise that is continuous or occurs repeatedly again and again for a long time. Sources of chronic or intense noise that could cause adverse effects to bats may include, but are not limited to: road traffic; trains; aircraft; industrial activities; gas compressor stations; loud music; crowds; oil and gas extraction; construction; and mining.

    Note: Additional information defining suitable summer habitat for the northern long-eared bat and tricolored bat can be found in Appendix A of the USFWS' Range-wide Indiana Bat and Northern long-eared bat Survey Guidelines at: https://www.fws.gov/media/range-wide-indiana-bat-and-northern-long-eared-bat-survey-guidelines.

    No

28. Does the action include, or is it reasonably certain to cause, the use of permanent or temporary artificial lighting within 1000 feet of suitable northern long-eared bat or tricolored bat roosting habitat?

    Note: Additional information defining suitable summer habitat for the northern long-eared bat and tricolored bat can be found in Appendix A of the USFWS' Range-wide Indiana Bat and Northern long-eared bat Survey Guidelines at: https://www.fws.gov/media/range-wide-indiana-bat-and-northern-long-eared-bat-survey-guidelines.

    No

29. Will the action include tree cutting or other means of knocking down or bringing down trees, tree topping, or tree trimming?

    Yes

30. Will the proposed action occur exclusively in an already established and currently maintained utility right-of-way?

    Yes

31. Will the proposed action result in the cutting of entire trees outside of the currently maintained utility right-of-way?

    No

32. Will tree trimming, limbing, or cutting be used to expand the footprint of any currently maintained utility rights-of-way?

    Yes

33. Does the action include emergency cutting or trimming of hazard trees in order to remove an imminent threat to human safety or property? See hazard tree note at the bottom of the key for text that will be added to response letters

    Note: A "hazard tree" is a tree that is an immediate threat to lives, public health and safety, or improved property.

    No

34. Does the project intersect with the 0- 9.9% forest density category?

    Automatically answered
    Yes

35. Does the project intersect with the 10.0- 19.9% forest density category map?

    Automatically answered
    No

36. Does the project intersect with the 20.0- 29.9% forest density category map?

    Automatically answered
    Yes

37. Does the project intersect with the 30.0- 100% forest density category map?

    Automatically answered
    Yes

38. Will the action cause trees to be cut, knocked down, or otherwise brought down across an area greater than 0.5 acre in total extent?

    No

39. Will the action cause trees to be cut, knocked down, or otherwise brought down across an area greater than 40 acres in total extent?

    No

40. Will the proposed action result in the use of prescribed fire?

    Note: If the prescribed fire action includes other activities than application of fire (e.g., tree cutting, fire line preparation) please consider impacts from those activities within the previous representative questions in the key. This set of questions only considers impacts from flame and smoke.

    No

41. Does the action area intersect the northern long-eared bat species list area?

    Automatically answered
    Yes

42. [Semantic] Is the action area located within 0.25 miles of a culvert that is known to be occupied by northern long-eared or tricolored bats?

    Automatically answered
    No

43. [Semantic] Is the action area located within 150 feet of a documented northern long-eared bat roost site?

    Note: The map queried for this question contains proprietary information and cannot be displayed. If you need additional information, please contact your State wildlife agency.

    Automatically answered
    No

44. Is suitable summer habitat for the northern long-eared bat present within 1000 feet of project activities?
If unsure, answer "Yes."

    Note: Additional information defining suitable summer habitat for the northern long-eared bat and tricolored bat can be found in Appendix A of the USFWS' Range-wide Indiana Bat and Northern long-eared bat Survey Guidelines at: https://www.fws.gov/media/range-wide-indiana-bat-and-northern-long-eared-bat-survey-guidelines.

    Yes

45. Has a presence/probable absence summer bat survey targeting the northern long-eared bat following the Service's Range-wide Indiana Bat and Northern Long-Eared Bat Survey Guidelines been conducted within the project area?

    No

46. Will drilling or blasting occur during the **Summer Occupancy** season for northern long-eared bats in the action area?

    Note: Bat activity periods for your state can be found in Appendix L of the Service's Range-wide Indiana Bat and Northern long-eared Bat Survey Guidelines.

    Yes

47. Does the action area intersect the tricolored bat species list area?

    Automatically answered
    Yes

48. [Semantic] Is the action area located within 0.25 miles of a culvert that is known to be occupied by northern long-eared or tricolored bats?

    Note: The map queried for this question contains proprietary information and cannot be displayed. If you need additional information, please contact your State wildlife agency.

    Automatically answered
    No

49. Is suitable summer habitat for the tricolored bat present within 1000 feet of project activities?
(If unsure, answer ""Yes."")

    Note: If there are trees within the action area that may provide potential roosts for tricolored bats (e.g., clusters of leaves in live and dead deciduous trees, Spanish moss (Tillandsia usneoides), clusters of dead pine needles of large live pines) answer ""Yes."" For a complete definition of suitable summer habitat for the tricolored bat, please see Appendix A in the Service's Range-wide Indiana Bat and Northern long-eared Bat Survey Guidelines.

    Yes

50. Will drilling or blasting occur during the **Fall Swarming** season for tricolored bats in the action area?

    Note: Bat activity periods for your state can be found in Appendix L of the Service's Range-wide Indiana Bat and Northern long-eared Bat Survey Guidelines.

    Yes

51. Do you have any documents that you want to include with this submission?

    No

PROJECT QUESTIONNAIRE

Enter the extent of the action area (in acres) from which trees will be removed - round up to the nearest tenth of an acre. For this question, include the entire area where tree removal will take place, even if some live or dead trees will be left standing.

0.1

IPAC USER CONTACT INFORMATION

Agency: BSC Group
Name: Alison Milliman
Address: 1 Mercantile Street Suite 610
City: Worcester
State: MA
Zip: 01608
Email amilliman@bscgroup.com
Phone: 6178964532

LEAD AGENCY CONTACT INFORMATION

Lead Agency: Army Corps of Engineers

Public Archaeology Laboratory

May 22, 2024

Jeffery Emidy
Executive Director and State Historic Preservation Officer
Rhode Island Historical Preservation & Heritage Commission
The Old State House
150 Benefit Street
Providence, Rhode Island 02903

Re: The Narragansett Electric Company, Line Q143-R144 Rebuild Project –
North Smithfield, Lincoln, North Providence, and Providence, Rhode Island
Phase I Site Identification Archaeological Survey Permit Amendment
PAL #3603.03

Attn: Charlotte Taylor and Elizabeth Totten

Dear Mr. Emidy:

The Narragansett Electric Company (TNEC) is planning to rebuild the 115 kV Q143 and R144 lines in North Smithfield, Lincoln, North Providence, and Providence, Rhode Island as part of the Lines Q143/R144 Rebuild Project (the Project). The rebuild Project consists of approximately 11.5 miles from the Woonsocket No. 26 Substation to the Admiral Street Substation in Providence. On behalf of TNEC, The Public Archaeology Laboratory, Inc. (PAL) completed a cultural resource due diligence for the proposed Project (see Cultural Resource Due Diligence).

PAL initiated a Phase I archaeological survey for the proposed Project in 2020 under Rhode Island Historical Commission and Heritage Commission (RIHPHC) Permit #20-05, which was issued by RIHPHC to PAL on March 24, 2020. On October 29, 2021, PAL submitted a report on the Phase I archaeological survey for a portion of the Project facilities between the Woonsocket substation and the Admiral Street Terminal and communicated that the Project was being placed on hold. In late 2023, TNEC re-activated the Project and requested that PAL resume the Phase I archaeological survey. PAL also plans to perform an historic architectural reconnaissance survey and effects assessment for the Project and will submit the results under separate cover later this year.

Please find enclosed the following scope of services for PAL to perform a Phase I archaeological site identification survey for the Project, which includes proposed conditions plans (Environmental Resource mapping) with PAL's archaeological sensitivity:

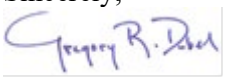
> *Scope of Services, Phase I Site Identification Archaeological Survey – The Narragansett Electric Company, Line Q143-R144 Rebuild Project, North Smithfield, Lincoln, North Providence, and Providence, Rhode Island – May 2, 2024*

PAL is requesting to reinstate and extend the RIHPHC Permit #20-05. We are also requesting that Erin Flynn replace Ora Elquist as the Principal Investigator on the permit.

By copy of this letter, PAL is also providing the enclosed documentation to the Mashpee Wampanoag Tribe, the Wampanoag Tribe of Gay Head (Aquinnah), and the Narragansett Indian Tribe, pursuant to the requirements of the USACE Rhode Island General Permit and guidance from RIHPHC.

Thank you for your time and attention to this matter. If you have any questions or require additional information, please do not hesitate to contact Erin Flynn, Principal Investigator, or me at your convenience.

Sincerely,



Greg Dubell
Senior Project Manager

Enclosures

cc: David Boers, Rhode Island Energy (w/encl. – via email)
Marc Smith, Rhode Island Energy (w/encl. – via email)
Alison Milliman, BSC (w/encl. – via email)
Keith Goulet, U.S. Army Corps of Engineers (w/encl. – via email)
John Brown, III, Narragansett Indian Tribe (w/encl. – via email)
Cora Peirce, Narragansett Indian Tribe (w/encl.)
Mark Andrews, Narragansett Indian Tribe (w/encl.)
Bettina Washington, Wampanoag Tribe of Gay Head (Aquinnah) (w/encl. – via email)
David Weeden, Mashpee Wampanoag Tribe (w/encl. – via email)
Nakia Hendricks, Jr., Mashpee Wampanoag Tribe (w/encl. – via email)

Alison Milliman

From: Dubell, Gregory (External) <GDubell@PALINC.COM>
Sent: Wednesday, May 22, 2024 2:36 PM
To: 'Taylor, Charlotte (HPHC)'; Totten, Elizabeth (HPHC); 'David Weeden'; 'Nakia Hendricks Jr'; '106Review'; 'Bettina Washington'; 'brwnjbb123 at aol.com'; 'tashtesook@aol.com'; Mark Andrews (andrewsdrywall@gmail.com); 'cora peirce'; Goulet, Keith A CIV USARMY CENAE (USA)
Cc: Marc Smith (RI Energy); Boers, David John (Contractor); Alison Milliman; Erin Flynn; Melissa Emery
Subject: [EXTERNAL] RE: Rhode Island Energy / TNEC Line Q143/R144 Rebuild Project - Phase I Archaeological Survey Permit Amendment Request
Attachments: TNEC Line Q143-R144 - Phase I Archaeological Survey Permit Amendment to RIHPHC - 5-22-24.pdf

Thanks Charlotte.

As a follow-up to the correspondence regarding the geotechnical soil boring program, please see attached for a letter from PAL to RIHPHC, cc'ing the Tribes, submitting a cultural resource due diligence report and a scope of work for PAL to perform a Phase I archaeological survey for the proposed TNEC Line Q143/R144 Rebuild Project.

PAL is requesting that RIHPHC amends Permit #20-05 to reflect the methodology outlined in the attached scope and to change the Principal Investigator to Erin Flynn.

The documentation referenced in the attached letter can be found at the following file share link: TNEC Line Q143-R144 Rebuild

Upon receipt of the Permit Amendment, PAL plans to schedule the Phase I archaeological survey fieldwork for mid to late June 2024 and continue into July. We plan to send an email notification to the Tribes in the event any Tribal representatives would like to accompany the PAL crew during the survey.

In the meantime, if there are questions or if anyone needs additional information, just let us know.

Thanks,
Greg

Gregory R. Dubell, RPA
Senior Project Manager
401.288.6322 direct | 401.575.0624 cell

The Public Archaeology Laboratory, Inc.
26 Main Street, Pawtucket, RI 02860
401.728.8780 | www.palinc.com

From: Taylor, Charlotte (HPHC) <Charlotte.Taylor@preservation.ri.gov>
Sent: Tuesday, May 21, 2024 4:03 PM
To: Gregory R. Dubell <GDubell@PALINC.COM>; 'David Weeden' <David.Weeden@mwtribe-nsn.gov>; 'Nakia Hendricks Jr' <Nakia.HendricksJr@mwtribe-nsn.gov>; '106Review' <106review@mwtribe-nsn.gov>; 'Bettina Washington' <thpo@wampanoagtribe-nsn.gov>; 'brwnjbb123 at aol.com' <brwnjbb123@aol.com>; 'tashtesook@aol.com' <tashtesook@aol.com>; Mark Andrews (andrewsdrywall@gmail.com) <andrewsdrywall@gmail.com>; 'cora peirce' <coradot@yahoo.com>; Goulet, Keith A CIV USARMY CENAE (USA) <Keith.A.Goulet@usace.army.mil>
Cc: Smith, Marc (RI Energy) <Marc.Smith1@nationalgrid.com>; 'Milliman, Alison' <AMilliman@bscgroup.com>; Erin Flynn <EFlynn@PALINC.COM>; Melissa Emery <memery@palinc.com>
Subject: RE: Rhode Island Energy / TNEC Line Q143/R144 Rebuild Project - Cultural Resource Assessment for Geotechnical Soil Borings

RIHPHC's letter regarding this assessment is attached.

Best,

Charlotte Taylor
Archaeologist, RIHPHC

From: Gregory R. Dubell <GDubell@PALINC.COM>
Sent: Thursday, May 9, 2024 2:04 PM
To: Taylor, Charlotte (HPHC) <Charlotte.Taylor@preservation.ri.gov>; 'David Weeden' <David.Weeden@mwtribe-nsn.gov>; 'Nakia Hendricks Jr' <Nakia.HendricksJr@mwtribe-nsn.gov>; '106Review' <106review@mwtribe-nsn.gov>; 'Bettina Washington' <thpo@wampanoagtribe-nsn.gov>; 'brwnjbb123 at aol.com' <brwnjbb123@aol.com>; 'tashtesook@aol.com' <tashtesook@aol.com>; Mark Andrews (andrewsdrywall@gmail.com) <andrewsdrywall@gmail.com>; 'cora peirce' <coradot@yahoo.com>; Goulet, Keith A CIV USARMY CENAE (USA) <Keith.A.Goulet@usace.army.mil>
Cc: Smith, Marc (RI Energy) <Marc.Smith1@nationalgrid.com>; 'Milliman, Alison' <AMilliman@bscgroup.com>; Erin Flynn <EFlynn@PALINC.COM>; Melissa Emery <memery@palinc.com>
Subject: Rhode Island Energy / TNEC Line Q143/R144 Rebuild Project - Cultural Resource Assessment for Geotechnical Soil Borings

Hello All,

Please see attached for a letter from PAL to MHC, cc'ing the Tribes and USACE, submitting a cultural resource assessment for Rhode Island Energy / The Narragansett Electric Company (TNEC) to perform 34 geotechnical soil borings as a pre-construction activity to design the Line Q143/R144 Rebuild Project in North Smithfield, Lincoln, North Providence, and Providence, Rhode Island.

PAL has assessed archaeological sensitivity along the Q143/R144 ROW and recommends that TNEC avoid ground disturbance within areas of sensitivity during the soil boring program, with the exception of the bore hole itself.

In the near future and under separate cover, PAL will be submitting an application for a State Archaeologist's Permit to perform a Phase I archaeological survey for the TNEC Line Q143/R144 Rebuild Project, focusing on structure replacement work pads and access roads, with fieldwork projected to take place later this field season.

In the meantime, if there are questions or if anyone needs additional information, just let us know.

Thanks,
Greg

Gregory R. Dubell, RPA
Senior Project Manager
401.288.6322 direct | 401.575.0624 cell

The Public Archaeology Laboratory, Inc.
26 Main Street, Pawtucket, RI 02860
401.728.8780 | www.palinc.com [palinc.com]

APPENDIX C

Q143S/R144 LINES REBUILD PROJECT

Rhode Island Energy Facility Siting Board
Siting Report

VISUAL SIMULATIONS

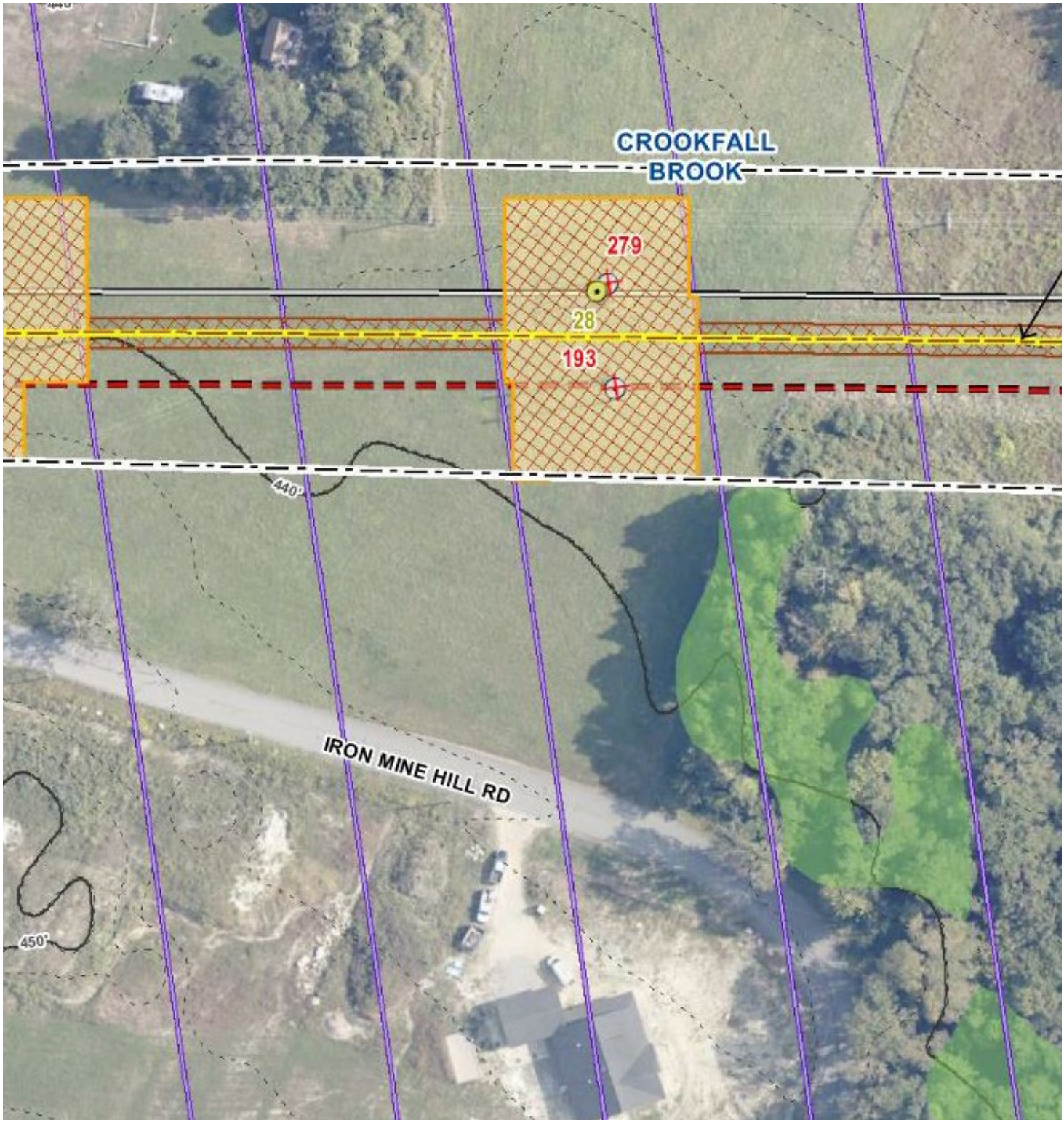

CROOKFALL
BROOK
279
28
193
440'
IRON MINE HILL RD
450'

Photo #1: Existing conditions of 303 Iron Mine Hill Rd. in North Smith, RI.

Photo #1a: Visual sim of the proposed line 'Q143S/ R144'. Here is showing Q143S, Structure 28 with weathered steel.

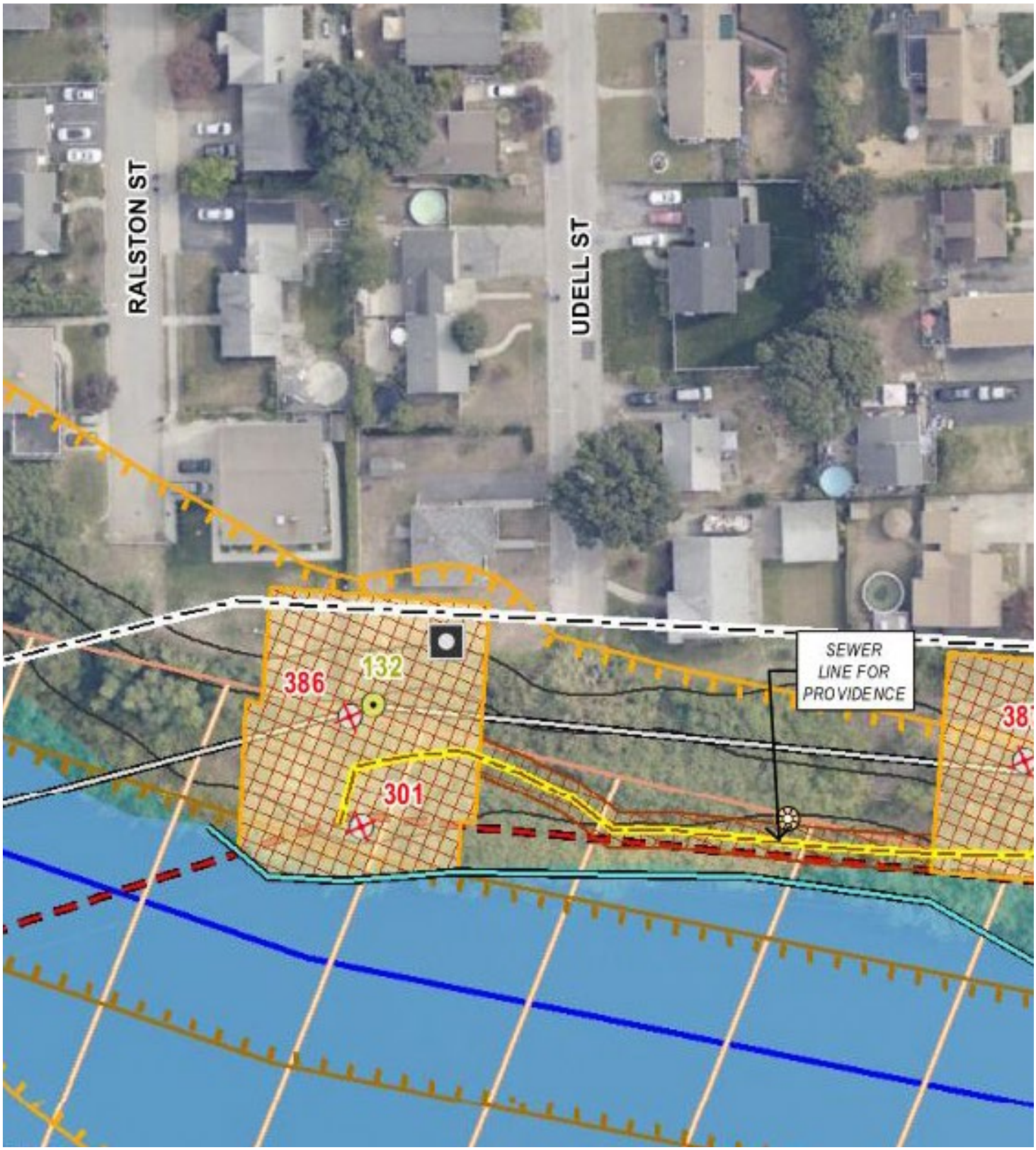

RALSTON ST
UDELL ST
386
132
301
SEWER
LINE FOR
PROVIDENCE

Photo #2: Existing conditions of 52 Ralston St. in Providence, RI.

Photo #2a: Visual sim of the proposed line 'Q143S/ R144'. Here is showing Q143S, Structure 132 with weathered steel.

City of WOONSOCKET, RI

Farnum #105 S/S

Woonsocket S/S

West Farnum S/S

Town of NORTH SMITHFIELD, RI

Town of BURRILLVILLE, RI

Town of SMITHFIELD, RI

Farnum Pike S/S

Washington S/S

Town of LINCOLN, RI

Town of CUMBERLAND, RI

City of CENTRAL FALLS, RI

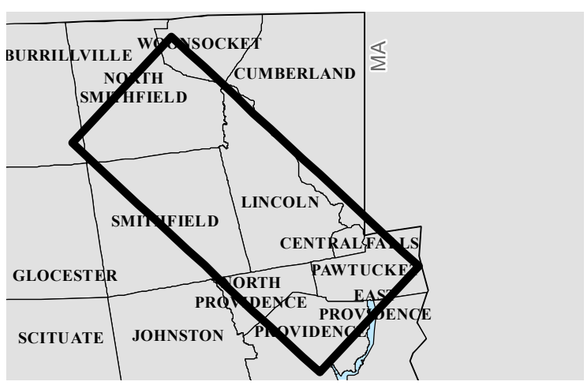
City of PAWTUCKET, RI

City of PROVIDENCE, RI

Admiral Street S/S

Town of NORTH PROVIDENCE, RI

Project Vicinity



Legend

- Project Features
- Existing Power Facility
- Town Boundary

Q143/R144 Lines Rebuild Project

Figure 1-1 - Project Overview Map

State of Rhode Island

Providence County:
City of Woonsocket, Town of North Smithfield, Town of Lincoln, Town of North Providence, City of Providence

BSC GROUP

NAD 1983 2011 StatePlane Rhode Island FIPS 3800 Ft US

Rhode Island Energy

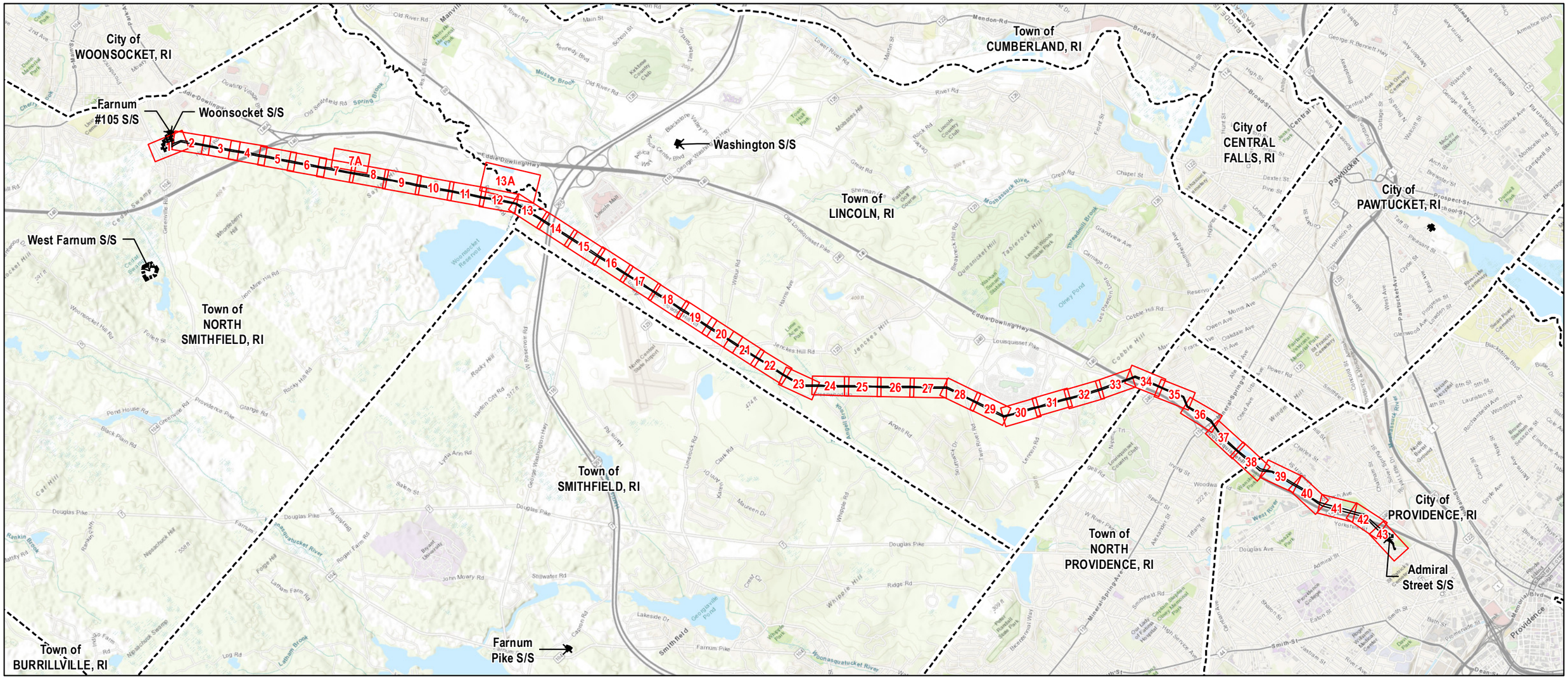
0 1 2 Miles

1 " = 4,250 '

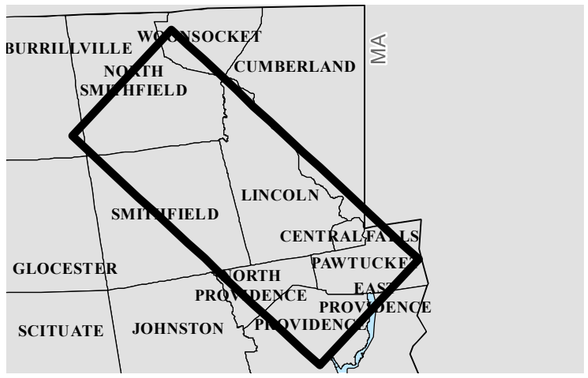
NOT FOR CONSTRUCTION

DATE: May 2025

AUTHOR: KANDREWS



Project Vicinity



Legend

- Project Features
- Existing Power Facility
- Town Boundary

Q143/R144 Lines Rebuild Project

Figure 3 -1 - Project Alignment Drawings Index Map

State of Rhode Island

Providence County:
City of Woonsocket, Town of North Smithfield, Town of Lincoln, Town of North Providence, City of Providence

BSC GROUP

NAD 1983 2011 StatePlane Rhode Island FIPS 3800 Ft US

Rhode Island Energy

0 1 2 Miles

1 " = 4,250 '

NOT FOR CONSTRUCTION

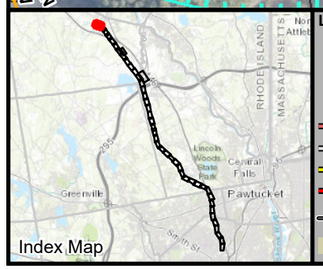
DATE: May 2025

AUTHOR: KANDREWS

File Location: G:\GISPrj\8984061\Output\Maps\MXD\ReportMaps\EFSB\Figure_3_1_Project_Alignment_Drawings.mxd
Date Saved: 3/4/2025 2:51:40 PM

ALL WORK IS ENTIRELY WITHIN DEM WETLAND JURISDICTION. WORK ON AGES 1-36 (PROPOSED STR 124) ARE ENTIRELY WITHIN RIVER REGION 2. PAGES 36-43 ARE ENTIRELY WITHIN URBAN RIVER REGION.

NS-W4
NS-W4
FARNUM #105 S/S
NORTH SMITHFIELD
WOONSOCKET S/S
NS-W5
NS-SC6
NS-S5A
LINE H17
NS-W3
LINE Q143S
LINE R144
LINE S174N
LINE T172N
NS-W1
NS-W2
NS-SC2
NS-S2
NS-SC1
GREENVILLE RD
Natural Heritage Area
LINE V148N
INSTALL PLUNGE POOL
TREE REMOVAL
CROSS ST
VINCENT AVE
URRICO AVE
FAIRVIEW AVE
JOHN AV



Legend

- Existing Structure
- Replace Structure
- Install Structure
- Remove Structure
- Existing Overhead Line
- Replace Overhead Line
- Install Overhead Line
- Remove Overhead Line
- Approximate Construction Vehicle Route
- Existing Access
- Existing Access to be Improved
- Engineered Access
- Access Preparation & Mow
- Temporary Access to be Restored
- Matted Work Areas
- Proposed Structure Work Pad
- Pull Pad
- Limit of Disturbance
- Delineated Stream/Pond Bank
- Delineated Stream Centerline
- Estimated Pond Bank
- Field Delineated Stream Area*
- Field Delineated Wetland Boundary
- Field Delineated Wetlands*
- USFWS Wetlands*
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- 100ft Jurisdictional Area to Wetlands
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- FEMA 100yr Floodplain*
- Surface Water Protection Area
- Protected Resource Location
- Natural Heritage Area
- Conservation Land
- Sensitive Resource
- Hazardous Material Site
- Leaking Underground Storage
- Approximate ROW Limits
- Guardrail
- Stonewall
- Approximate Gas Pipeline
- Temporary Safety Fencing
- Sensitive Resource Area
- Town Boundary
- Manhole
- Catch Basin
- Culvert
- Company Gate
- Noncompany Gate
- Proposed Tree Removal
- Existing 2ft Contours
- Existing 10ft Contours
- Proposed Major Contour
- Proposed Minor Contour

N

1 inch = 100 feet
0 50 100
Feet

Indicates Layers Set to Transparency

Q143/R144 LINES REBUILD PROJECT

Figure 3-1 - Project Alignment Drawings

North Smithfield, RI

RIDEM
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Rhode Island Energy
BSC GROUP

ALL WORK IS ENTIRELY WITHIN DEM WETLAND JURISDICTION. WORK ON AGES 1-36 (PROPOSED STR 124) ARE ENTIRELY WITHIN RIVER REGION 2. PAGES 36-43 ARE ENTIRELY WITHIN URBAN RIVER REGION.

NS-W5 NS-SC5 NS-SC5A NS-S5A NS-W6A NS-SC6 NS-W6 NORTH SMITHFIELD Natural Heritage Area NS-W7

LINE H17 LINE V148N LINE Q143S LINE R144

INSTALL PLUNGE POOL INSTALL STONE FILTER TREE REMOVAL

PHEASANT RUN RD HANTON RD URRICO AVE FAIRVIEW AVE ROBIN WAY

Index Map

Legend

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Q143/R144 LINES REBUILD PROJECT

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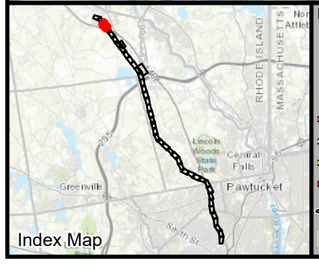

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Q143/R144 LINES REBUILD PROJECT

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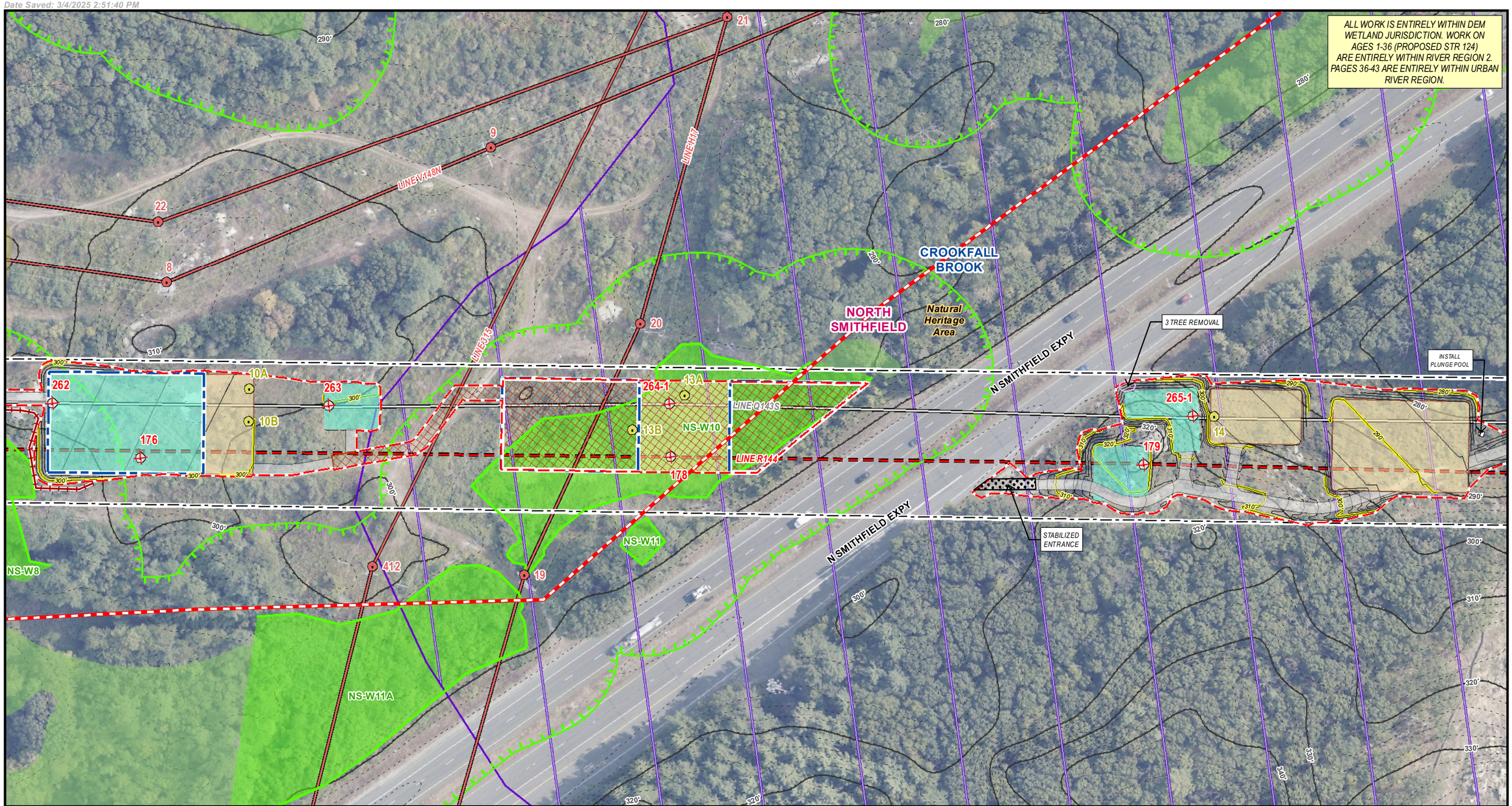

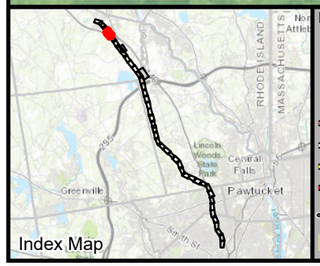

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Q143/R144 LINES REBUILD PROJECT

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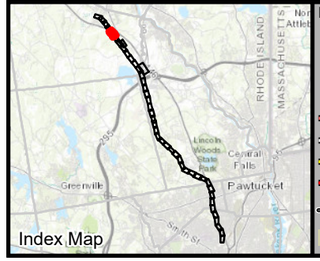
N SMITHFIELD EXPY
N SMITHFIELD EXPY
CROOKFALL BROOK
PRINCE RD
NORTH SMITHFIELD
INSTALL PLUNGE POOL
15
266
180
NS-W12
LINE R144
NS-S13
NS-W13
LINE Q143S
267
16
181
SPAN STREAM
NS-W13
Spring Brook
Natural Heritage Area
268
17
182



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Q143/R144 LINES REBUILD PROJECT

Figure 3-1 - Project Alignment Drawings

North Smithfield, RI

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Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Rhode Island Energy
BSC GROUP

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PRINCE RD

CROOKFALL BROOK

NS-W14

NS-W15

NS-W15

LINE Q143

LINE R144

NS-S15

NORTH SMITHFIELD

Natural Heritage Area

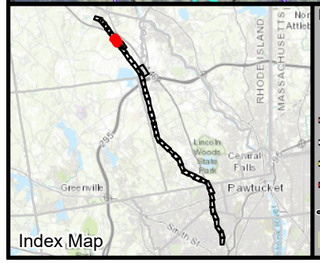
17 268 182

18 269 183

19 270 184

20 271 185

280' 290' 300' 310' 320' 330' 340' 350' 360' 370' 380' 390'



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- Leaking Underground Storage
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- Town Boundary
- Manhole
- Catch Basin
- Culvert
- Company Gate
- Noncompany Gate
- Proposed Tree Removal
- Existing 2ft Contours
- Existing 10ft Contours
- Proposed Major Contour
- Proposed Minor Contour

N

1 inch = 100 feet
0 50 100
Feet

*Indicates Layers Set to Transparency

Q143/R144 LINES REBUILD PROJECT

Figure 3-1 - Project Alignment Drawings

North Smithfield, RI

RIDEM
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

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SHEET 7A
SHEET 7

ST JUDE

STABILIZED ENTRANCE

MATTING MAY BE REQUIRED BASED ON FIELD CONDITIONS

CROOKFALL BROOK

LINE Q143S

LINE R144

NS-W16

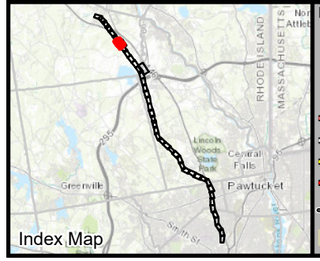
AREA MAY REQUIRE MATTING ON LAWN

MATTING MAY BE REQUIRED BASED ON FIELD CONDITIONS

NORTH SMITHFIELD

20 271 185 21 272 186 22 273 187 23 274 188

380' 390' 400' 410' 420' 430' 440'



Legend

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Q143/R144 LINES REBUILD PROJECT

Figure 3-1 - Project Alignment Drawings

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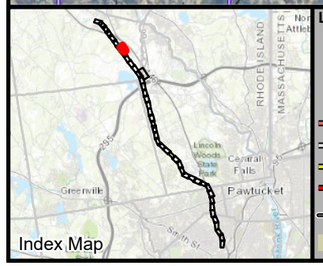
360'
370'
380'
390'
400'
410'
420'
430'
440'

SAYLES HILL RD
ST JUDE
RUE DE ST JUDE RD
CROOKFALL BROOK
NORTH SMITHFIELD

SHEET 7A
SHEET 7

STABILIZED ENTRANCE

MATTING MAY BE REQUIRED BASED ON FIELD CONDITIONS



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0 50 100
Feet

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Q143/R144 LINES REBUILD PROJECT

Figure 3-1 - Project Alignment Drawings

North Smithfield, RI

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RUE DE ST JUDE RD

IRON MINE HILL RD

STABILIZED ENTRANCE

CROOKFALL BROOK

NORTH SMITHFIELD

LINE Q143S

LINE R144

24 275 NS-W16 189

25 276 190

26 277 191

27 278 NS-W17 192

430' 440' 450'

Index Map

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Q143/R144 LINES REBUILD PROJECT

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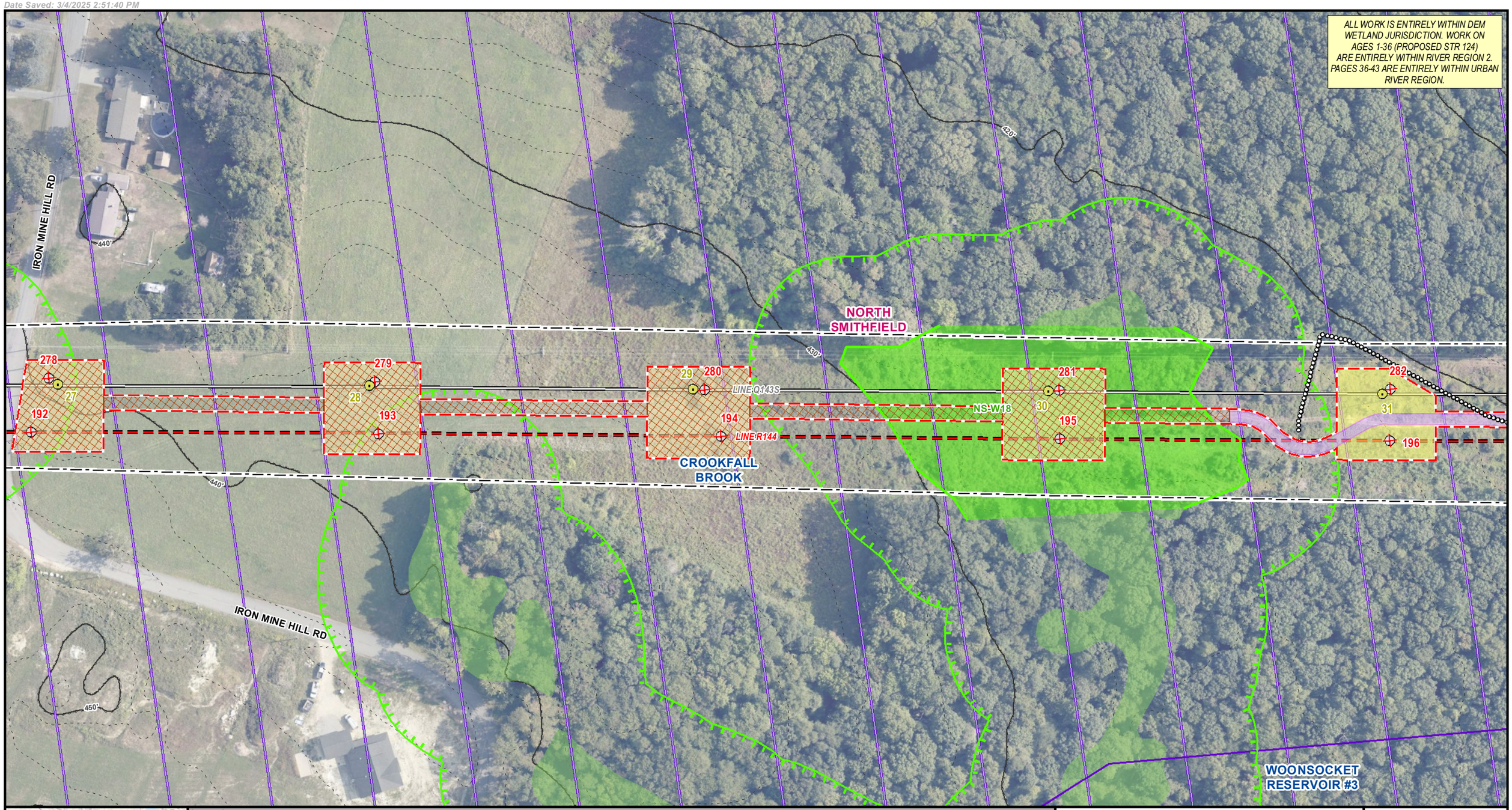

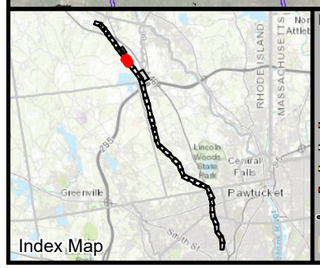

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Feet

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Q143/R144 LINES REBUILD PROJECT

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NORTH SMITHFIELD

CROOKFALL BROOK

WOONSOCKET RESERVOIR #3

AIR BRIDGE STONE WALL WITH MATTING

Index Map

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Q143/R144 LINES REBUILD PROJECT

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North Smithfield, RI

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NORTH SMITHFIELD

CROOKFALL BROOK

310'

320'

340'

350'

330'

360'

310'

300'

Natural Heritage Area

35 286 LINE Q143S 200

36 287 201

NS-W23

NS-W22

NS-SC22

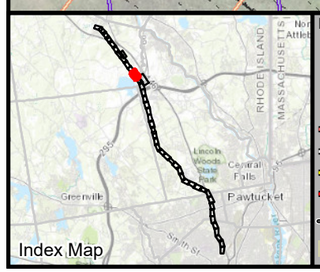
LINE R144

288 37 202

289 38 203

370'

380'



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Q143/R144 LINES REBUILD PROJECT

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North Smithfield, RI

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LINCOLN
Crookfall Brook
CROOKFALL BROOK
Natural Heritage Area
NS-W24
LINE Q143S
LINE R144
RESERVOIR RD
NORTH SMITHFIELD
289
38
203
290
39
204
291
40
205
292
41
206
42A/B
293
207
300'
310'
320'
330'

Index Map

Legend

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Q143/R144 LINES REBUILD PROJECT

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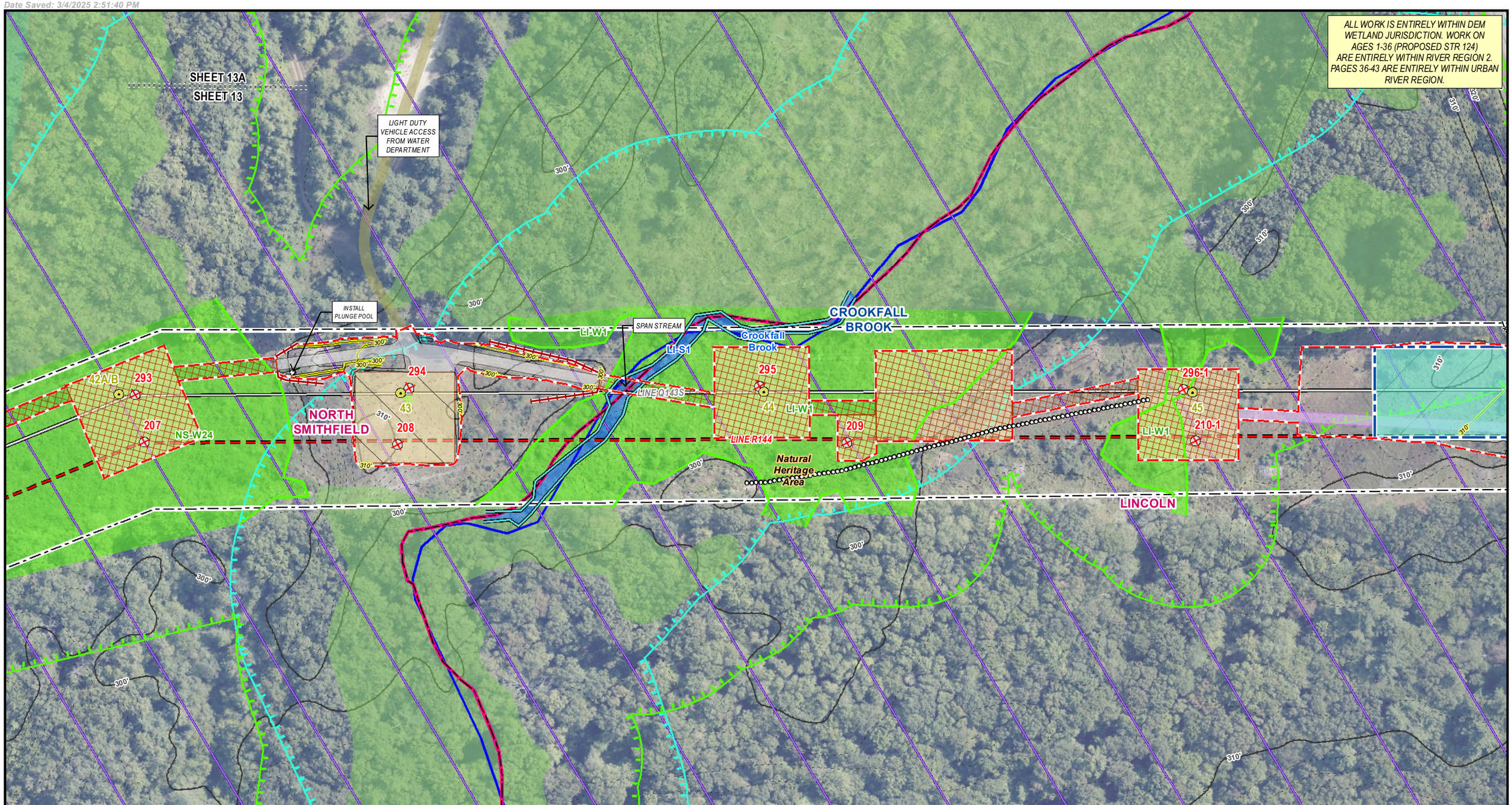

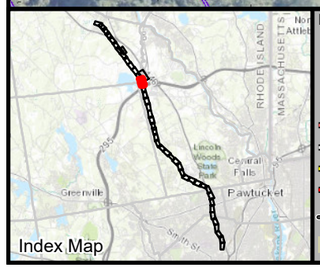

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Q143/R144 LINES REBUILD PROJECT

Figure 3-1 - Project Alignment Drawings

North Smithfield & Lincoln, RI

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ACCESS FROM RESERVOIR ROAD -71.486997 41.950618

EXISTING ESTABLISHED ACCESS ROAD. NO WETLAND CROSSINGS ARE REQUIRED.

EXISTING CULVERTED STREAM CROSSING

LINCOLN

CROOKFALL BROOK

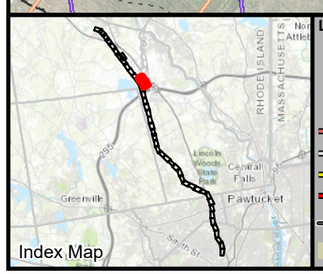
NORTH SMITHFIELD

RESERVOIR RD

Natural Heritage Area

Crookfall Brook

SHEET 13A
SHEET 13



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1 inch = 150 feet
0 80 160
Feet

***Indicates Layers Set to Transparency**

Q143/R144 LINES REBUILD PROJECT

Figure 3-1 - Project Alignment Drawings

North Smithfield & Lincoln, RI
Page 13A of 43

RIDEM
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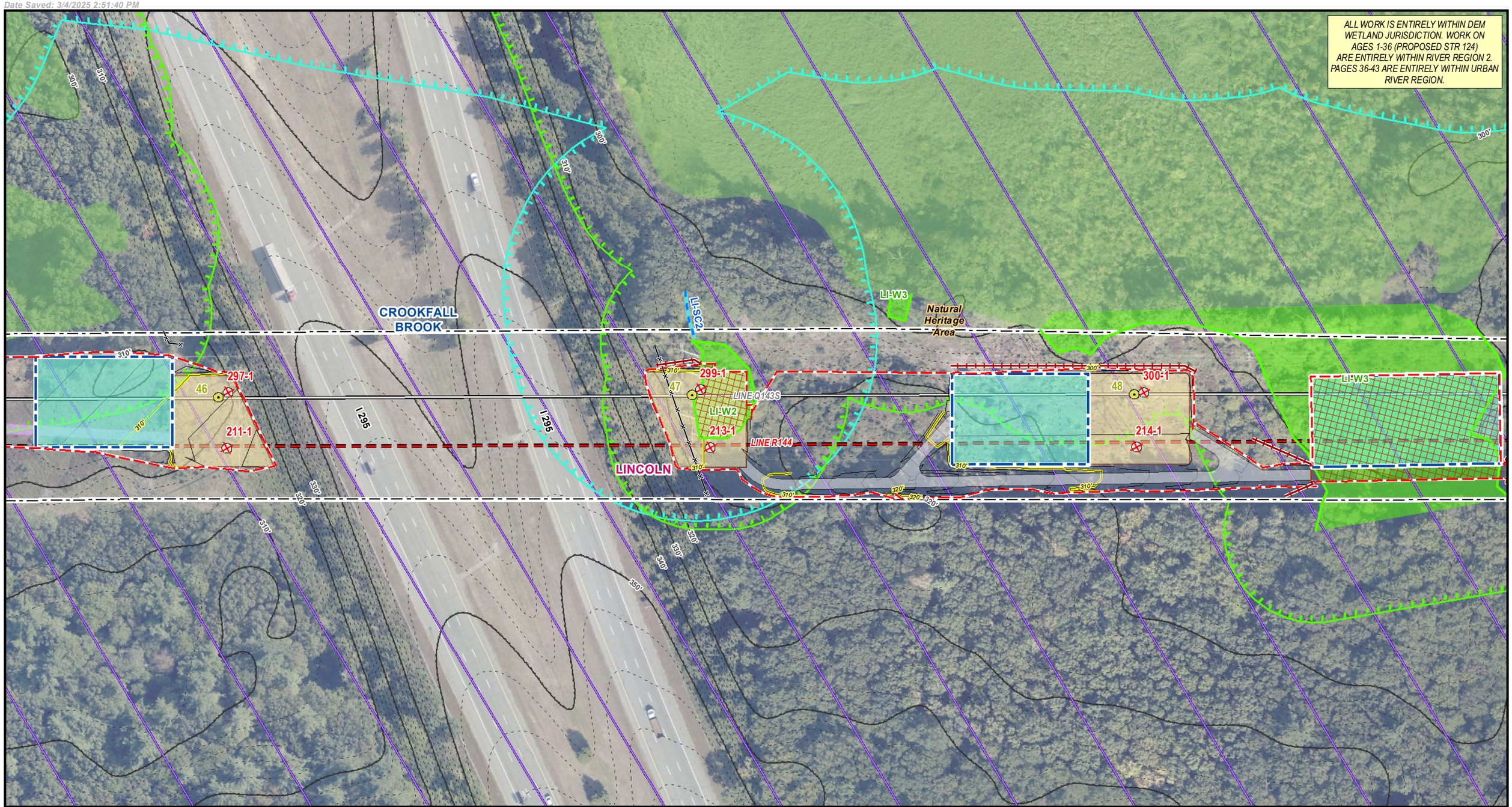

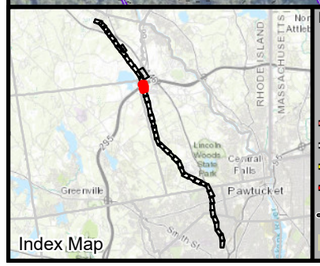

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- Remove Structure
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- Pull Pad
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- Leaking Underground Storage
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- Stonewall
- Approximate Gas Pipeline
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- Noncompany Gate
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- Proposed Minor Contour

N

1 inch = 100 feet
0 50 100
Feet

*Indicates Layers Set to Transparency

Q143/R144 LINES REBUILD PROJECT

Figure 3-1 - Project Alignment Drawings

Lincoln, RI

RIDEM
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

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GEORGE WASHINGTON HWY

APPROXIMATE CONSTRUCTION VEHICLE ROUTE. COORDINATE WITH PROPERTY OWNER.

COORDINATE WORK AREA WITH PROPERTY OWNER

LI-W3

301

49

215

302

50

216

LINE Q143S

LINE R144

LINCOLN

CROOKFALL BROOK

Natural Heritage Area

STABILIZED ENTRANCE

303

51

217

LI-W4

304

52

218

LI-S4

STABILIZED ENTRANCE

Index Map

Legend

- Existing Structure
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- Install Structure
- Remove Structure
- Existing Overhead Line
- Replace Overhead Line
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Q143/R144 LINES REBUILD PROJECT

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COORDINATE WORK AREA WITH PROPERTY OWNER

APPROXIMATE CONSTRUCTION VEHICLE ROUTE. COORDINATE WITH PROPERTY OWNER.

APPROXIMATE CONSTRUCTION VEHICLE ROUTE. COORDINATE WITH PROPERTY OWNER.

12 TREE REMOVAL

STONEWALL TO BE DISMANTLED OR AIR BRIDGED AS NEEDED

STONEWALL TO BE DISMANTLED OR AIR BRIDGED AS NEEDED

COORDINATE WORK AREA WITH PROPERTY OWNER

CROOKFALL BROOK

ALBION RD

LINCOLN

COURT DR

NEW ENGLAND WAY

Natural Heritage Area

LINE Q143S

LINE R144

LI-W4

LI-W5

LI-W6

LI-W7

LI-W8

LI-P1

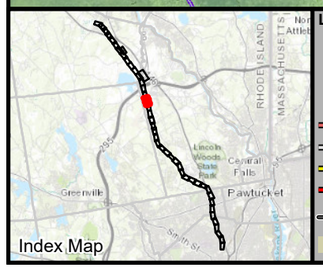
LI-SC5

52 53 54

218 219 220 221

304 305 306 307

320' 330' 340' 350'



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Q143/R144 LINES REBUILD PROJECT

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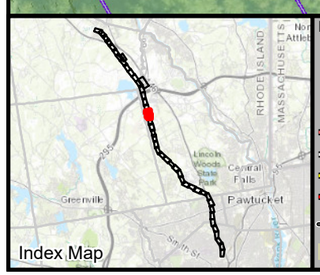
NEW ENGLAND WAY
COURT DR
LI-SC8
LI-W8
LI-P1
LI-SC9
Natural Heritage Area
LI-SC10
LI-W10
LINE Q143S
LINE R144
LI-W9
LINCOLN
SPAN STREAM
LI-S10
INSTALL PLUNGE POOL
STABILIZED ENTRANCE
ALBION RD
POWDER HILL RD
CROOKFALL BROOK
55
56
57
308
309
310
222
223
224
350'
340'
360'
370'
380'
390'
400'
410'



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Feet

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Q143/R144 LINES REBUILD PROJECT

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WELLINGTON RD

CAROL DR

POWDER HILL RD

CROWNMARK DR

LI-W10

LI-W11

LI-W13

LI-W12

LI-S10

311

58

225-1

59

312

226-1

Natural Heritage Area

STONEWALL TO BE DISMANTLED OR AIR BRIDGED AS NEEDED

227

LINE Q143S

LINCOLN

LINE R144

313

60

228-1

61

314

229-1

230

STABILIZED ENTRANCE

INSTALL PLUNGE POOL

STABILIZED ENTRANCE

STABILIZED ENTRANCE

INSTALL STONE FILTER

APPROXIMATE CONSTRUCTION VEHICLE ROUTE. COORDINATE WITH PROPERTY OWNER.

COORDINATE WORK AREA WITH PROPERTY OWNER

390'

400'

410'

420'

Index Map

Legend

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Q143/R144 LINES REBUILD PROJECT

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STABILIZED ENTRANCE

WELLINGTON RD

POWDER HILL RD

LI-W13

LI-W12

LI-W14

Natural Heritage Area

LINE Q143S

LINE R144

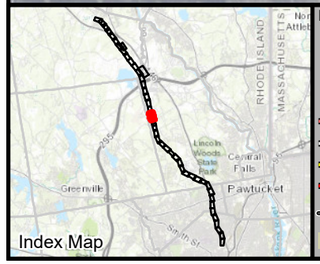
LINCOLN

410'

420'

62 315 63 316 64 317 65 318

230 231 232 233-1 234



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STABILIZED ENTRANCE

LINCOLN

WILBUR RD

POWDER HILL RD

JENCKES HILL RD

LANTERN BROOK DR

LINE Q143S

LINE R144

LI-W14

LI-W15

LI-W16

LI-W17

Natural Heritage Area

410'

400'

390'

420'

65 318 234

66 319 235

67 320 236

68 321 237

Index Map

Legend

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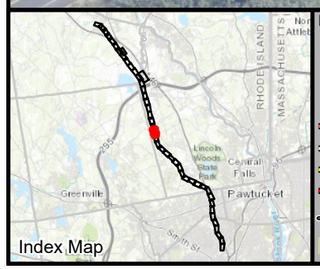

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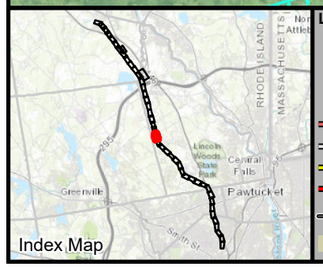
TATTERSALL DR

324
71
240
325
72
241
326
73
242
327
74
243
STABILIZED ENTRANCE
Natural Heritage Area
LINE Q143S
LINCOLN
LINE R144
LI-W19
LI-W20
West River
420'
410'
400'



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AVOID IMPACT TO STONE FEATURE

LINCOLN

LINE Q143S

LINE R144

LI-W20

GREENWOOD LN

Index Map

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- Sensitive Resource
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- Leaking Underground Storage
- Approximate ROW Limits
- Guardrail
- Stonewall
- Approximate Gas Pipeline
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- Town Boundary
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1 inch = 100 feet
0 50 100
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*Indicates Layers Set to Transparency

Q143/R144 LINES REBUILD PROJECT

Figure 3-1 - Project Alignment Drawings

Lincoln, RI

RIDEM
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

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Angell Brook
STONYBRIDGE DR
ROSEWOOD DR
AVOID IMPACT TO STONE FEATURE
331
78
247
79
332
248
SPAN STREAM
LINE Q143S
LINE R144
LI-S20
LINCOLN
AREA MAY REQUIRE MATTING ON LAWN
STABILIZED ENTRANCE
STABILIZED ENTRANCE
333
80
249
81
334
250
PAYNE RD
WINGATE RD
GREENWOOD LN
Angell Brook
MIDDLEBROOK LN
380'
370'

Index Map

Legend

- Existing Structure
- Replace Structure
- Install Structure
- Remove Structure
- Existing Overhead Line
- Replace Overhead Line
- Install Overhead Line
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- Approximate Construction Vehicle Route
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RED CHIMNEY DR

ROSEWOOD DR

AREA MAY REQUIRE MATTING ON LAWN

LI-W21

81 334 250 390'

82 335 251

83 336 LINE Q143S LINE R144 LINCOLN 380' 390'

252

ANGELL RD

STABILIZED ENTRANCE

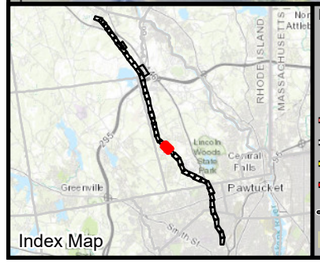
84 337 370'

253

85 360'

GREENWOOD LN

MIDDLEBROOK LN



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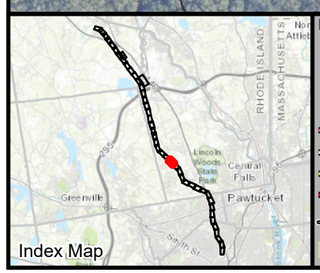
338
85
254
339
86
255
340
87
256
341
88
257
LINE Q143S
LINE R144
LINCOLN
LI-W22
LI-W23
Natural Heritage Area



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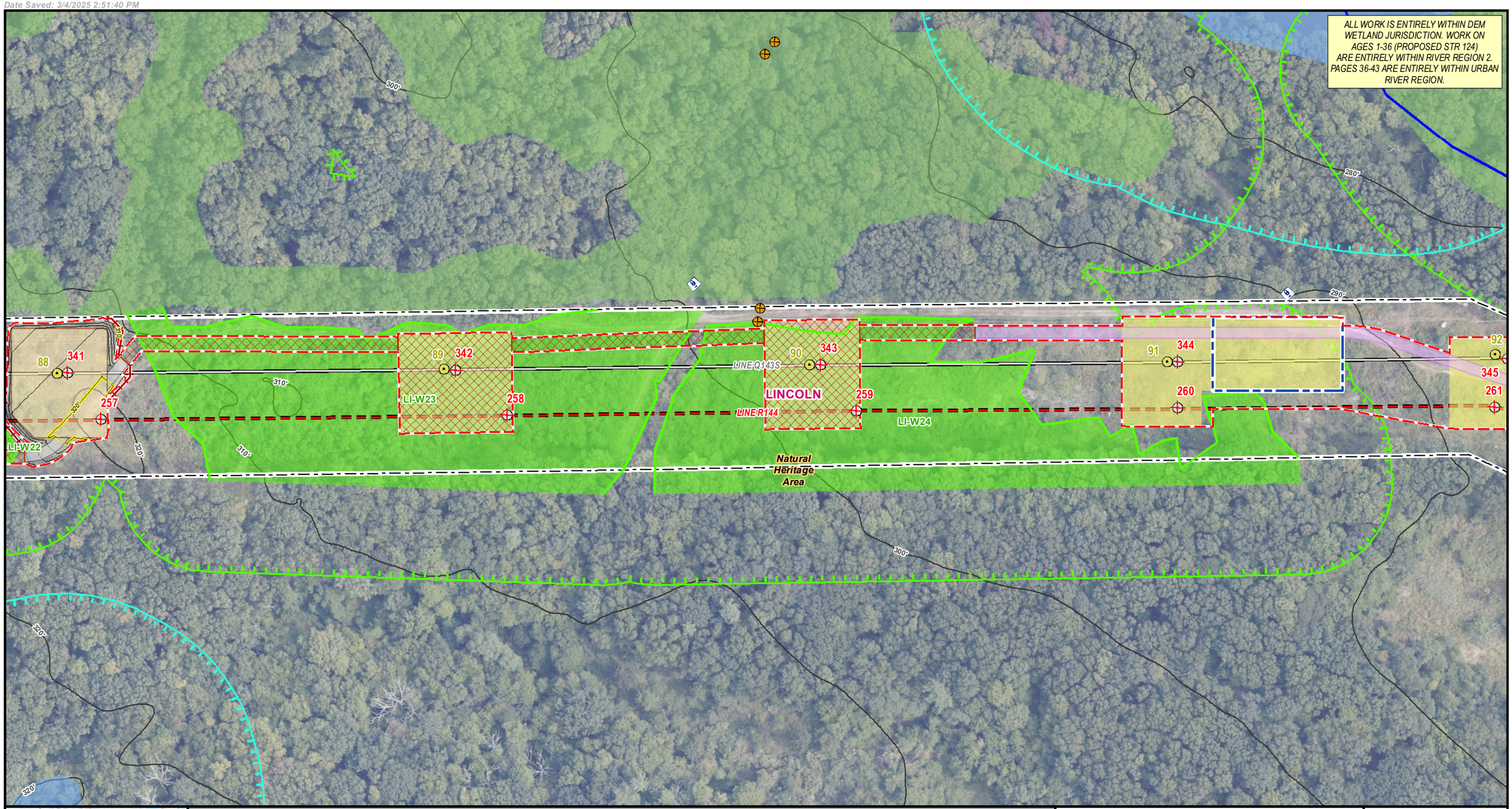

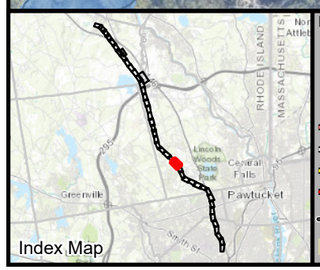

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Q143/R144 LINES REBUILD PROJECT

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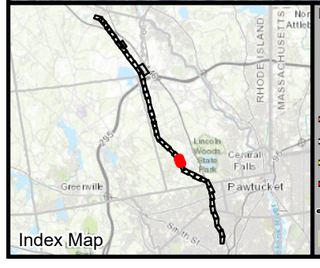

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Q143/R144 LINES REBUILD PROJECT

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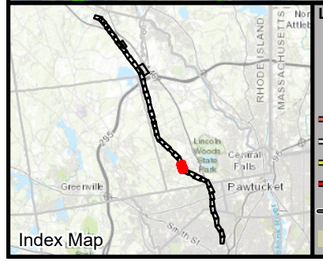

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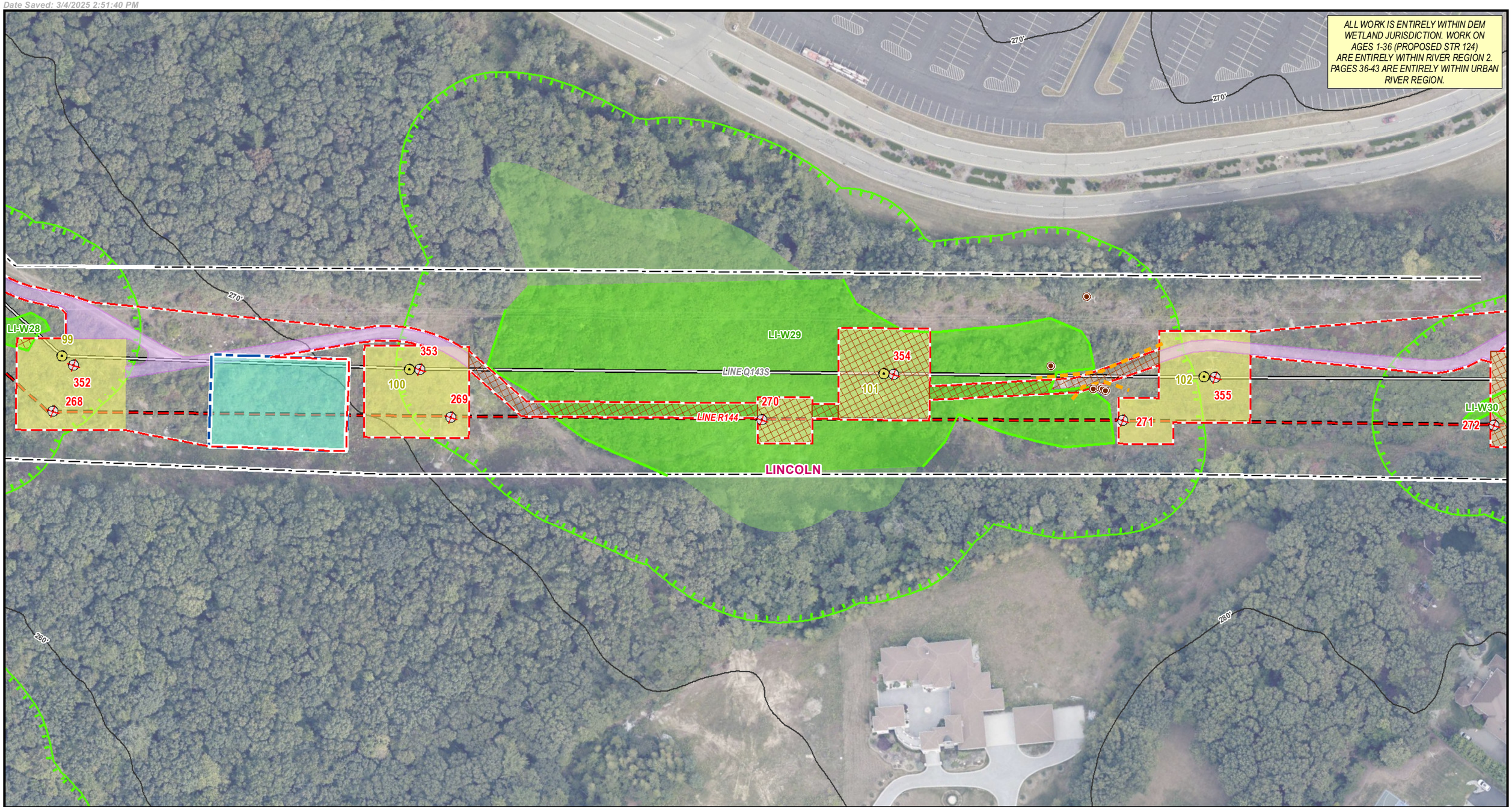

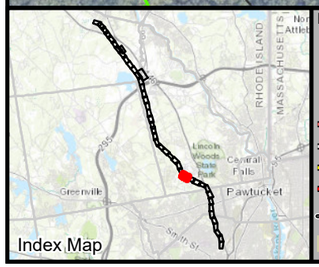

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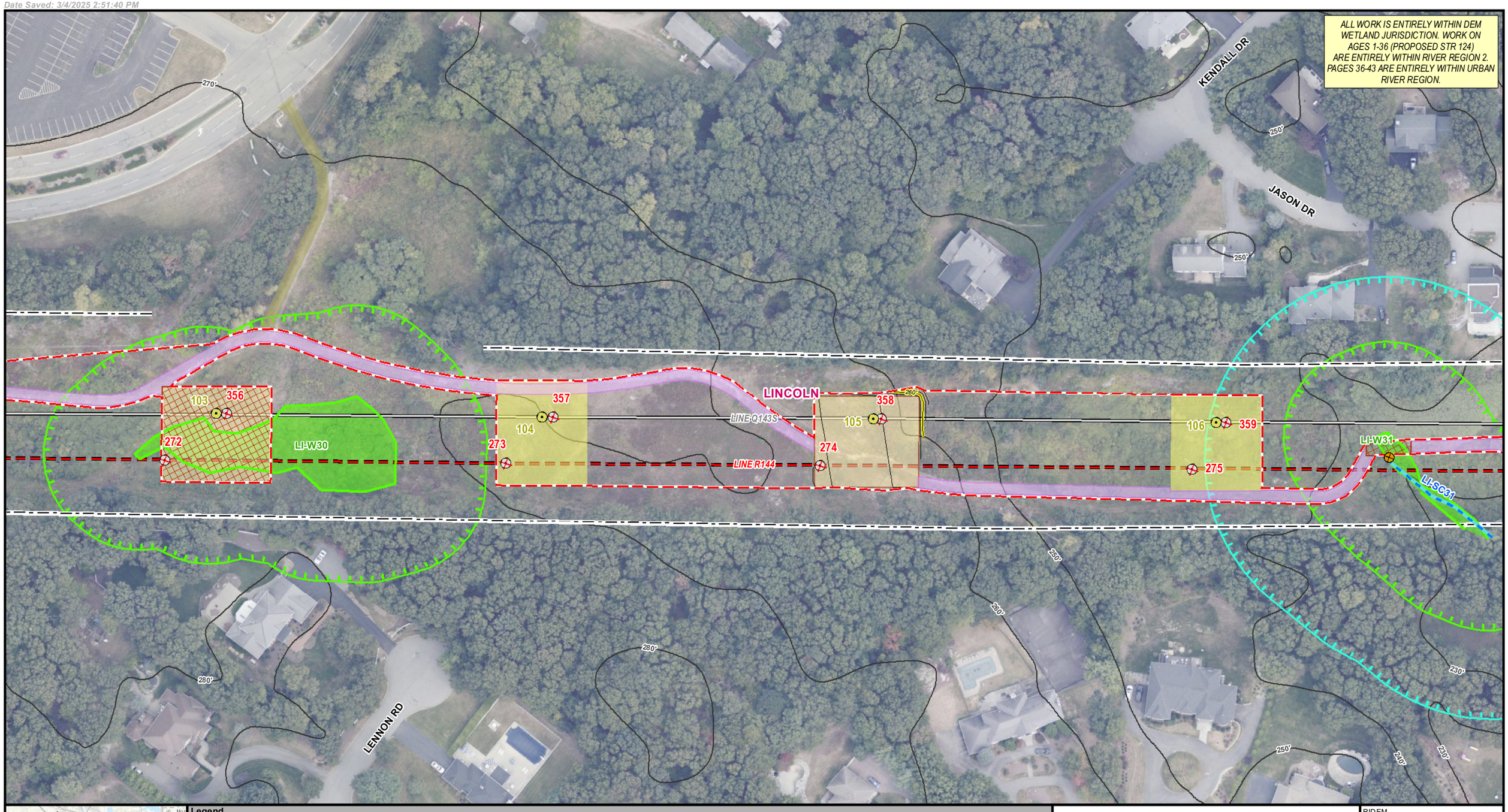

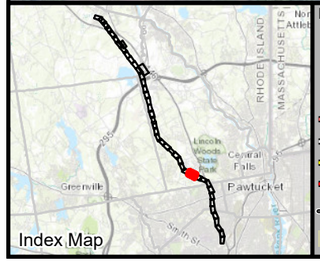

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JASON DR

PADDOCK DR

LINE Q143S

LINE R144

LINCOLN

LI-W31

LI-SC31

LI-W32

360
107
276

361
108
277

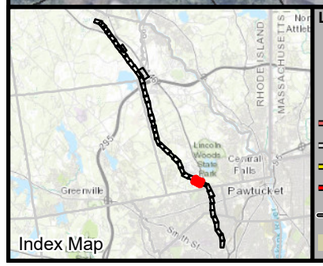
362
109
278

363
110
279

STABILIZED ENTRANCE

4 TREE REMOVAL

2 TREE REMOVAL



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OLD LOUISQUISSET PIKE
WOODWARD RD
LINCOLN
LINE Q143S
LINE R144
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STABILIZED ENTRANCE
LI-W32
LI-W33
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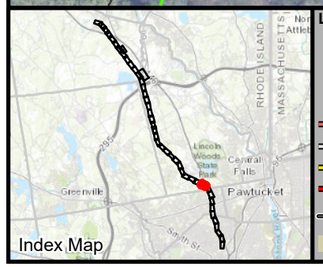
363
279
364
111
280
365
112
281
113
366-1
282-1
210'
220'
230'



Legend

- Existing Structure
- Replace Structure
- Install Structure
- Remove Structure
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- Replace Overhead Line
- Install Overhead Line
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- Field Delineated Wetlands*
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- Proposed Major Contour
- Proposed Minor Contour

N

1 inch = 100 feet
0 50 100
Feet

Indicates Layers Set to Transparency

Q143/R144 LINES REBUILD PROJECT

Figure 3-1 - Project Alignment Drawings

Lincoln, RI

RIDEM
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

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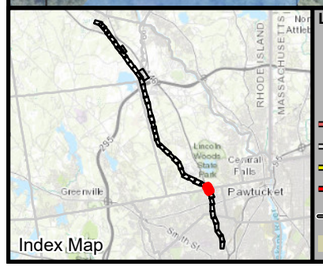
MARK DR
LINDSEY DR
HERITAGE DR
MANCHESTER FARM RD
ORLANDO DR
MEADOW RD
AMBROSE ST
STABILIZED ENTRANCE
1 TREE REMOVAL
LINCOLN
NORTH PROVIDENCE
EDDIE DOWLING HWY
EDDIE DOWLING HWY
STATE HWY 146
STATE HWY 146
STATE HWY 146
LINE Q143S
LINE R144
NP-W1
NP-W1
NP-S1
366-1
367-1
368-1
369-1
370
282-1
283-1
284-1
285-1
286-1
113
114
115
116
117



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Feet

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Q143/R144 LINES REBUILD PROJECT

Figure 3-1 - Project Alignment Drawings

Lincoln & North Providence, RI

RIDEM
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

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RANDALL RD
MEADOW RD
AMBROSE ST
FLORENCE ST
BORAH ST
LINCOL
1 TREE REMOVAL
NP-W1
NP-W1
NP-S1
NP-S3
371-1
118
286-1
287-1
NP-W2
NP-W3
LINE Q143
LINE R144
372-1
119
288-1
NORTH PROVIDENCE
120
373
289
STABILIZED ENTRANCE
STABILIZED ENTRANCE
INSTALL PLUNGE POOL
374
CHARLES ST
STATE HWY 146
STATE HWY 146
STATE HWY 146
STATE HWY 146
STATE HWY 146
NP-W4
NP-S4
NP-W4
121
375
290
NP-W4

Index Map

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Q143/R144 LINES REBUILD PROJECT

Figure 3-1 - Project Alignment Drawings

North Providence, RI

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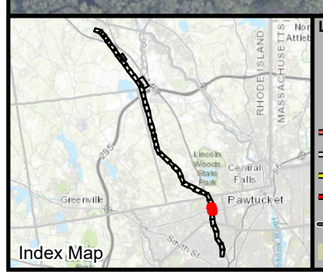

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Q143/R144 LINES REBUILD PROJECT

Figure 3-1 - Project Alignment Drawings

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NORTH PROVIDENCE

NP-W5
126A
380
126B
295-1
LINE Q143S
LINE R144
381-1
127
296-1
NP-S6
PR-S1A
NP-W6
128
382-1
297-1

STATE HWY 146
STATE HWY 146
STATE HWY 146
STATE HWY 146

Index Map

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Q143/R144 LINES REBUILD PROJECT

Figure 3-1 - Project Alignment Drawings

North Providence, RI

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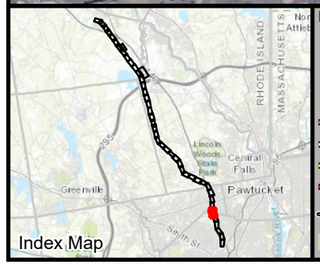
VOLTURNO ST
HUMBERT AVE
PR-S1A
LINE Q143S
LINE R144
NP-W6
NP-S7
382-1
128
297-1
383
129
298-1
299
384
130
131
385
300
STABILIZED ENTRANCE
STABILIZED ENTRANCE
NORTH PROVIDENCE
PROVIDENCE
STATE HWY 146
STATE HWY 146
60'
70'
80'
90'



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N

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0 50 100
Feet

Indicates Layers Set to Transparency

Q143/R144 LINES REBUILD PROJECT

Figure 3-1 - Project Alignment Drawings

North Providence & Providence, RI

RIDEM
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

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File Location: G:\GISPrj\8984061\Output\Maps\MXD\ReportMaps\EFSB\Figure_3_1_Project_Alignment_Drawings.mxd
Date Saved: 3/4/2025 2:51:40 PM

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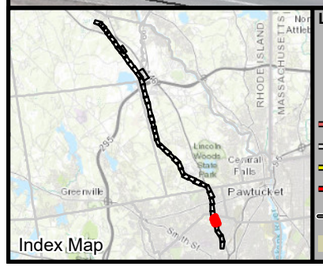
FAMIGLIETTI DR
RALSTON ST
UDELL ST
PROSPER ST
MACGREGOR ST
MANHATTAN ST
NEWBURY ST
PROVIDENCE
STANHOPE ST
STABILIZED ENTRANCE
1 TREE REMOVAL
SEWER LINE FOR PROVIDENCE
SEWER LINE FOR PROVIDENCE
LINE Q143S
LINE R144
PR-SB1A
PR-S1A
STATE HWY 146
STATE HWY 146
STATE HWY 146
60'
70'
80'



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0 50 100
Feet

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Q143/R144 LINES REBUILD PROJECT

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Providence, RI

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ALASKA ST
LANGDON ST
SHERMAN ST
EVERSON ST
LAKESIDE ST
SHAW ST
BRANCH AVE
PROVIDENCE
STATE HWY 146
LINE Q143S
LINE R144
STABILIZED ENTRANCE
SPAN STREAM
PR-S2
PR-W1
PR-W2
PR-SB1A
West River
390
136
305
137
391-1
306-1
139
392-1
138
307-1
308-1
80'
70'
60'
50'
40'

Index Map

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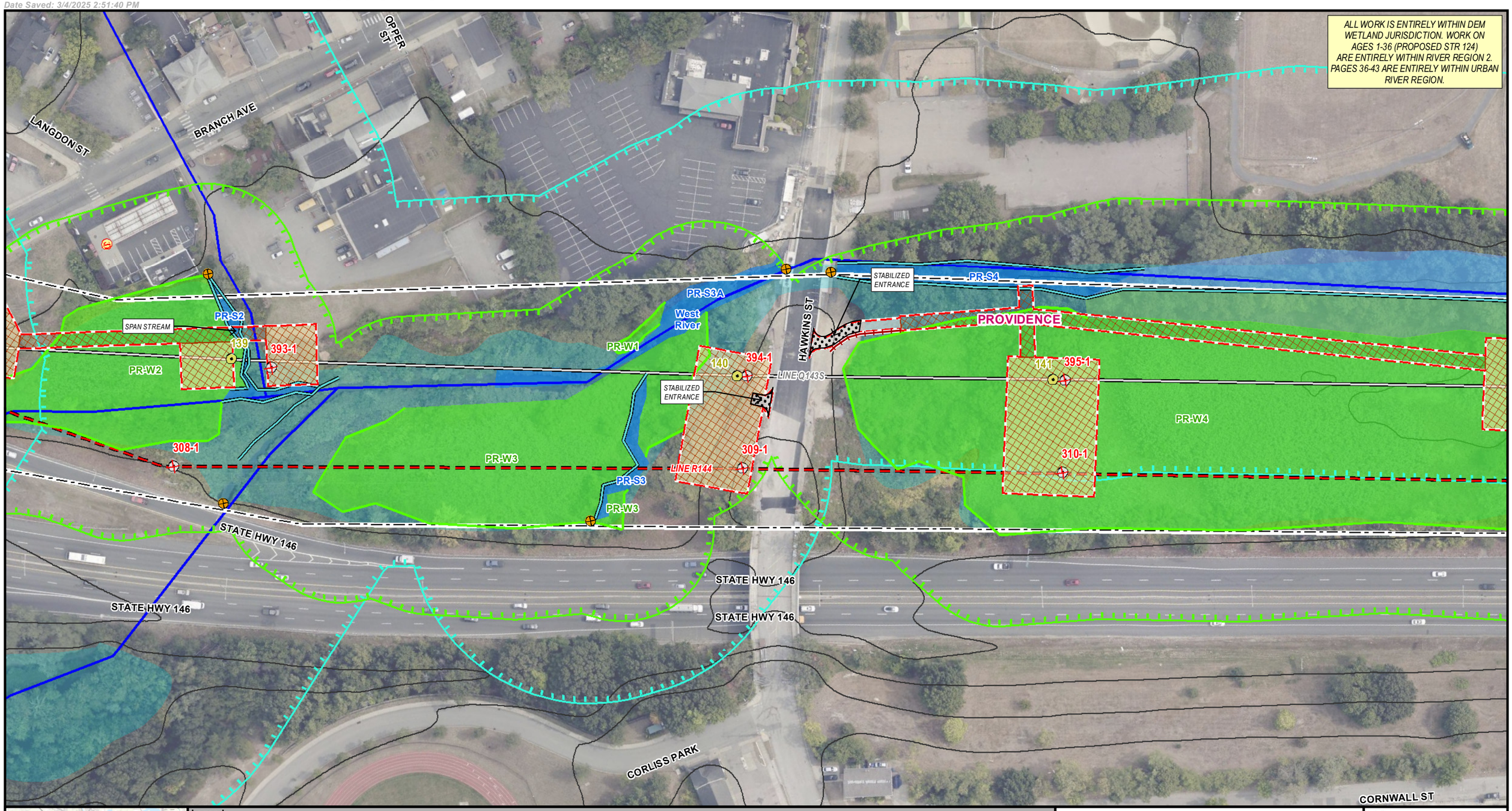

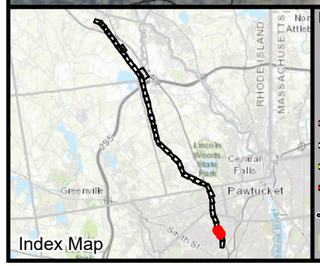

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West River

143 397-1 144 398-1 396-1 142 312-1 311-1 313-1 399-1 145 400 146 314

LINE Q143S

LINE R144

PROVIDENCE

PR-W4

STATE HWY 146

STATE HWY 146

MATTING MAY BE REQUIRED TO PROVIDE A STABLE WORK SURFACE. ASSUME ~40% AREA TO BE MATTED.

CORNWALL ST

CHESHIRE ST

YORKSHIRE ST

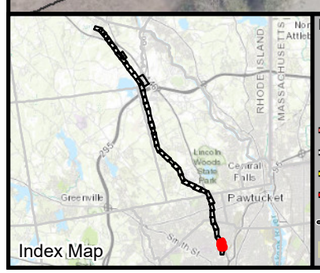
LONGMONT ST

BERKSHIRE ST

SALINA ST

DONELSON ST

Natural Heritage Area



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- Hazardous Material Site
- Leaking Underground Storage
- Approximate ROW Limits
- Guardrail
- Stonewall
- Approximate Gas Pipeline
- Temporary Safety Fencing
- Sensitive Resource Area
- Town Boundary
- Manhole
- Catch Basin
- Culvert
- Company Gate
- Noncompany Gate
- Proposed Tree Removal
- Existing 2ft Contours
- Existing 10ft Contours
- Proposed Major Contour
- Proposed Minor Contour

N

1 inch = 100 feet
0 50 100
Feet

*Indicates Layers Set to Transparency

Q143/R144 LINES REBUILD PROJECT

Figure 3-1 - Project Alignment Drawings

Providence, RI

RIDEM
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Rhode Island Energy
BSC GROUP

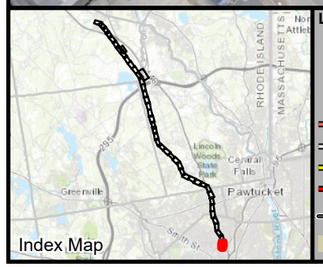
File Location: G:\GISPrj\8984061\Output\Maps\MXD\ReportMaps\EFSB\Figure_3_1_Project_Alignment_Drawings.mxd
Date Saved: 3/4/2025 2:51:40 PM

ALL WORK IS ENTIRELY WITHIN DEM WETLAND JURISDICTION. WORK ON AGES 1-36 (PROPOSED STR 124) ARE ENTIRELY WITHIN RIVER REGION 2. PAGES 36-43 ARE ENTIRELY WITHIN URBAN RIVER REGION.

MATTING MAY BE REQUIRED TO PROVIDE A STABLE WORK SURFACE. ASSUME ~40% AREA TO BE MATTED.

West River
STATE HWY 146
STATE HWY 146
CLARKSON STREET S/S
CLARKSON ST
ADMIRAL TERMINAL
Admiral Terminal
Admiral Terminal
ADMIRAL STREET S/S
Admiral St Sub
Admiral St Sub
ADMIRAL ST
PROVIDENCE
Natural Heritage Area
STABILIZED ENTRANCE
SALINA ST
DONELSON ST
SUFFOLK ST
PUMGANSETT ST
CHAD BROWN ST
BERKSHIRE ST
JUNE ST

400 146 147A 400A 147B 148 401-1 LINE Q143S LINE Q143 LINE R144 LINE R144S 315 314 316-1 402 401-A 149A 149B 317A 317B 403 401-C 150A 150B 317C 151A 151B 152A 152B 153A 153B 318 319



Legend

- Existing Structure
- Replace Structure
- Install Structure
- Remove Structure
- Existing Overhead Line
- Replace Overhead Line
- Install Overhead Line
- Remove Overhead Line
- Approximate Construction Vehicle Route
- Existing Access
- Existing Access to be Improved
- Engineered Access
- Access Preparation & Mow
- Temporary Access to be Restored
- Matted Work Areas
- Proposed Structure Work Pad
- Pull Pad
- Limit of Disturbance
- Delineated Stream/Pond Bank
- Delineated Stream Centerline
- Estimated Pond Bank
- Field Delineated Stream Area*
- Field Delineated Wetland Boundary
- Field Delineated Wetlands*
- USFWS Wetlands*
- USFWS Open Water*
- 100ft Jurisdictional Area to Wetlands
- 200ft Jurisdictional Area to Streams
- FEMA 100yr Floodplain*
- Surface Water Protection Area
- Protected Resource Location
- Natural Heritage Area
- Conservation Land
- Sensitive Resource
- Hazardous Material Site
- Leaking Underground Storage
- Approximate ROW Limits
- Guardrail
- Stonewall
- Approximate Gas Pipeline
- Temporary Safety Fencing
- Sensitive Resource Area
- Town Boundary
- Manhole
- Catch Basin
- Culvert
- Company Gate
- Noncompany Gate
- Proposed Tree Removal
- Existing 2ft Contours
- Existing 10ft Contours
- Proposed Major Contour
- Proposed Minor Contour

N

1 inch = 100 feet
0 50 100
Feet

*Indicates Layers Set to Transparency

Q143/R144 LINES REBUILD PROJECT

Figure 3-1 - Project Alignment Drawings

Providence, RI

RIDEM
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

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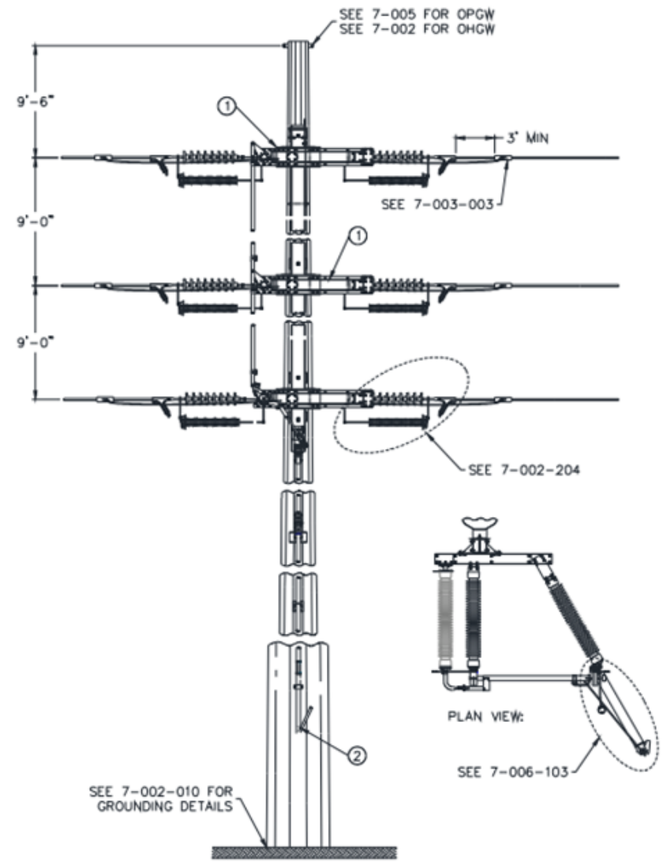
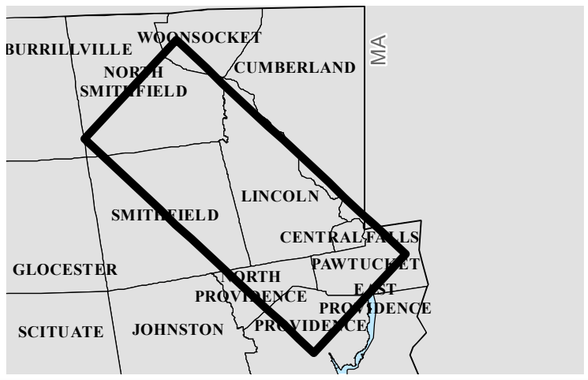
ppl PPL Electric Utilities	**7-006-004** 138kV Manually Operated Load Break Air Break (LBAB)	Revision: 00 Effective Date: 7/21/2017 Sheet 2 of 2



Project Vicinity



Q143/R144 Lines Rebuild Project

Figure 3-2 - Typical Structure Details - Page 1

State of Rhode Island

Providence County:
City of Woonsocket, Town of North Smithfield, Town of Lincoln, Town of North Providence, City of Providence

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NAD 1983 2011 StatePlane Rhode Island FIPS 3800 Ft US

Rhode Island Energy
a PPL company

NOT FOR CONSTRUCTION

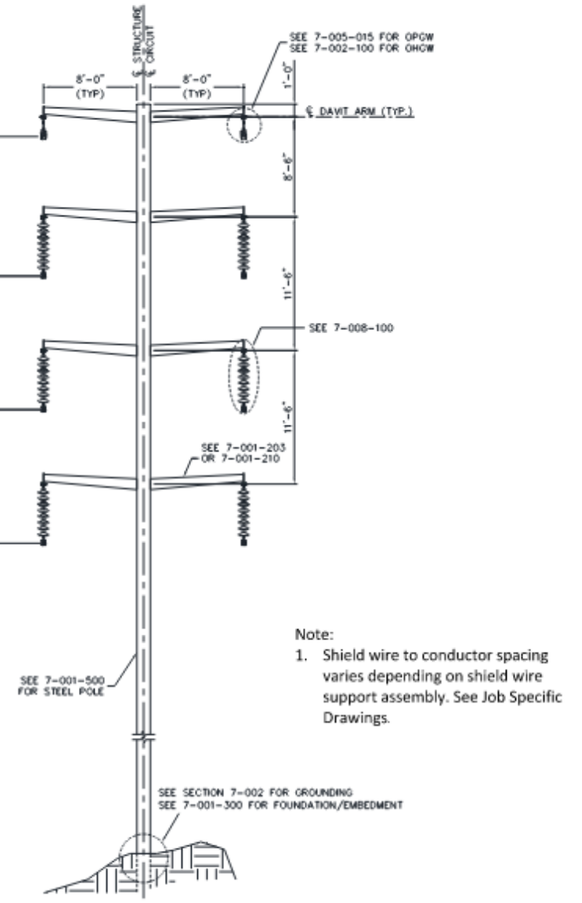
DATE: 4/14/2025

AUTHOR: KANDREWS

7-008-001
115/138kV Double Circuit Steel Pole
Tangent Suspension Structure

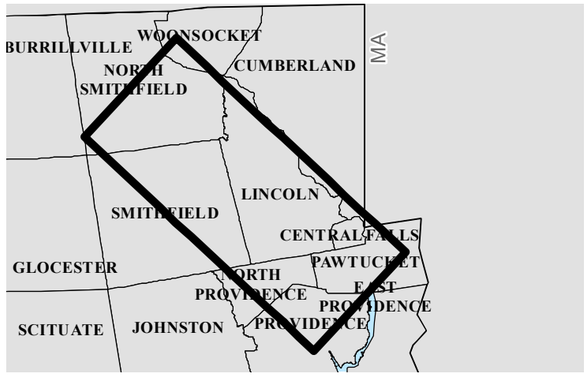
Revision: 02
Effective Date: 05/21/2023
Sheet 1 of 1

T-7-008-001



Note:
1. Shield wire to conductor spacing varies depending on shield wire support assembly. See Job Specific Drawings.

Project Vicinity



Q143/R144 Lines Rebuild Project

Figure 3-2 - Typical Structure Details - Page 2

State of Rhode Island

Providence County:
City of Woonsocket, Town of North Smithfield, Town of Lincoln, Town of North Providence, City of Providence

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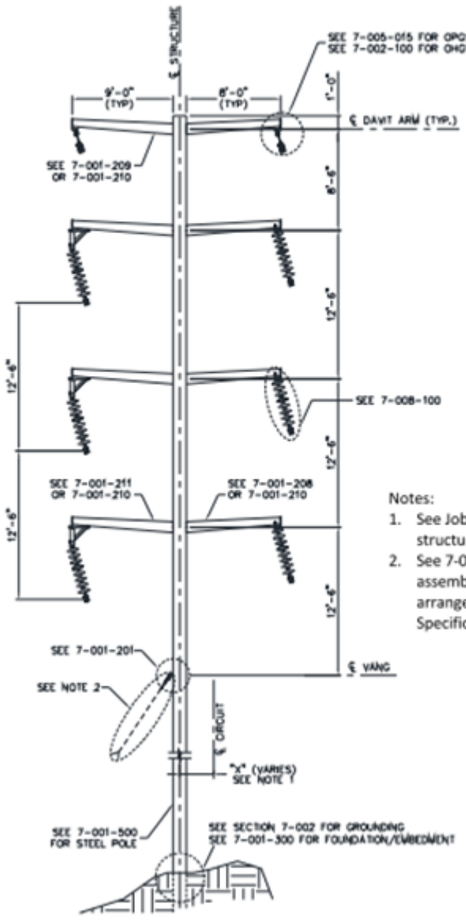
DATE: 4/14/2025

AUTHOR: KANDREWS

7-008-002
115/138kV Double Circuit Steel Pole
Light Angle Suspension Structure

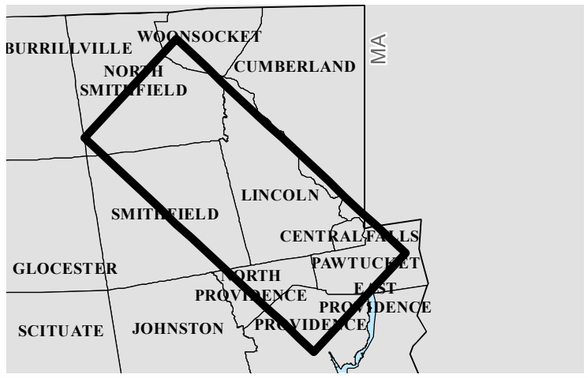
Revision: 02
Effective Date: 05/21/2023
Sheet 1 of 1

T-7-008-002



Notes:
1. See Job Specific Drawings for structure layout dimensions.
2. See 7-001 for guy wire and anchor assemblies. Guy and anchor arrangement may vary per Job Specific Drawings.

Project Vicinity



Q143/R144 Lines Rebuild Project

Figure 3-2 - Typical Structure Details - Page 3

State of Rhode Island

Providence County:
City of Woonsocket, Town of North Smithfield, Town of Lincoln, Town of North Providence, City of Providence

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DATE: 4/14/2025

AUTHOR: KANDREWS

7-008-004
115/138kV Double Circuit Steel Pole
Tension on Arm Structure

Revision: 02
Effective Date: 05/21/2023
Sheet 1 of 1

T-7-008-004

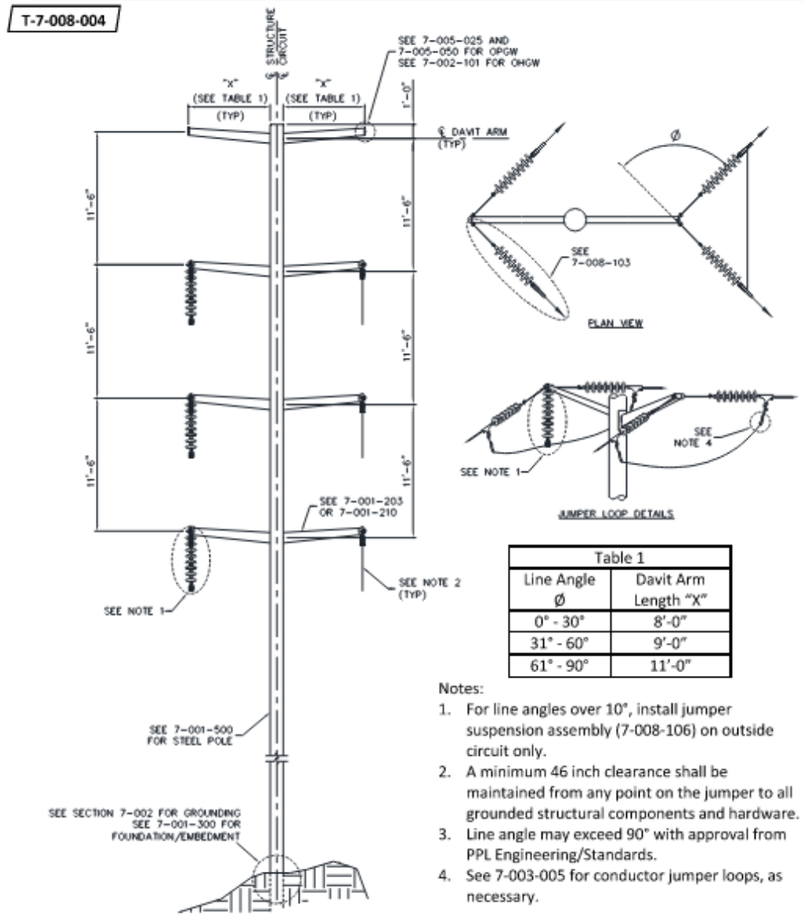
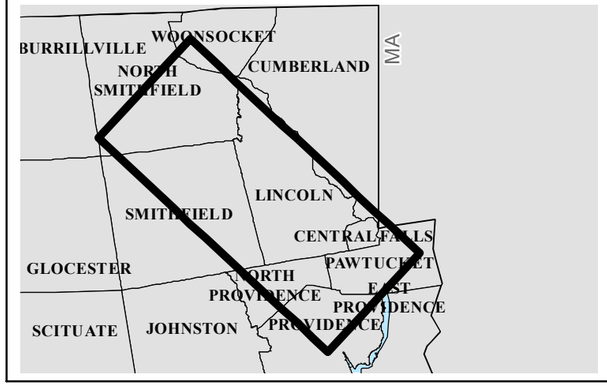


Table 1	
Line Angle Ø	Davit Arm Length "X"
0° - 30°	8'-0"
31° - 60°	9'-0"
61° - 90°	11'-0"

Notes:
1. For line angles over 10°, install jumper suspension assembly (7-008-106) on outside circuit only.
2. A minimum 46 inch clearance shall be maintained from any point on the jumper to all grounded structural components and hardware.
3. Line angle may exceed 90° with approval from PPL Engineering/Standards.
4. See 7-003-005 for conductor jumper loops, as necessary.

Project Vicinity



Q143/R144 Lines Rebuild Project

Figure 3-2 - Typical Structure Details - Page 4

State of Rhode Island

Providence County:
City of Woonsocket, Town of North Smithfield, Town of Lincoln, Town of North Providence, City of Providence

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DATE: 4/14/2025

AUTHOR: KANDREWS

7-008-005
115/138kV Double Circuit Steel Pole
Tension on Pole Structure

Revision: 02
Effective Date: 05/21/2023
Sheet 1 of 1

T-7-008-005

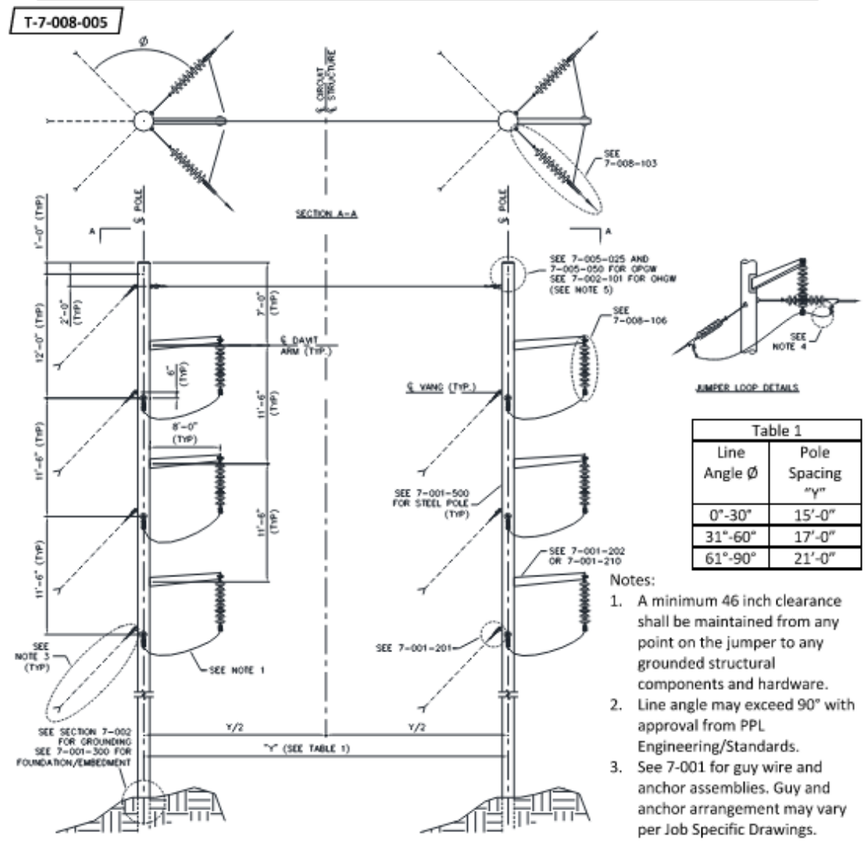
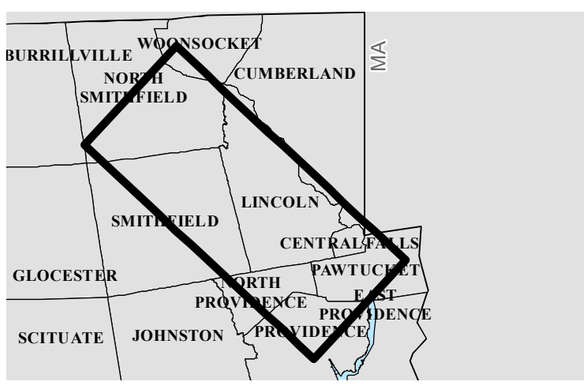


Table 1	
Line Angle Ø	Pole Spacing "Y"
0°-30°	15'-0"
31°-60°	17'-0"
61°-90°	21'-0"

Notes:

1. A minimum 46 inch clearance shall be maintained from any point on the jumper to any grounded structural components and hardware.
2. Line angle may exceed 90° with approval from PPL Engineering/Standards.
3. See 7-001 for guy wire and anchor assemblies. Guy and anchor arrangement may vary per Job Specific Drawings.
4. See 7-003-005 for conductor jumper loops, as necessary.
5. Shield wire assembly may be installed on the pole top plate for standard class poles.
6. For areas with side slopes or uneven terrain, see Job Specific Drawings for potential differences in attachment points as measured from the pole top.

Project Vicinity



Q143/R144 Lines Rebuild Project

Figure 3-2 - Typical Structure Details - Page 5

State of Rhode Island

Providence County:
City of Woonsocket, Town of North Smithfield, Town of Lincoln, Town of North Providence, City of Providence

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NOT FOR CONSTRUCTION

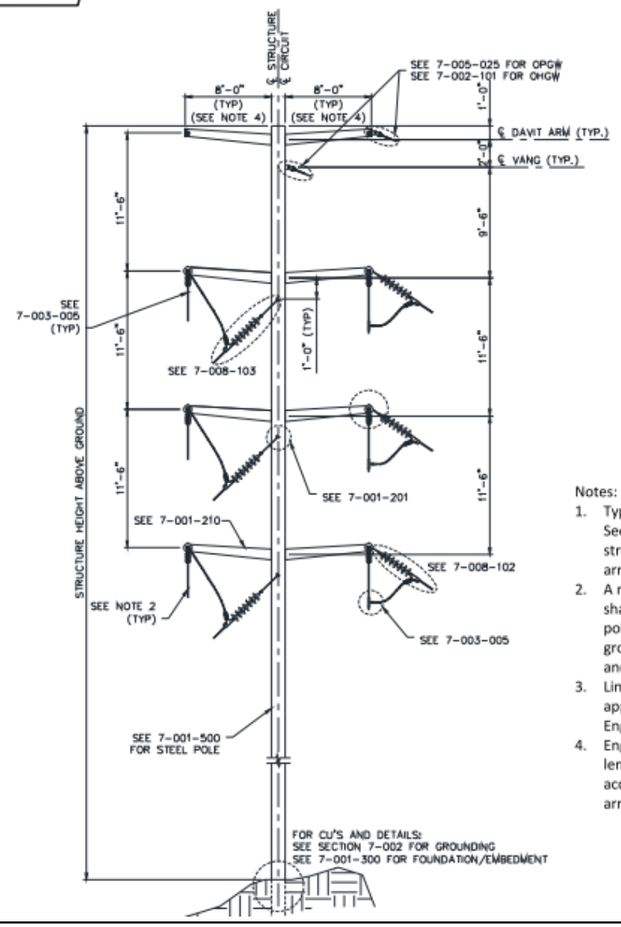
DATE: 4/14/2025

AUTHOR: KANDREWS

7-008-006
115/138kV Double Circuit Steel Pole
0° to 90° Tap Structure

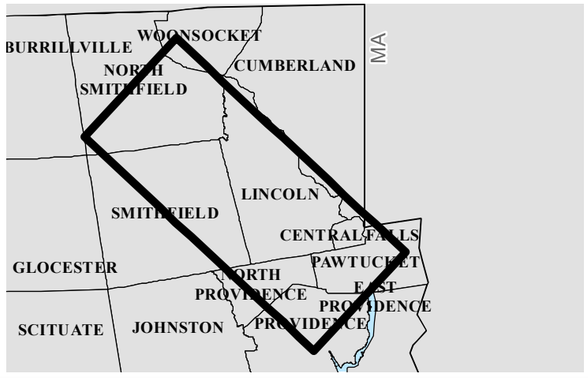
Revision: 01
Effective Date: 05/21/2023

T-7-008-006



Notes:
1. Typical shield wire layout shown. See Job Specific Instructions for structure specific shield wire arrangement.
2. A minimum 46 inch clearance shall be maintained from any point on the jumper to all grounded structural components and hardware.
3. Line angle may exceed 90° with approval from PPL Engineering/Standards.
4. Engineer may increase arm length as necessary to accommodate specific line arrangement.

Project Vicinity



Q143/R144 Lines Rebuild Project

Figure 3-2 - Typical Structure Details - Page 6

State of Rhode Island

Providence County:
City of Woonsocket, Town of North Smithfield, Town of Lincoln, Town of North Providence, City of Providence

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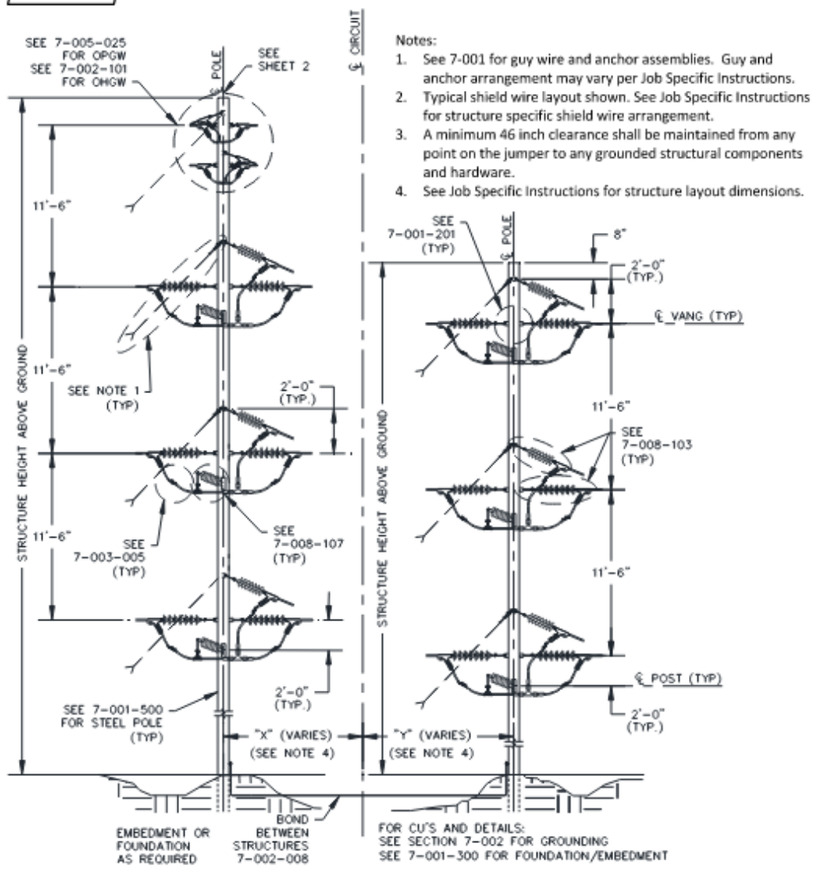
DATE: 4/14/2025

AUTHOR: KANDREWS

ppl	**7-008-007** 115/138kV Double Circuit Steel Pole High-Low Tap Structure	Revision: 01 Effective Date: 05/21/2023 Sheet 1 of 4

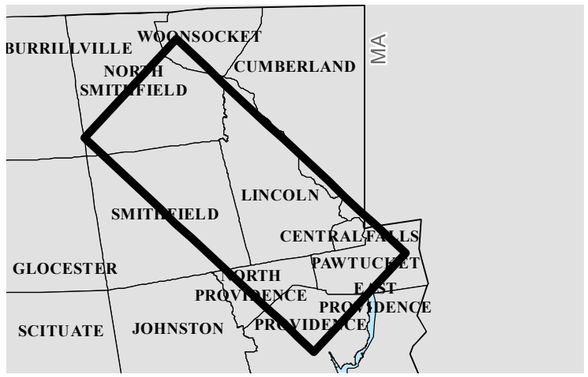
T-7-008-007



Notes:

1. See 7-001 for guy wire and anchor assemblies. Guy and anchor arrangement may vary per Job Specific Instructions.
2. Typical shield wire layout shown. See Job Specific Instructions for structure specific shield wire arrangement.
3. A minimum 46 inch clearance shall be maintained from any point on the jumper to any grounded structural components and hardware.
4. See Job Specific Instructions for structure layout dimensions.

Project Vicinity



Q143/R144 Lines Rebuild Project

Figure 3-2 - Typical Structure Details - Page 7

State of Rhode Island

Providence County:
City of Woonsocket, Town of North Smithfield, Town of Lincoln, Town of North Providence, City of Providence

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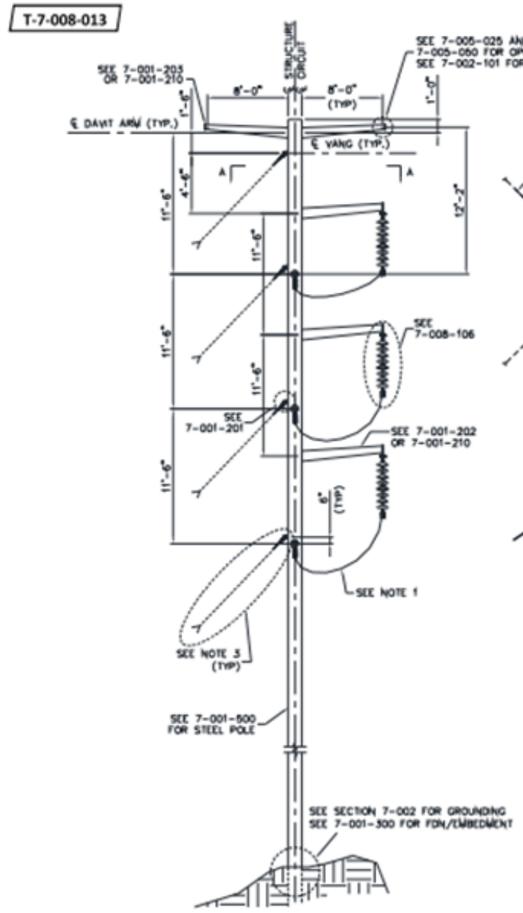
DATE: 4/14/2025

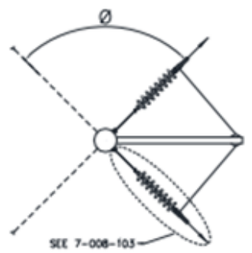
AUTHOR: KANDREWS

7-008-013
115/138kV Single Circuit Steel Pole
Tension on Pole Structure

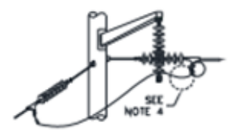
Revision: 02
Effective Date: 05/21/2023
Sheet 1 of 1

T-7-008-013





SECTION A-A

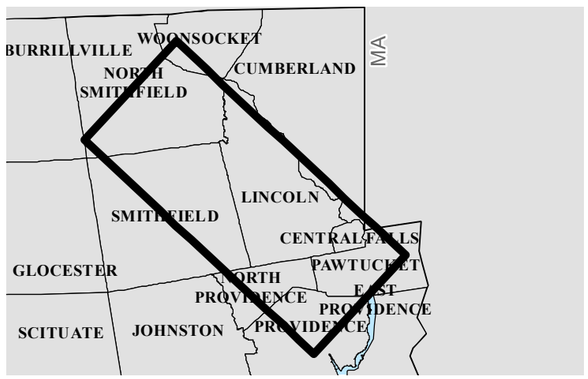


JUMPER LOOP DETAILS

Notes:

1. A minimum 46 inch clearance shall be maintained from any point on the jumper to all grounded structural components and hardware.
2. Line angle may exceed 90° with approval from PPL Engineering/Standards.
3. See 7-001 for guy wire and anchor assemblies. Guy wire and anchor assemblies may vary per Job Specific Drawings.
4. See 7-003-005 for conductor jumper loops, as necessary.

Project Vicinity



Q143/R144 Lines Rebuild Project

Figure 3-2 - Typical Structure Details - Page 8

State of Rhode Island

Providence County:
City of Woonsocket, Town of North Smithfield, Town of Lincoln, Town of North Providence, City of Providence

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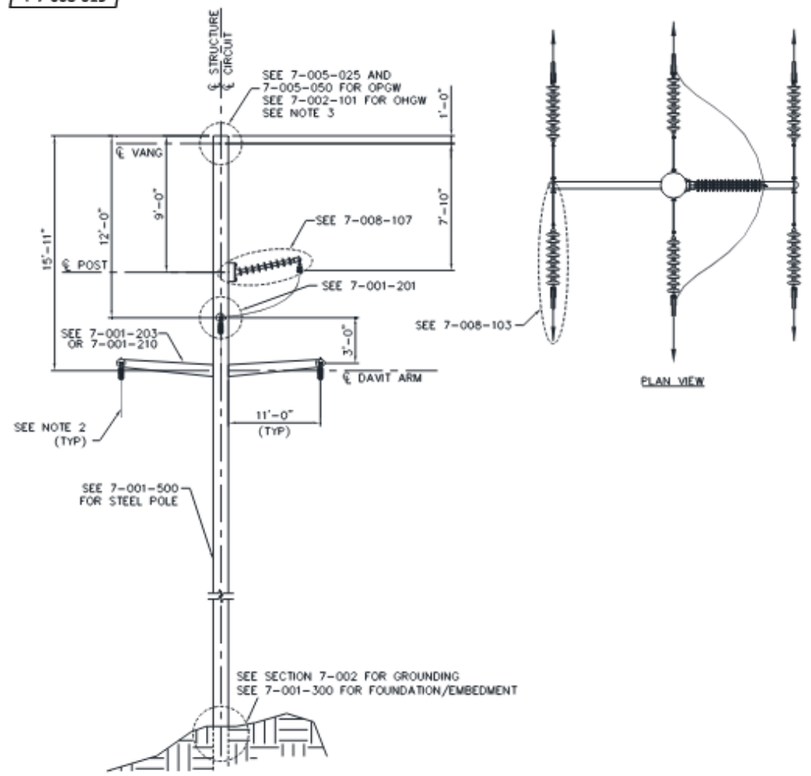
DATE: 4/14/2025

AUTHOR: KANDREWS

7-008-015
115/138kV Single Circuit Steel Pole
Transposition Structure

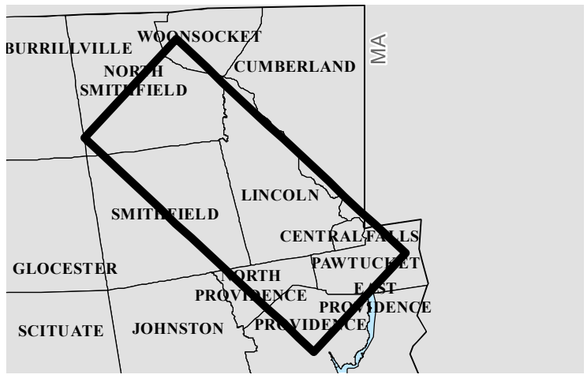
Revision: 02
Effective Date: 05/21/2023
Sheet 1 of 1

T-7-008-015



Notes:
1. Typical shield wire layout shown. See Job Specific Drawings for structure specific shield wire arrangement.
2. A minimum 46-inch clearance shall be maintained from any point on the jumper to all grounded structural components and hardware.
3. Shield wire assembly may be installed on the pole top plate for standard class poles.

Project Vicinity



Q143/R144 Lines Rebuild Project

Figure 3-2 - Typical Structure Details - Page 9

State of Rhode Island

Providence County:
City of Woonsocket, Town of North Smithfield, Town of Lincoln, Town of North Providence, City of Providence

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Rhode Island Energy
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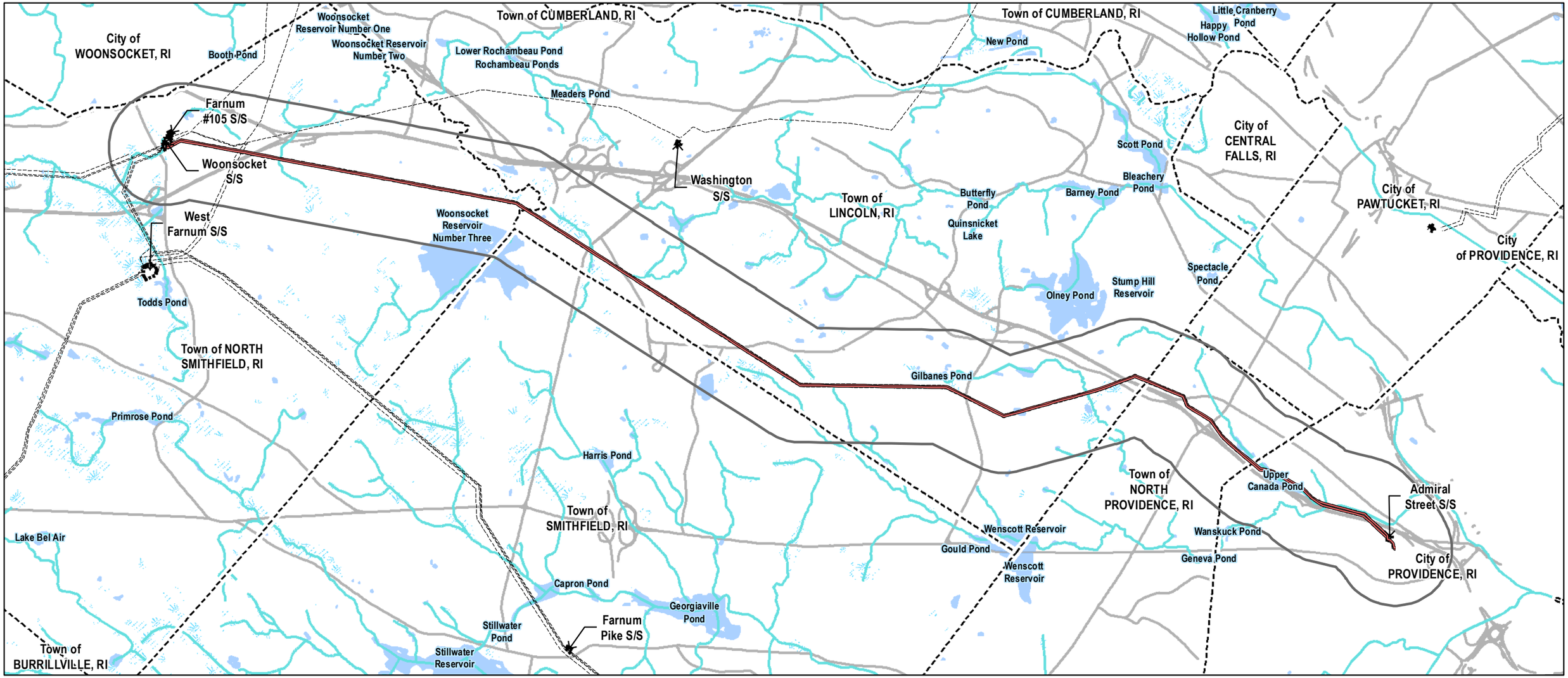
NOT FOR CONSTRUCTION

DATE: 4/14/2025

AUTHOR: KANDREWS



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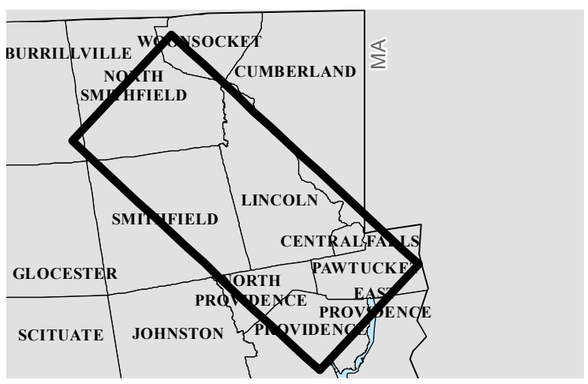

Legend

- Project Features
- Existing Transmission Line
- 5,000ft Study Area
- Existing Power Facility
- State Highway
- River or Stream
- Lake or Pond
- Swamp or Marsh
- Town Boundary

Q143/R144 Lines Rebuild Project

Figure 5-1 - Study Area

State of Rhode Island

Providence County:
City of Woonsocket, Town of North Smithfield, Town of Lincoln, Town of North Providence, City of Providence

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Rhode Island Energy

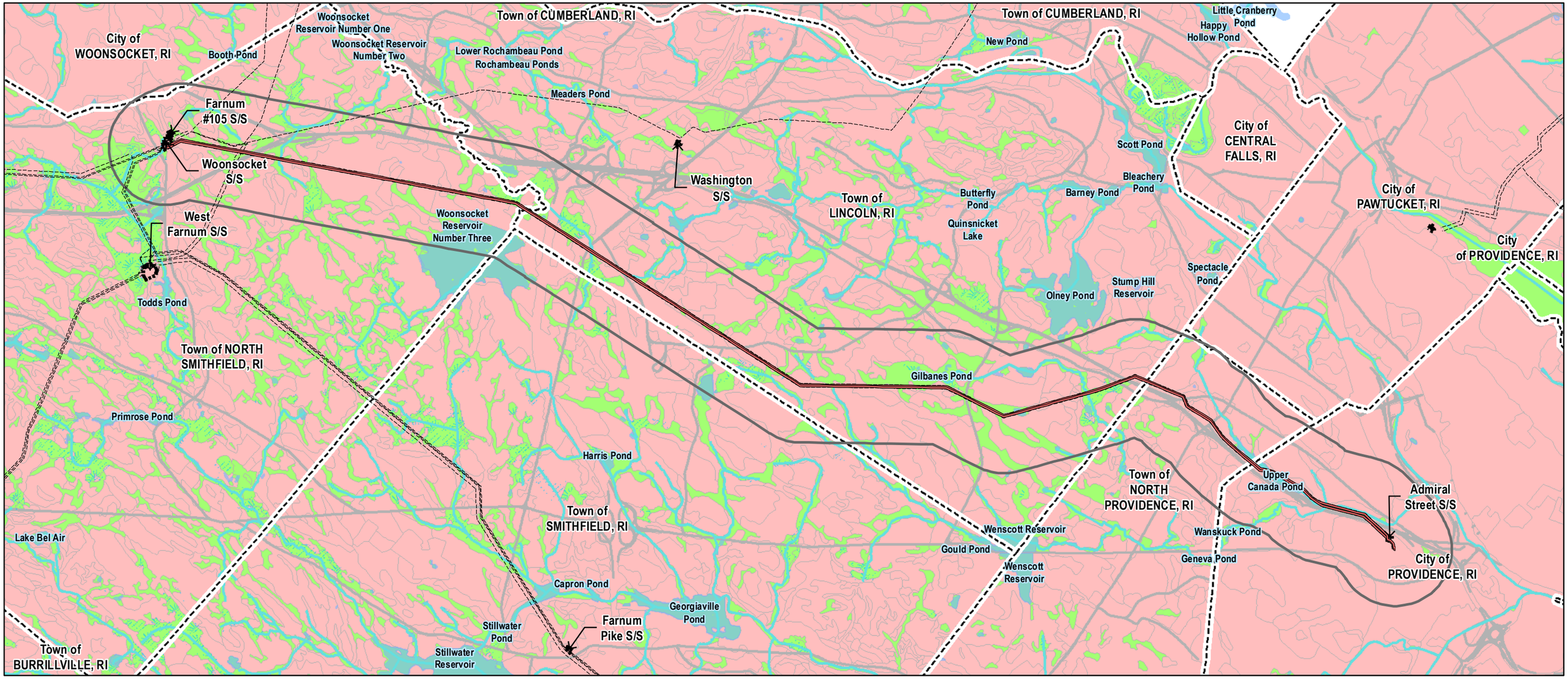
0 1 2 Miles

1 " = 4,250 '

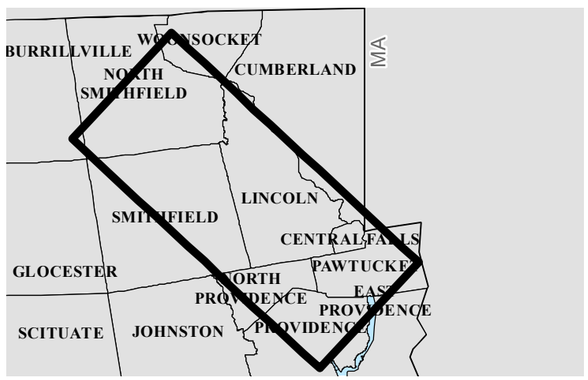
NOT FOR CONSTRUCTION

DATE: 10/11/2024

AUTHOR: KANDREWS



Project Vicinity



Legend

- Project Features
- Existing Transmission Line
- 5,000ft Study Area
- Existing Power Facility
- State Highway
- River or Stream
- Lake or Pond
- Swamp or Marsh
- Town Boundary

Hydric Rating

- Yes
- No

Q143/R144 Lines Rebuild Project

Figure 5-2 - Hydric Soils

State of Rhode Island

Providence County:
City of Woonsocket, Town of North Smithfield, Town of Lincoln, Town of North Providence, City of Providence

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Rhode Island Energy

0 1 2 Miles

1 " = 4,250 '

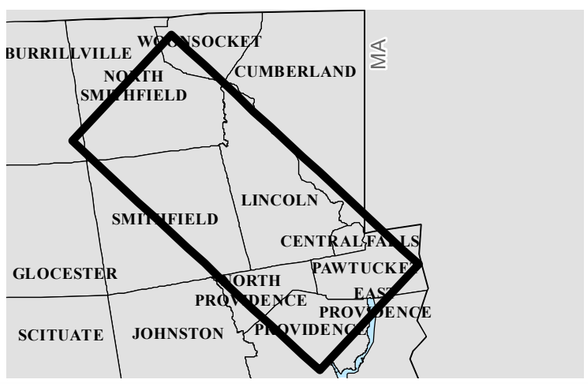
NOT FOR CONSTRUCTION

DATE: 10/11/2024

AUTHOR: KANDREWS

City of WOONSOCKET, RI
Booth Pond
Woonsocket Reservoir Number One
Woonsocket Reservoir Number Two
Town of CUMBERLAND, RI
Lower Rochambeau Pond
Rochambeau Ponds
Meaders Pond
Farnum #105 S/S
Woonsocket S/S
West Farnum S/S
Washington S/S
Woonsocket Reservoir Number Three
Town of LINCOLN, RI
Butterfly Pond
Quinsnicket Lake
Town of CUMBERLAND, RI
New Pond
Little Cranberry Pond
Happy Hollow Pond
Scott Pond
City of CENTRAL FALLS, RI
Barney Pond
Bleachery Pond
City of PAWTUCKET, RI
City of PROVIDENCE, RI
Spectacle Pond
Stump Hill Reservoir
Olney Pond
Todds Pond
Town of NORTH SMITHFIELD, RI
Primrose Pond
Gilbanes Pond
Harris Pond
Town of SMITHFIELD, RI
Town of NORTH PROVIDENCE, RI
Upper Canada Pond
Admiral Street S/S
City of PROVIDENCE, RI
Wenscott Reservoir
Gould Pond
Wenscott Reservoir
Wanskuck Pond
Geneva Pond
Lake Bel Air
Capron Pond
Georgiaville Pond
Stillwater Pond
Farnum Pike S/S
Stillwater Reservoir
Town of BURRILLVILLE, RI

Project Vicinity



Legend

- Project Features
- Existing Transmission Line
- 5,000ft Study Area
- Existing Power Facility
- State Highway
- River or Stream
- Lake or Pond
- Swamp or Marsh
- Town Boundary

Wetlands

- NWI Freshwater Wetland
- NWI Wetland

Q143/R144 Lines Rebuild Project

Figure 5-3 - Wetland Resources

State of Rhode Island

Providence County:
City of Woonsocket, Town of North Smithfield, Town of Lincoln, Town of North Providence, City of Providence

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NAD 1983 2011 StatePlane Rhode Island FIPS 3800 Ft US

Rhode Island Energy

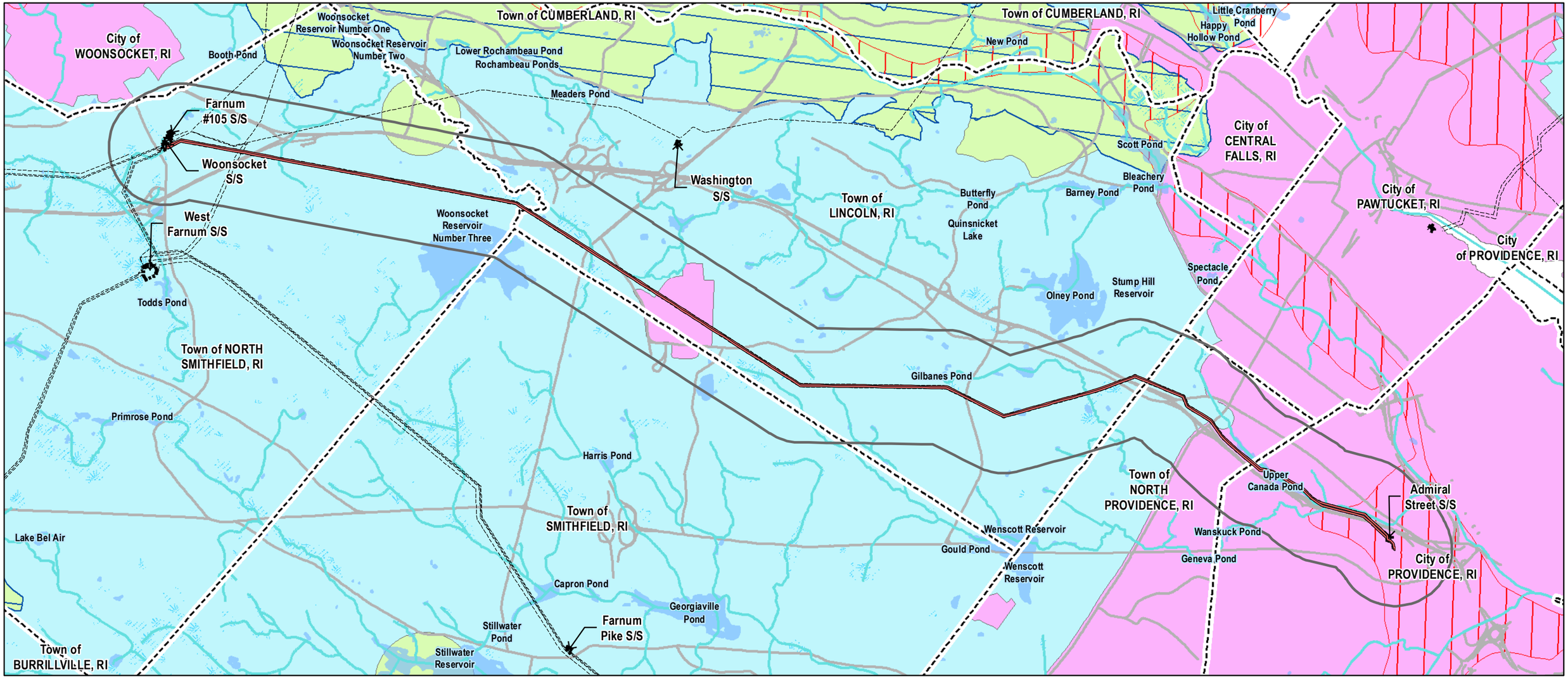
0 1 2 Miles

1 " = 4,250 '

NOT FOR CONSTRUCTION

DATE: 10/11/2024

AUTHOR: KANDREWS



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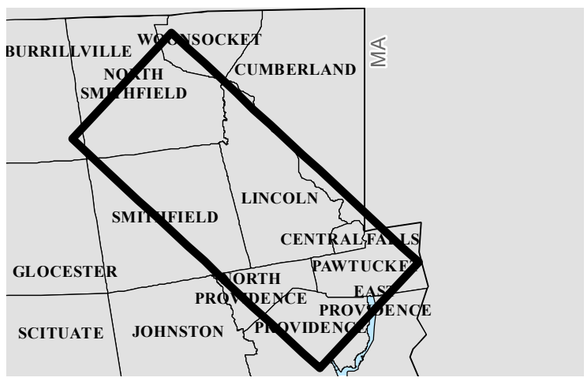

Legend

- Project Features
- Existing Transmission Line
- 5,000ft Study Area
- Existing Power Facility
- State Highway
- River or Stream
- Lake or Pond
- Swamp or Marsh
- Town Boundary
- Groundwater Reservoir
- Groundwater Recharge Areas

Groundwater Quality Standard

- GA
- GAA
- GB

Q143/R144 Lines Rebuild Project

Figure 5-4 - Groundwater Resources

State of Rhode Island

Providence County:
City of Woonsocket, Town of North Smithfield, Town of Lincoln, Town of North Providence, City of Providence

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Rhode Island Energy

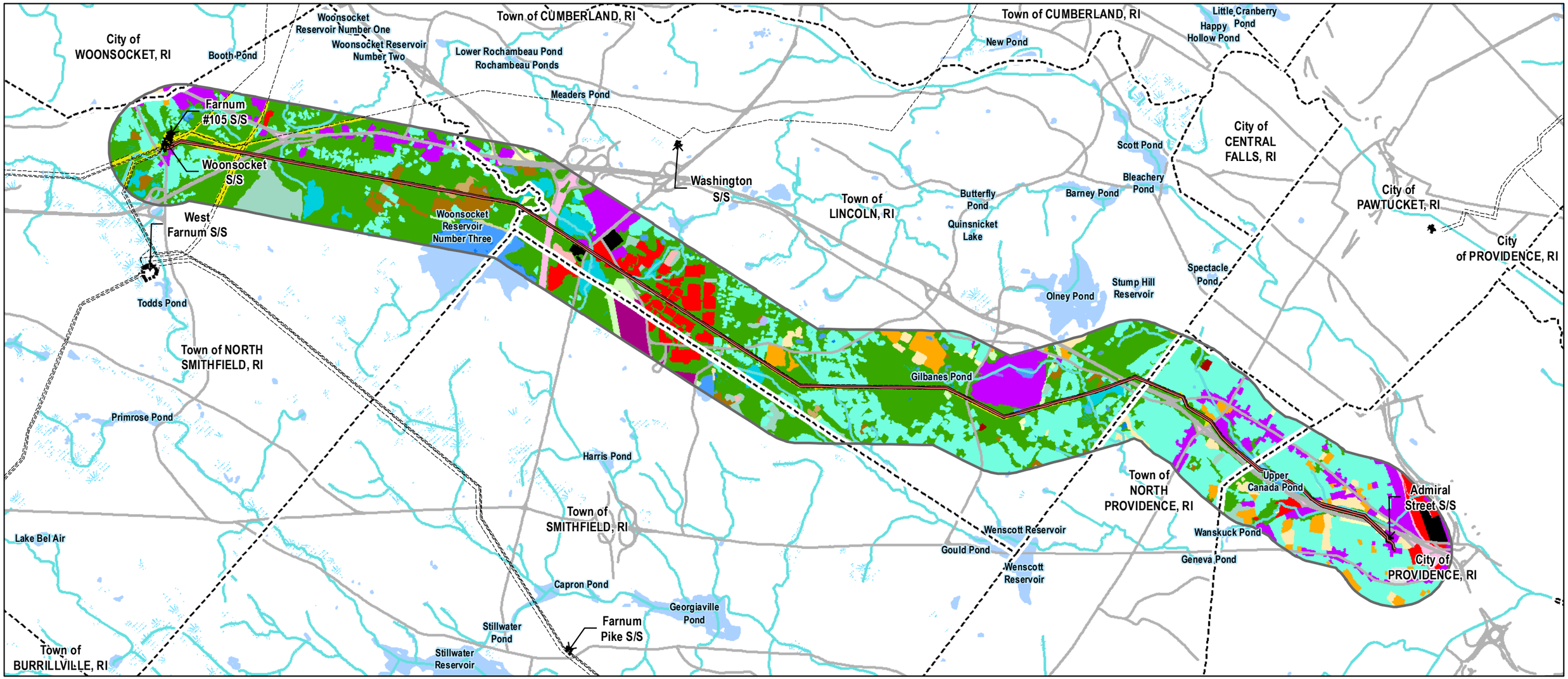
0 1 2 Miles

1 " = 4,250 '

NOT FOR CONSTRUCTION

DATE: 10/11/2024

AUTHOR: KANDREWS



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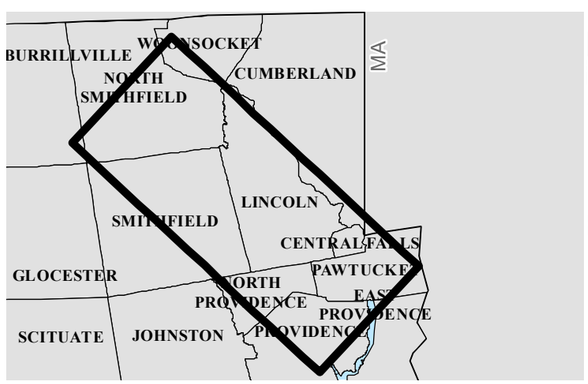

Legend

- Project Features
- Existing Transmission Line
- 5,000ft Study Area
- Existing Power Facility
- State Highway
- River or Stream
- Lake or Pond
- Swamp or Marsh
- Town Boundary

Land UseLand Cover

- Airports (and associated facilities)
- Beaches
- Brushland
- Cemeteries
- Commercial
- Confined Feeding Operations
- Agriculture, Pasture
- Forest
- Recreation
- Ground-mounted Solar Energy Systems
- Residential
- Idle Agriculture (abandoned fields and orchards)
- Industrial & Manufacturing
- Institutional (schools, hospitals, churches, etc.)
- Vacant Land
- Orchards, Groves, Nurseries
- Other Transportation (terminals, docks, etc.)
- Utility Easement
- Transportation
- Transitional Areas (urban open)
- Waste Disposal (landfills, junkyards, etc.)
- Water
- Water and Sewage Treatment
- Wetland

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Figure 6-1 - Land Use Classification

State of Rhode Island

Providence County:
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Rhode Island Energy

0 1 2 Miles

1 " = 4,250 '

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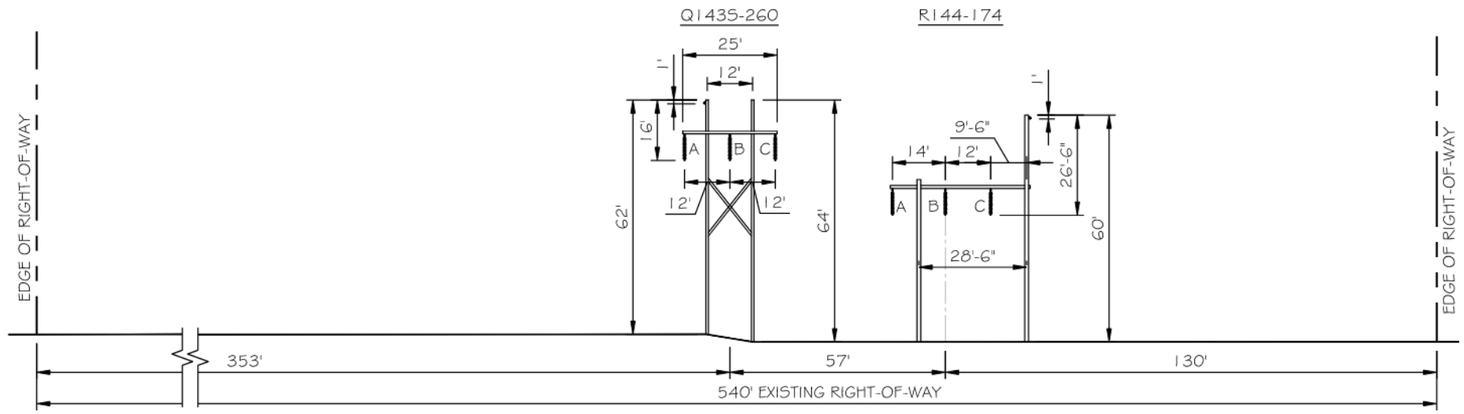

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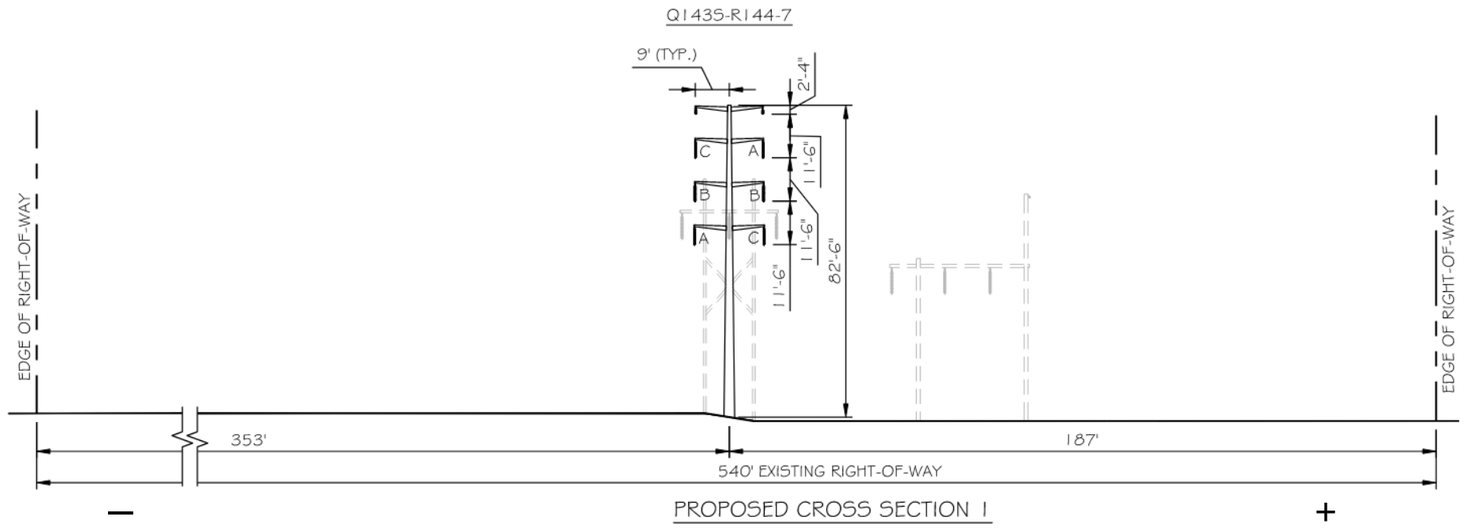

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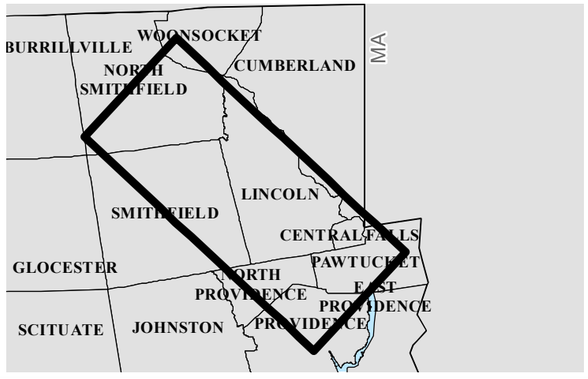

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Figure 7-1 - Typical Cross Section Details - Page 1

State of Rhode Island

Providence County:
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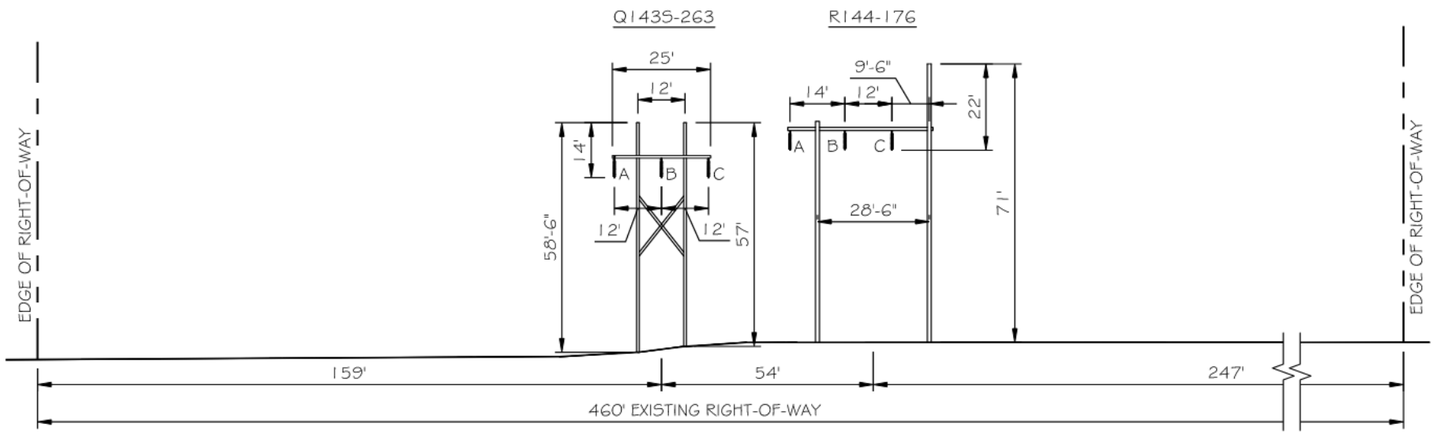
DATE: 4/14/2025

AUTHOR: KANDREWS



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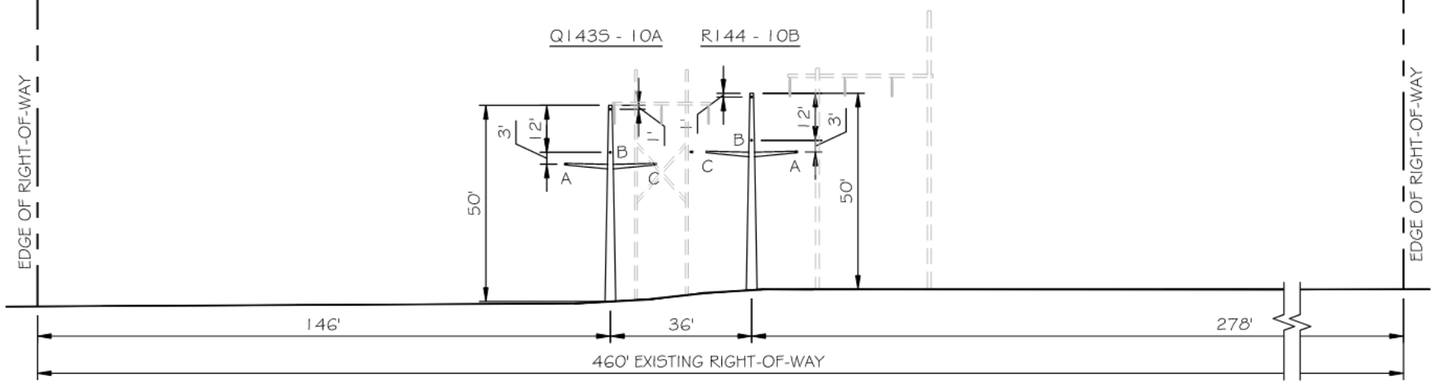

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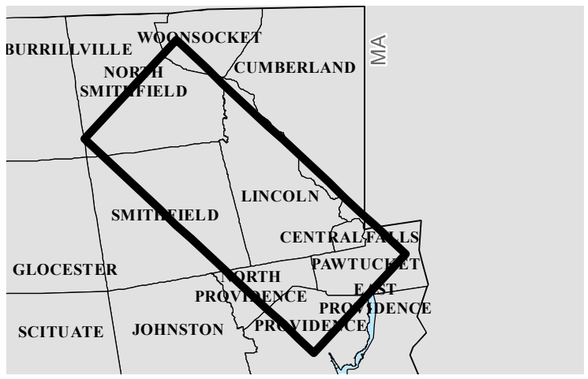

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Figure 7-1 - Typical Cross Section Details - Page 2

State of Rhode Island

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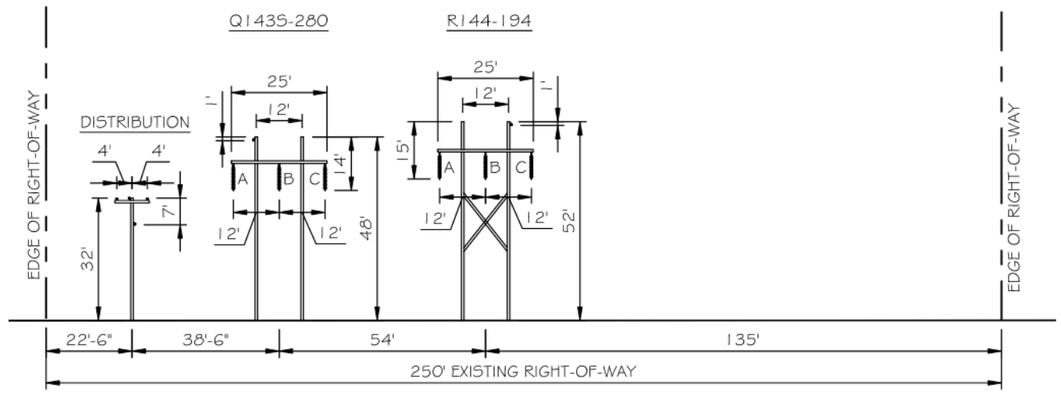

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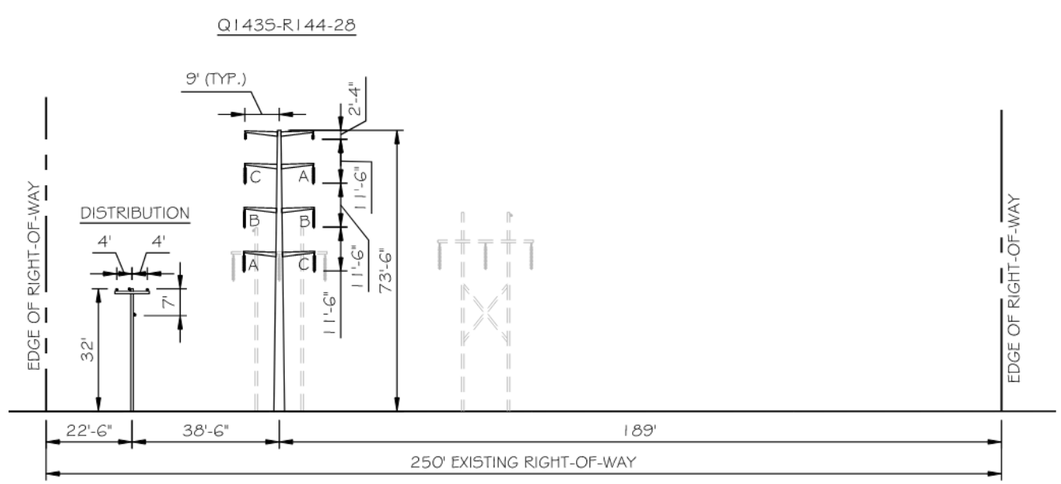

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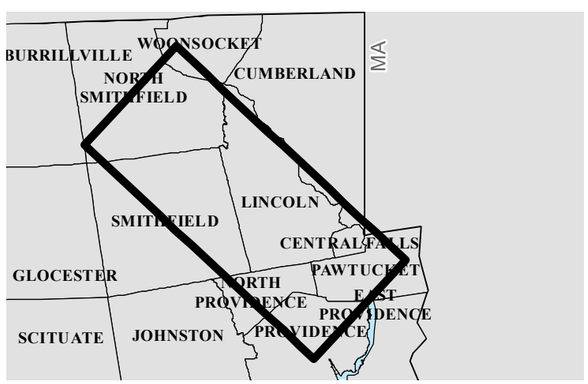

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Figure 7-1 - Typical Cross Section Details - Page 3

State of Rhode Island

Providence County:
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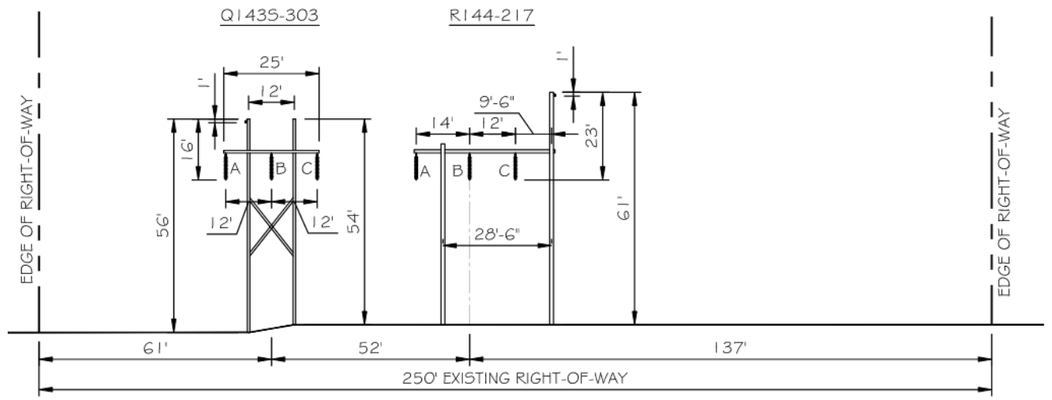

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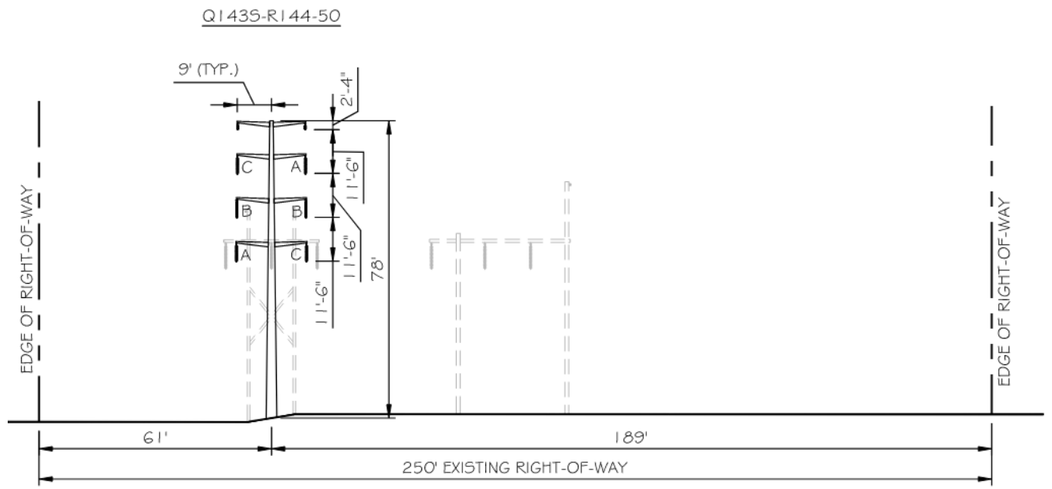

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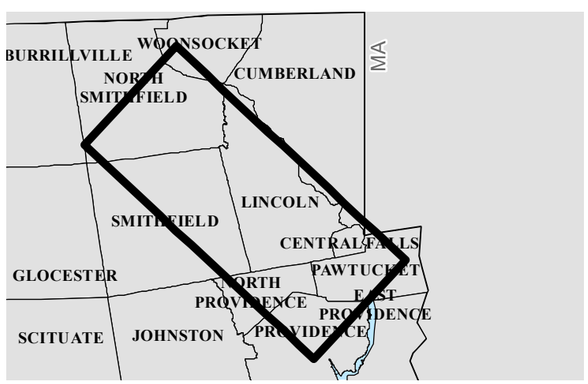

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Figure 7-1 - Typical Cross Section Details - Page 4

State of Rhode Island

Providence County:
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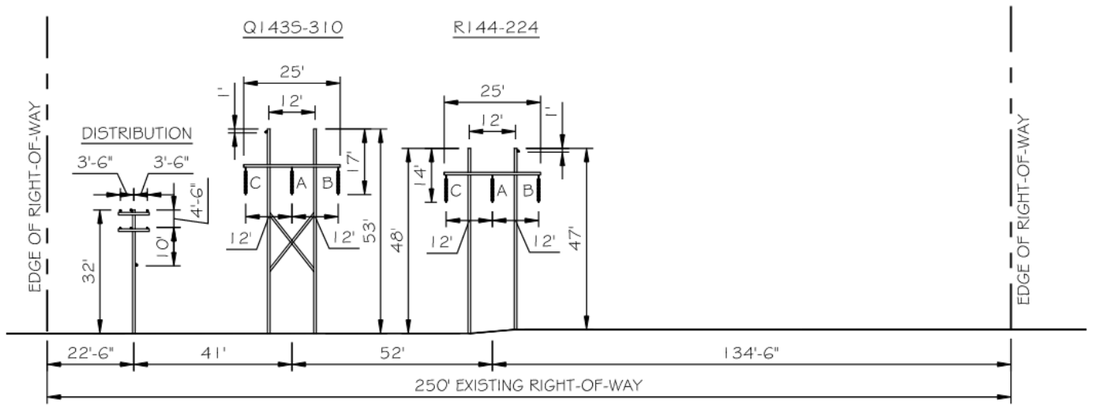

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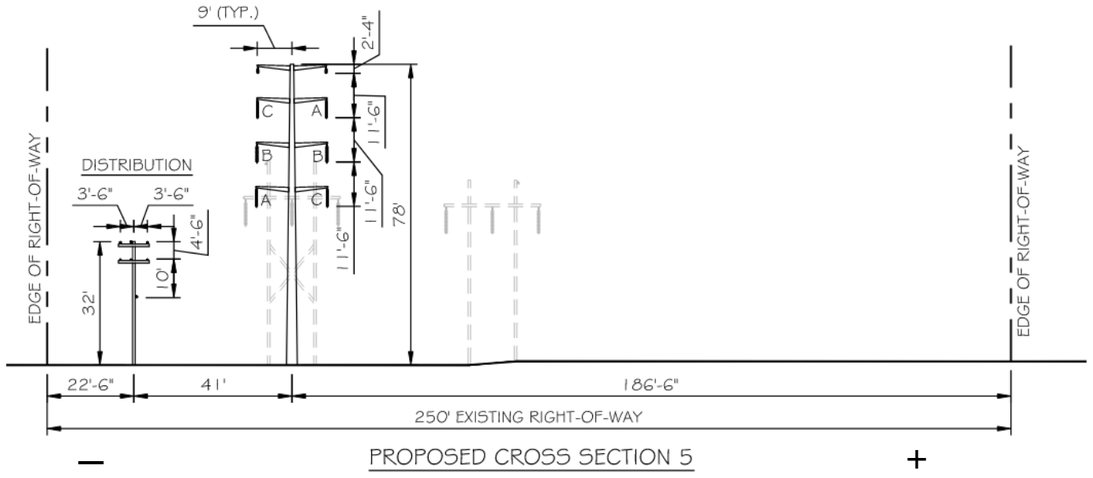

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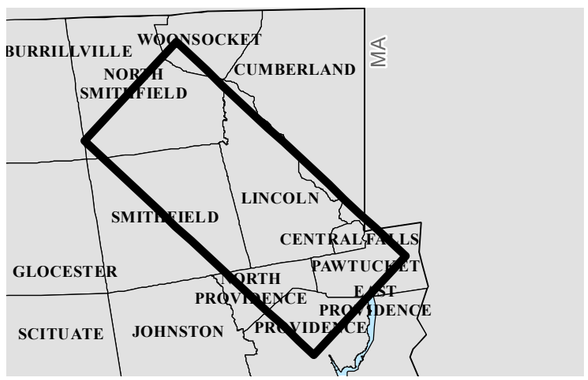

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Figure 7-1 - Typical Cross Section Details - Page 5

State of Rhode Island

Providence County:
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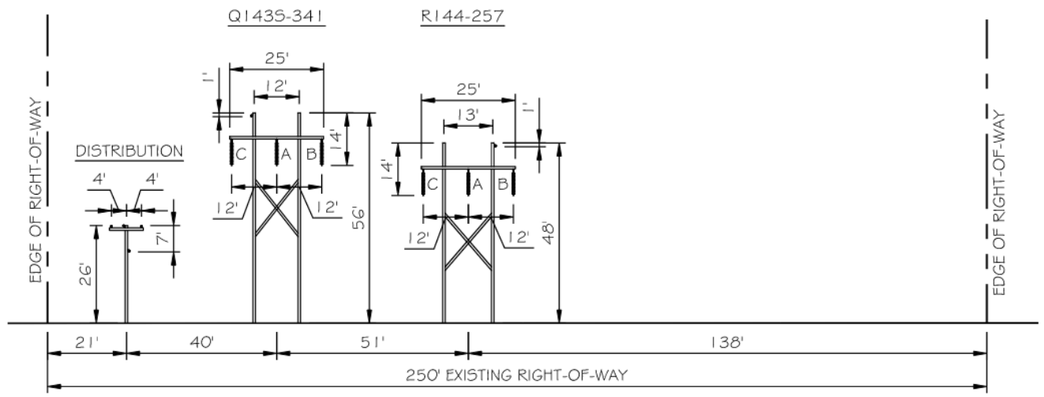

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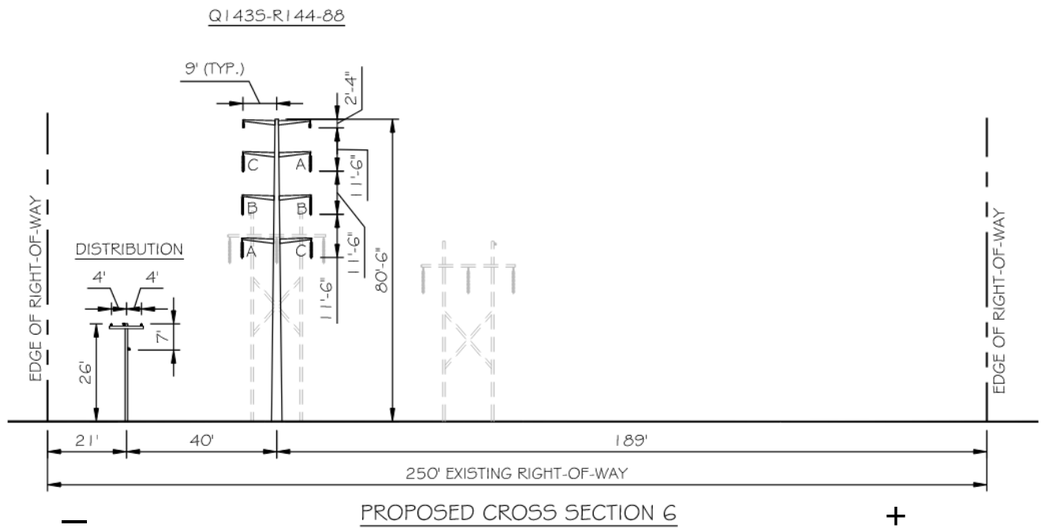

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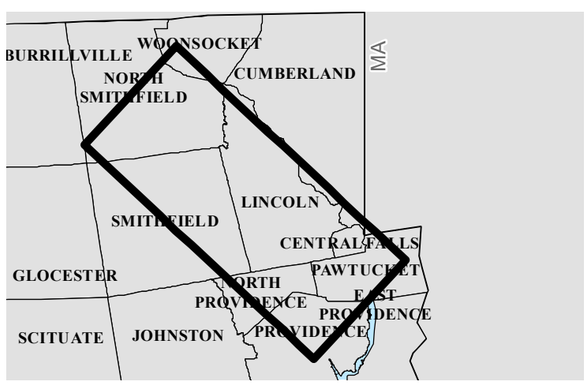

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Figure 7-1 - Typical Cross Section Details - Page 6

State of Rhode Island

Providence County:
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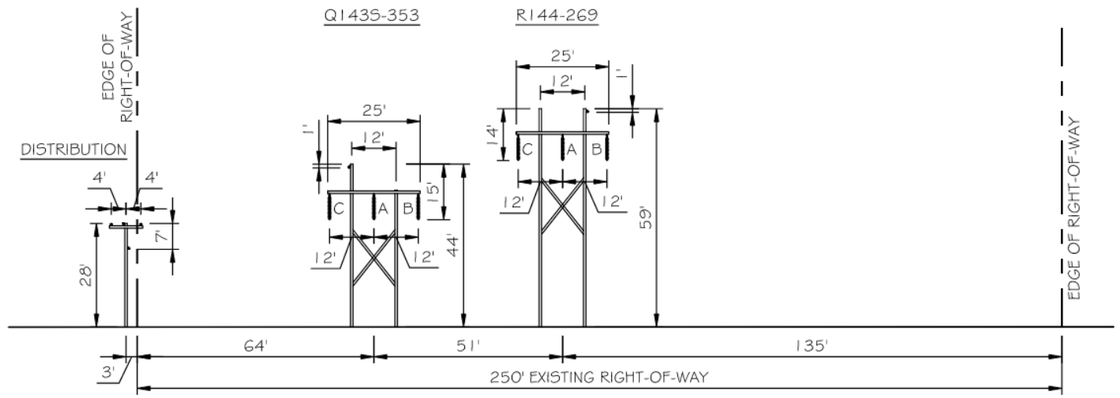

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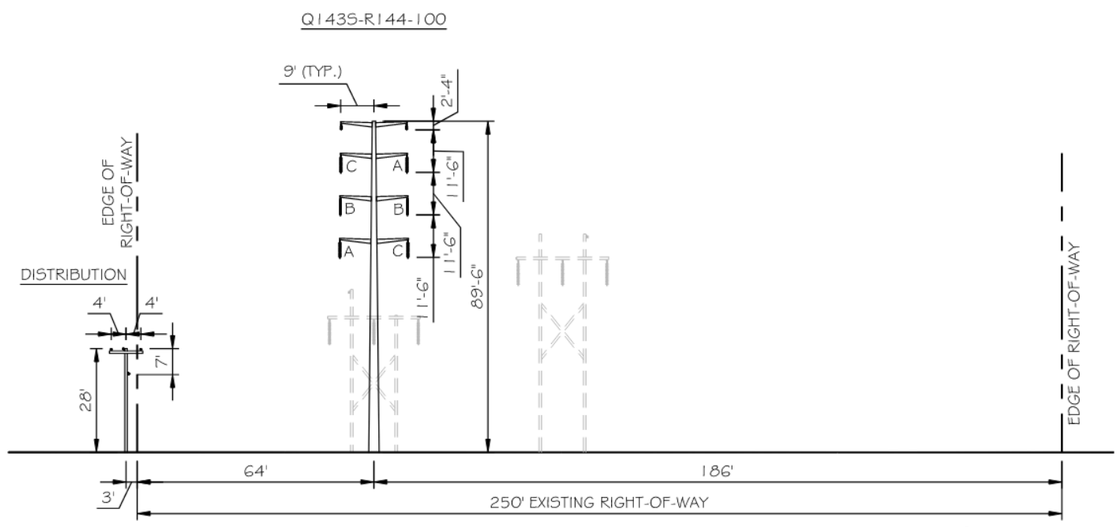

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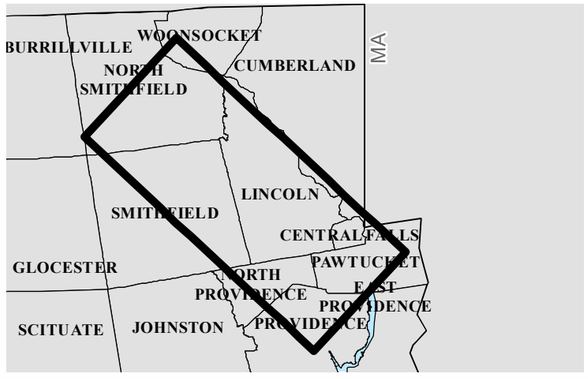

Q143/R144 Lines Rebuild Project

Figure 7-1 - Typical Cross Section Details - Page 7

State of Rhode Island

Providence County:
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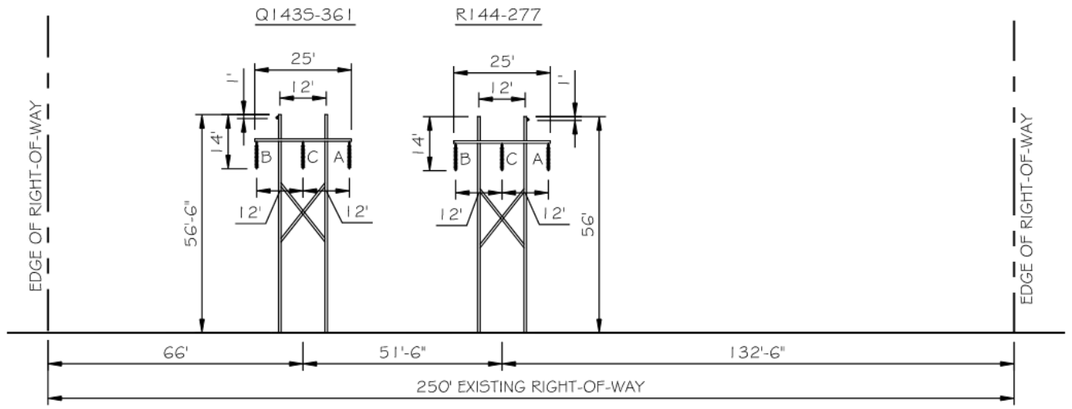

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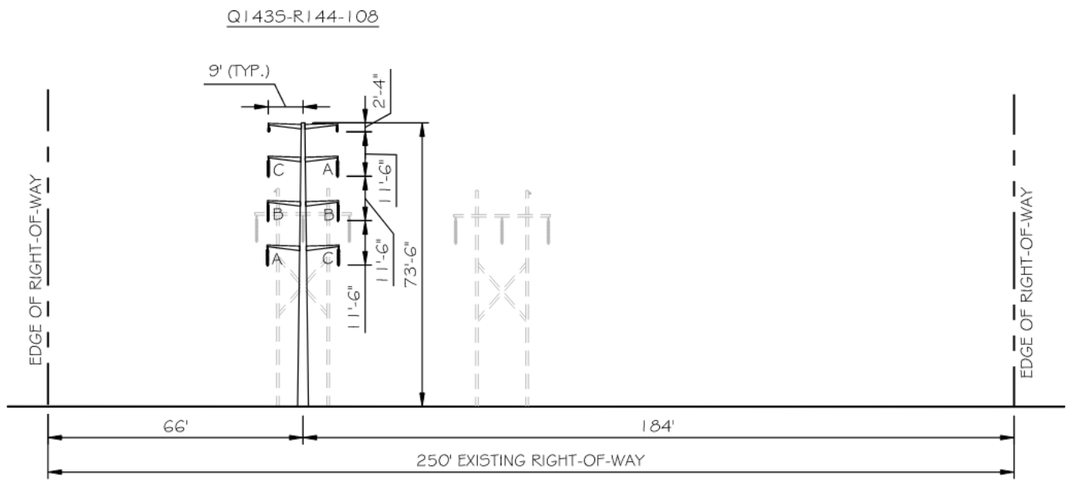

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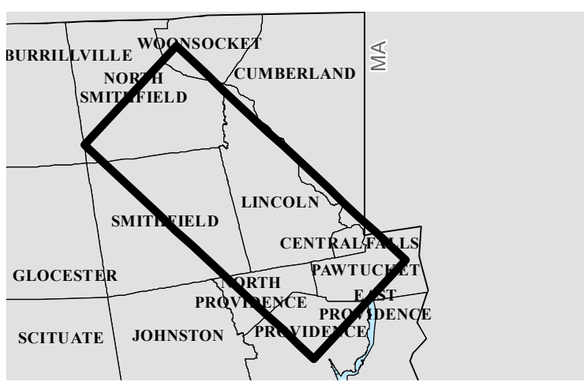

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Figure 7-1 - Typical Cross Section Details - Page 8

State of Rhode Island

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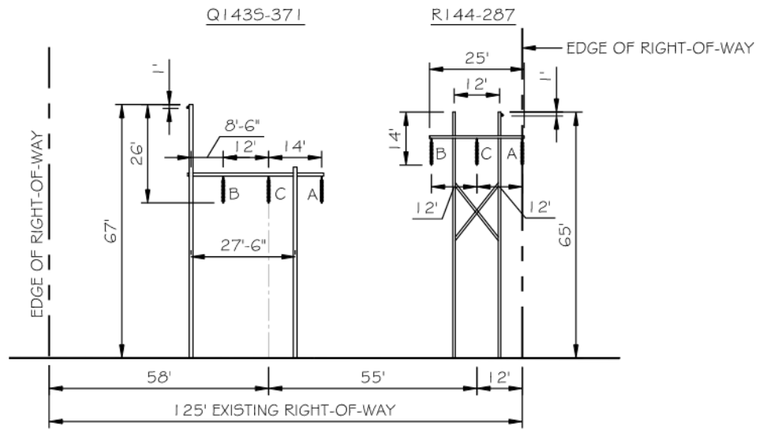

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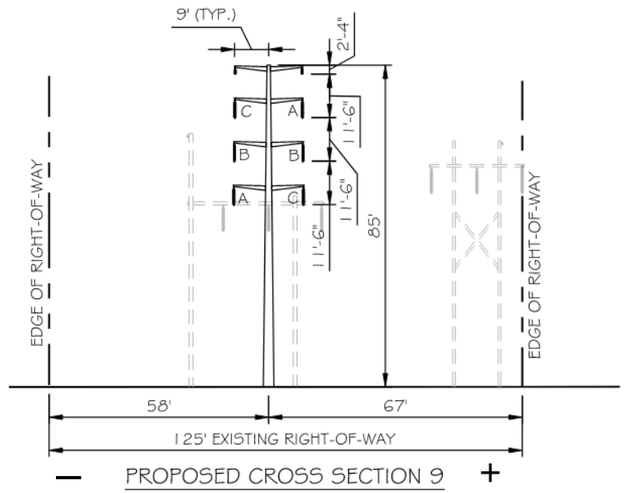

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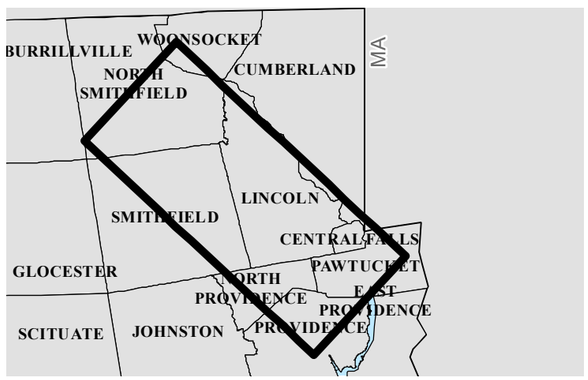

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Figure 7-1 - Typical Cross Section Details - Page 9

State of Rhode Island

Providence County:
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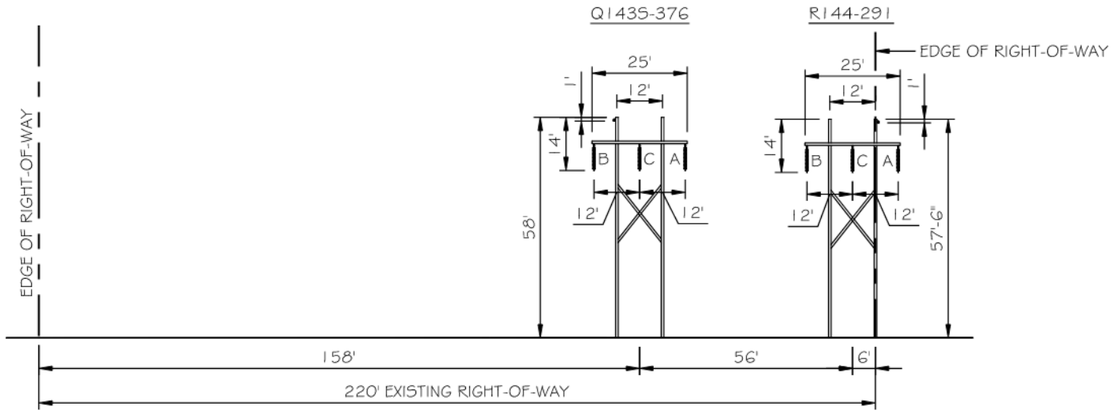

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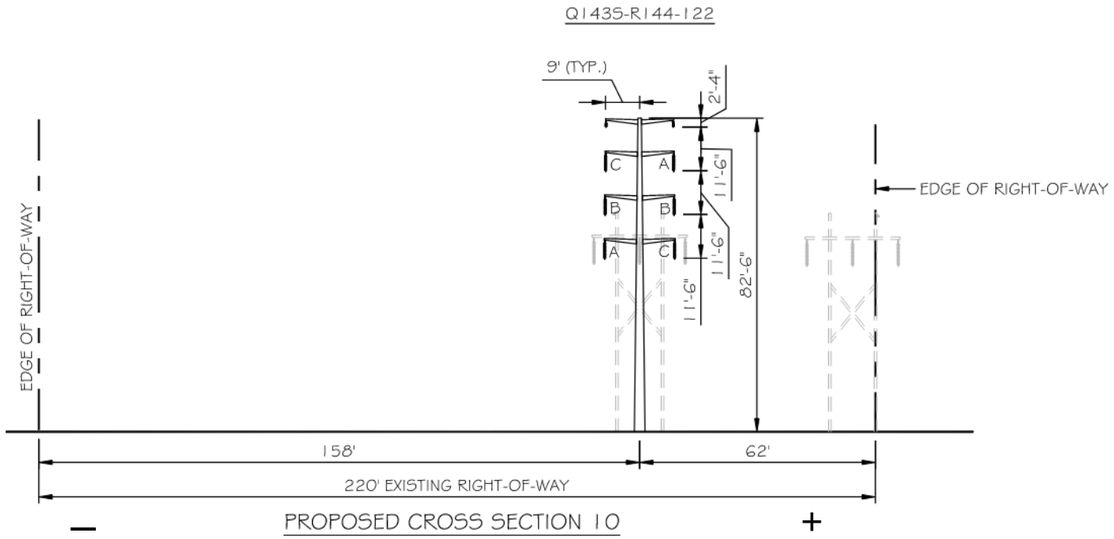

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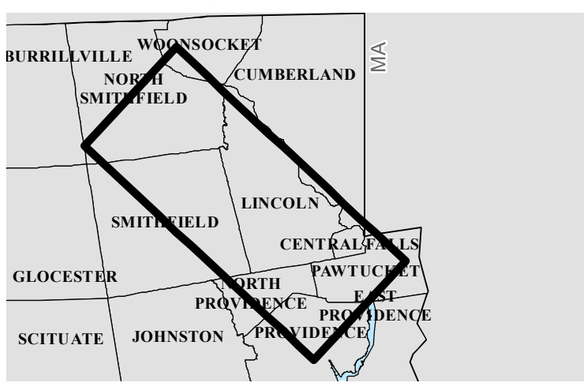

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Figure 7-1 - Typical Cross Section Details - Page 10

State of Rhode Island

Providence County:
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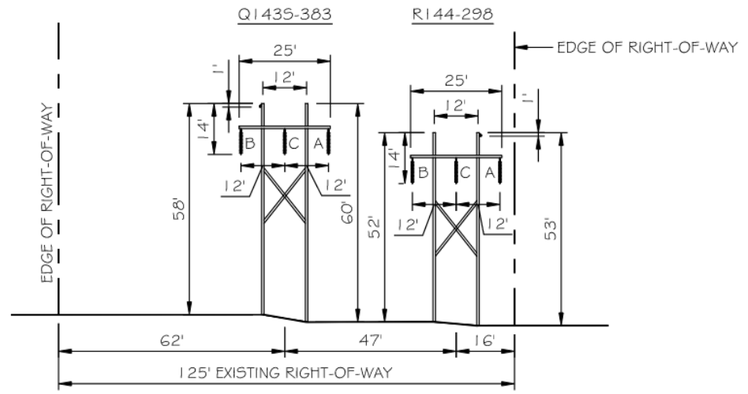

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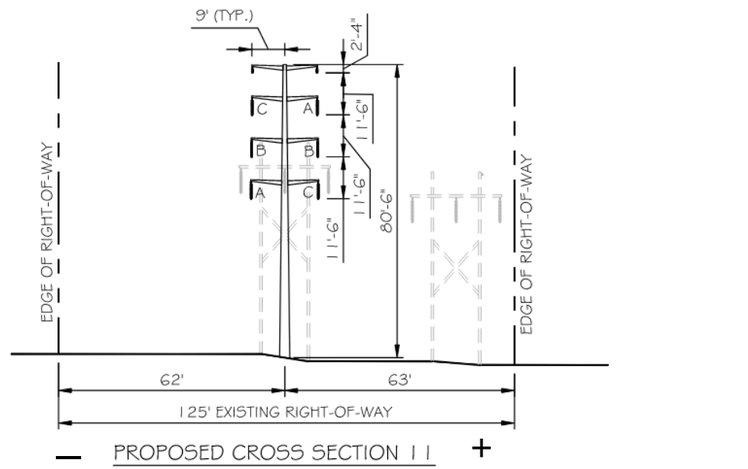

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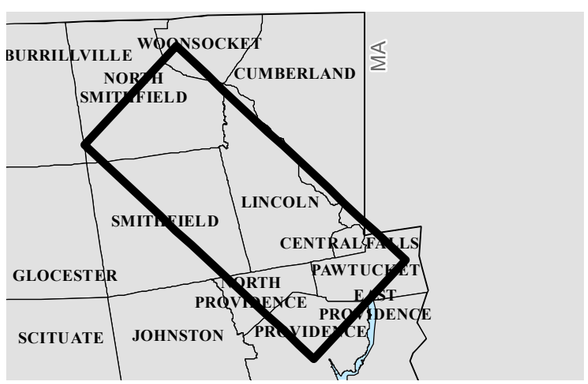

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Figure 7-1 - Typical Cross Section Details - Page 11

State of Rhode Island

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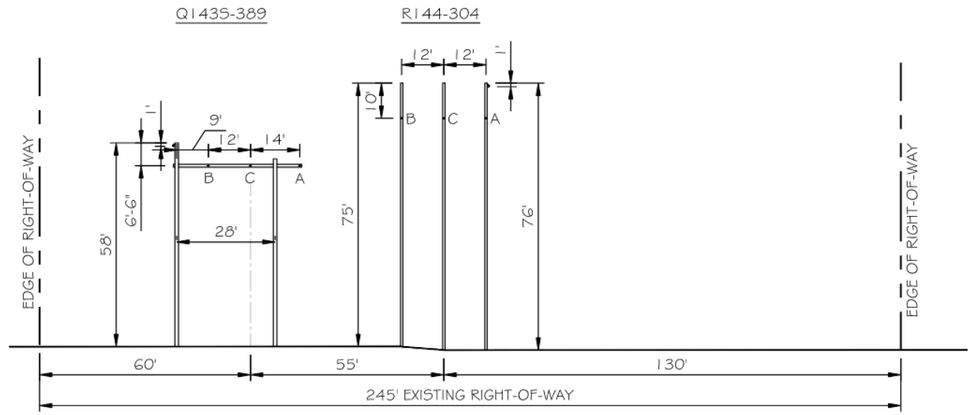

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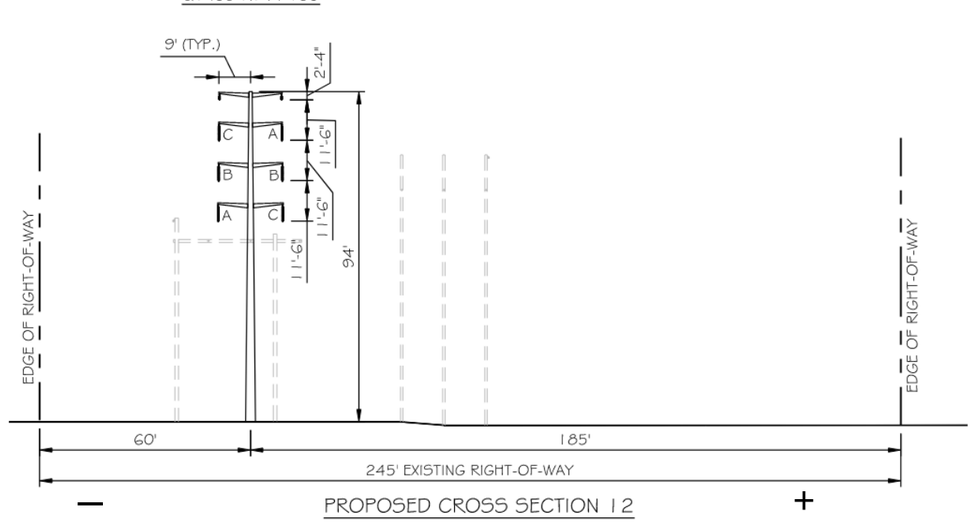

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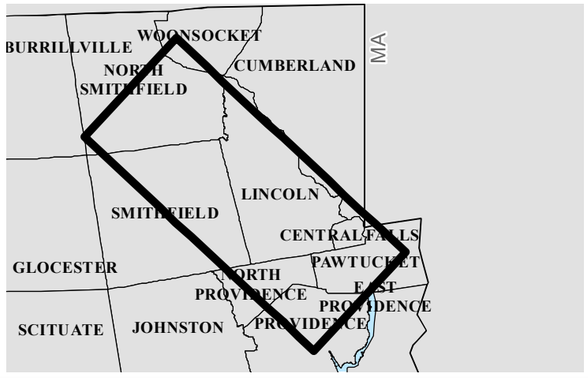

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Figure 7-1 - Typical Cross Section Details - Page 12

State of Rhode Island

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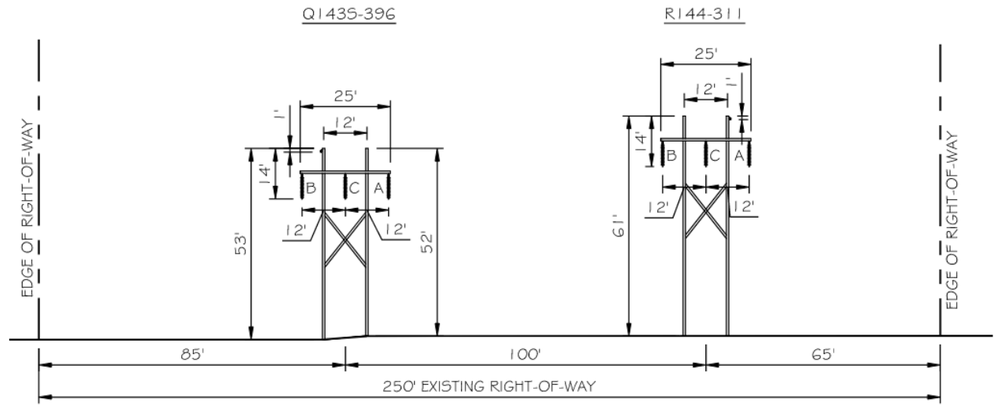

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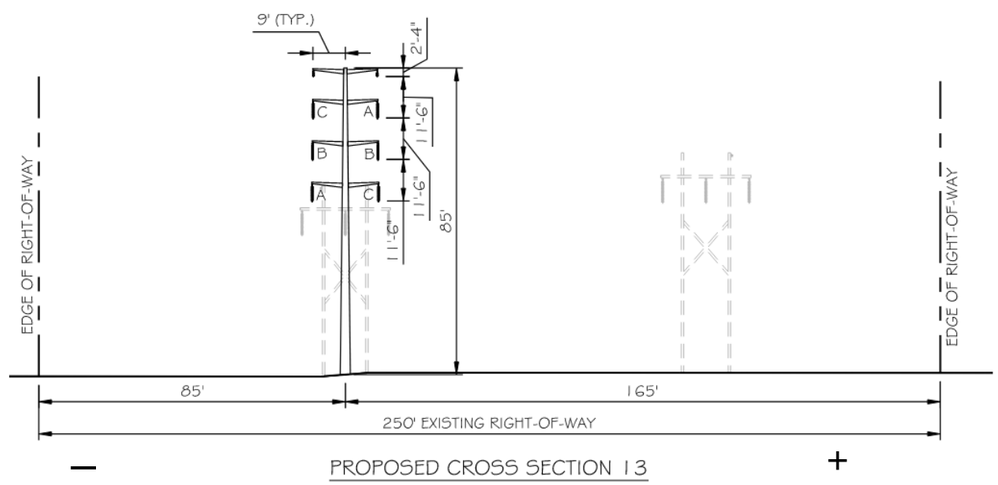

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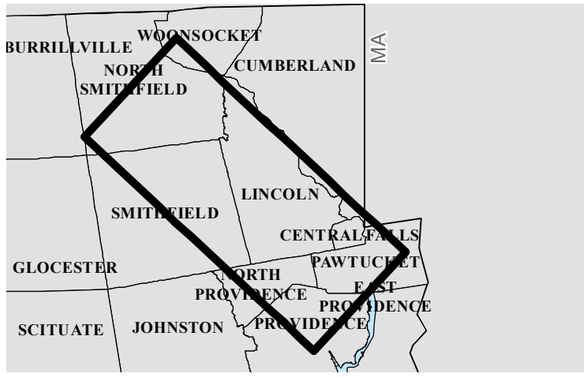

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Figure 7-1 - Typical Cross Section Details - Page 13

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Providence County:
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AUTHOR: KANDREWS

STATE OF RHODE ISLAND

Energy Facility Siting Board

89 Jefferson Boulevard
Warwick, Rhode Island 02888
(401) 941-4500

June 2, 2025

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Robinson & Cole
One Financial Plaza, 14th Floor
Providence, RI 02903-2485

Re: Docket No. SB-2025-02
The Narragansett Electric Company's (TNEC) Notice of Intent Application for Q143S/R144 Lines Rebuild Project - Providence, North Providence, Lincoln and North Smithfield

Dear Mr. Watson:

Pursuant to R.I. Gen. Laws § 42-98-8, I hereby notify you that the Notice of Intent Application for the rebuild of a section of the Q143/R144 Lines located in Providence, North Providence, Lincoln, and North Smithfield, as described in the application filed with the Energy Facility Siting Board ("EFSB") by the Narragansett Electric Company (Company) on May 16, 2025 is docketed as of June 2, 2025. The matter is assigned **Docket Number SB-2025-02**, and this letter shall constitute written notice of the docketing date.

Docketing of this matter is not an indication that it will be given expedited treatment. The Company may be required to file a full application should the EFSB determine the issues associate with the matter require further review.

Should you have any questions, please do not hesitate to call me at 401-780-2108.

Sincerely,

Kristen L. Masse

Kristen L. Masse, Coordinator
RI Energy Facility Siting Board
cc: Service List

STATE OF RHODE ISLAND
ENERGY FACILITY SITING BOARD

IN RE THE NARRAGANSETT ELECTRIC COMPANY d/b/a RHODE ISLAND ENERGY Q143S/R144 LINES REBUILD PROJECT (PROVIDENCE, NORTH PROVIDENCE, LINCOLN AND NORTH SMITHFILED)	**:**	**DOCKET NO. SB-2025-02**

ENERGY FACILITY SITING BOARD'S FIRST SET OF DATA REQUESTS TO THE NARRAGANSETT ELECTRIC COMPANY
Issued: June 2, 2025 Due: June 16, 2025

EFSB 1-1 Refer to Section 4.3 of Exhibit TNEC-2.
Please provide a complete copy of the Company's current standards, policies, engineering guidance, or transmission line design criteria that prohibit the use of wood poles for new or replacement transmission structures. Include all applicable versions or revisions that have been in effect since 2010.

EFSB 1-2 Refer to Section 4.3 of Exhibit TNEC-2.
Please provide the following related to the Company's prohibition on the use of wood poles:

a. The date this policy or standard was adopted;
b. The rationale or justification for the policy at the time of adoption;
c. The individuals or departments involved in creating or approving the policy;
d. Any documentation or meeting materials from when the policy was developed or adopted.
e. If this is a PPL policy, provide the internal policy of National Grid prior to the acquisition of PPL related to the use of wooden poles

EFSB 1-3 Refer to Section 4.3 of Exhibit TNEC-2.
Please indicate whether the Company's policy prohibiting wood poles was:

a. Developed internally for use specifically in Rhode Island;
b. Based on or derived from policies or standards developed for other jurisdictions (e.g., Pennsylvania);
c. Adopted in response to any external standard, guidance, or recommendation from a national body (e.g., NESC, ANSI, RUS, or NERC).

Please explain the reasoning in each case and provide supporting documentation. Please explain if the policy was peer-reviewed or approved by a regulatory or independent third-party engineering firm.

EFSB 1-4 Refer to Section 2.1 of Exhibit TNEC-2 at pages 3–4 and Section 4.3 at page 15.
Please identify and provide any modeling studies, reliability analyses, or risk assessments conducted by or for the Company that compare the use of steel

monopoles versus wood pole structures for 115kV transmission lines, including but not limited to:

a. Structural reliability and failure rates;
b. Lifespan estimates;
c. Safety considerations;
d. Cost-effectiveness over time.

Include the full reports and all referenced data sources or assumptions.

EFSB 1-5 Refer to Section 4.3 of Exhibit TNEC-2 at page 15.
Please provide the Company's cost comparison analysis between wood pole structures and steel monopoles for this Project. Specifically:

a. Initial installation cost per structure type;
b. Estimated maintenance costs over the assumed lifespan of each structure type;
c. Assumed service life for each material;
d. Basis for the conclusion that steel monopoles are more cost-effective or appropriate in this context.

EFSB 1-6 Refer to Section 2.1 of Exhibit TNEC-2.
Please identify any guidance, standard, or requirement from the NERC that addresses or recommends specific pole materials (wood vs. steel) for various situations regarding transmission line or sub transmission line structures similar to the assets in the instant case. If no such guidance exists, please confirm.

EFSB 1-7 Refer to Section 4.3 of Exhibit TNEC-2 at page 15.
Please indicate whether the Company's standards prohibiting the installation of new wood poles for transmission line structures were reviewed, modified, or re-adopted following the acquisition of the Rhode Island electric service territory.

a. If the policy was developed in another jurisdiction (e.g., Pennsylvania), please provide the justification for its applicability to the Rhode Island service territory.
b. Provide any engineering assessments, policy memos, or other documents explaining why these standards are appropriate for Rhode Island-specific conditions.
c. Explain why the previous project on this line previously replaced wooden poles with wooden poles

EFSB 1-8 Refer to Section 4.3 of Exhibit TNEC-2 at page 15.
Please describe the Company's current process for reviewing and updating its transmission structure design standards, including:

a. How frequently the policy is reviewed;
b. The departments or roles responsible for policy review and updates;

c. The last date on which the policy concerning the prohibition of wood poles was reviewed or revised.

Please provide any documentation related to the review process or schedule.

EFSB 1-9 Refer to Section 2.1 of Exhibit TNEC-2 at pages 3–4.
Please provide a detailed cost comparison between wood pole and steel monopole transmission structures, including:

a. Total installed cost per structure type;
b. Average cost over the expected useful life of each structure type;
c. The estimated annual revenue requirement impact of using steel versus wood for the poles proposed in this Project per pole, and total cost impacts.

Include all assumptions, cost model inputs, and supporting analyses or spreadsheets.

EFSB 1-10 Refer to Section 2.1 of Exhibit TNEC-2 at pages 3–4.
Please identify the assumed useful life for each type of structure currently in place on the Q143S and R144 lines (e.g., wood H-frames, wood three-pole, steel two-pole, monopoles), and for the proposed replacement steel monopoles.

a. For each pole structure proposed to be replaced, please identify its original installation year and current age. As part of this response also estimate the remaining useful life for poles most recently installed as recently as 2014-2019.
b. Provide the Company's assessment of where each structure is within its expected service life using a scatterplot of installed date and expected life to show groupings of which poles are close to the end of life, and the amount of poles that may have longer remaining useful life.
c. Explain the engineering on multiple design scenarios of how the steel monopolies and wooden poles could or could not be integrated on the same line. (e.g. half replacement, full replacement, quarter replacement, or replacing on failure).

EFSB 1-11 Refer to Section 2.1 of Exhibit TNEC-2 at pages 3–4.
Please provide all documentation supporting the Company's justification for replacing the existing poles, including but not limited to:

a. Field inspection reports;
b. Photographic evidence;
c. Structural condition assessments;
d. Records of any recent failures, emergency repairs, or public safety concerns associated with the existing poles.

EFSB 1-12 Refer to Section 2.1 of Exhibit TNEC-2 at pages 3–4.
Please identify and describe the inspection practices applied to the Q143S and R144 transmission lines over the past ten (10) years, including:

a. The method used during each inspection (e.g., foot patrol, climbing inspection, drone inspection, aerial flyover, LiDAR scan, infrared imaging, or other);
b. The dates of the last two inspections for each line;
c. A description of how results from each inspection were documented, evaluated, and used to inform maintenance or capital replacement decisions.

In your response, please:

- Provide all associated field notes, reports, and supporting documentation from each inspection; and
- Include a summary and guide indicating the specific inspection findings that led to the determination that the wood pole structures should be replaced with steel monopoles.
- If field inspection data was not used in the decision to replace the poles, please explain the basis for the replacement decision and why field data was not considered.

EFSB 1-13 Refer to Section 2.1 of Exhibit TNEC-2 at pages 3–4.
Please provide the full inspection data for the last two complete inspections of the Q143S and R144 lines.

a. Include any notes, field sheets, electronic data, photos, or defect logs generated as part of the inspections.
b. If summary reports were prepared, please include those as well.

EFSB 1-14 Refer to Section 2.1 of Exhibit TNEC-2 at pages 3–4.
Please provide a detailed inventory of each structure on the Q143S and R144 lines that is proposed for replacement, including:

a. Original installation year;
b. Structure type;
c. Current condition rating or assessment;
d. Estimated percent of useful life consumed;
e. Whether each structure was cited as a reason for project need or rebuild in any inspection, model, or analysis.

Please provide this in spreadsheet format if available.

EFSB 1-15 Refer to Section 2.1 of Exhibit TNEC-2 at pages 3–4.
Please provide all field inspection data, defect logs, photographic documentation, and engineering reports that informed the Company's conclusion that the Q143S and R144 lines are at or near end-of-life and must be replaced. Include any records of observed defects, structural modeling output, or risk assessment

summaries. As part of this response please discuss the ROW and distance of vegetation within the ROW and the potential for limb or tree damage to both steel monopolies or wooden structures based on distances and likelihood to impact

EFSB 1-16 Refer to Section 2.1 and 4.5 of Exhibit TNEC-2 at pages 3–4 and 16. On page 3, it states that "neither the original structures nor the replacement structures would be able to support the new, heavier conductor." Did the Company model the use of other conductor types that were lighter in weight? If so, please describe the analysis and results. If not, please explain why not?
Please also provide:

a. The full results of the modeling analysis referenced in TNEC-2, including assumptions and structure configurations used;
b. Documentation of the conductor properties and temperature conditions applied;
c. The methodology used to evaluate NESC 250C clearance compliance; and
d. An explanation of how these modeling results were extrapolated to justify full line replacement.

EFSB 1-17 On page 3 of TNEC-2, it states that "Load in the area is expected to increase slightly (~5MW) with the completion of upgrades at the Admiral Street Substation in mid-2026. The proposed conductor allows for future load growth and reduces likelihood of revisiting the corridor multiple times resulting in less disturbance to the environment and lower mobilization costs to complete the work."

a. What is the maximum load growth that the current conductors can reasonably support? Please explain.
b. Please explain the extent to which the new proposed conductor increases the capacity of the existing transmission line.
c. With regards to the disturbances to the environment, please elaborate on use case and the counterfactual cases impact to the environment.

EFSB 1-18 Why did the Company choose Aluminum Conductor Steel-Supported (ACSS) cable for the Project? Did the Company consider other conductors, such as Aluminum Conductor Steel-Reinforced (ACSR) cable, Aluminum Conductor Composite Core (ACCC) cable, or another conductor type? Please list all alternative conductors considered and explain the company's reasoning.

EFSB 1-19 Refer to Section 2.1 of Exhibit TNEC-2 at pages 3–4.
Please describe any maintenance or reinforcement strategies that were considered or performed prior to recommending full replacement of the Q143S and R144 lines.

a. Provide any internal evaluations of continued maintenance versus rebuild;
b. Include cost comparisons of major maintenance versus full replacement;

c. Clarify whether asset optimization or reliability indices were used to support the replacement decision.
d. Discuss the previous replacement project referenced on page 3 of TNEC-2 started in 2014 on 134 structures of targeted wooden poles and why a similar type of project was not selected for this line.

EFSB 1-20 Refer to Section 2.1 of Exhibit TNEC-2 at pages 3–4.
Please provide the underlying forecast used to support the stated 5 MW load growth in the area, including:

a. Assumptions, time horizon, and feeder/substation data;
b. Whether the existing line could serve the forecasted load if only reconductored;
c. Whether load growth was a primary or secondary factor in selecting full line rebuild.

EFSB 1-21 Refer to Section 4.1 of Exhibit TNEC-2 at page 15.
Please provide a summary of all alternatives considered to full line replacement, including any non-wires alternatives (NWA), partial rebuilds, or staged upgrade options.

a. If no NWAs were considered, please explain why not;
b. If partial rebuilds were dismissed, provide the analysis supporting that dismissal.

EFSB 1-22 Refer to Sections 2.1 and 4.5 of Exhibit TNEC-2 at pages 3–4 and 16.
Please provide any cost-benefit analysis or lifecycle cost evaluation prepared for the Q143S and R144 Lines Rebuild Project.

a. Include all capital and O&M cost components for both rebuild and maintain scenarios;
b. Identify assumptions used regarding asset performance, failure risk, or reliability impacts;
c. Provide any modeled customer rate impacts or revenue requirement implications.

EFSB 1-23 On page 3 of TNEC-2, it states: "The line was partially refurbished in 2014 as 134 structures were replaced, modeling has indicated that neither the original structures nor the replacement structures would be able to support the new, heavier conductor."

a. Please provide a detailed description of the refurbishment project.
b. If there were any filings made with the EFSB associated with the refurbishment project, please provide a copy.
c. Please explain with specificity all the facts supporting the Company's conclusion that the 134 wood structures that were refurbished in 2014

would not be able to support the new heavier conductor? What is meant by not supporting the conductor?

EFSB 1-24 In Section 4.3 of TNEC-2, it states that reinforcing or replacing "in-kind" new wood pole structures would address "short-term concerns" and would be "a cheaper alternative in the short term."

a. Please describe the "short-term concerns" that would be addressed and any longer term concerns that would not be addressed.
b. How much "cheaper" would the Project be if "in-kind" new pole structures were used? Please indicate and explain the project cost differential that supports the conclusion that replacing the wood poles with in-kind structures would be cheaper than the Company's current proposal.

EFSB 1-25 Please provide copies of any presentations that have been provided to ISO New England and/or any NEPOOL committee relating to the Project and minutes (if any) that were prepared by any entity relating to the presentation.

EFSB 1-26 Please provide a copy of any internal sanctioning documents that were used by the Company for authorizing the investments in the Project.

EFSB 1-27 Please provide an estimate of the revenue requirement increase in LNS rates that results from the Project. Please provide an illustrative calculation and estimate of the revenue requirement that would be included in Local Network Service (LNS) rates in each of the first three years after Project costs have begun to be included in LNS rates. Please also provide the annual amount of revenue requirement estimated (i) to be charged directly in Rhode Island Energy in the transmission component of retail delivery rates and (ii) to be charged to Pascoag Utility District (i.e., now called the Clear River Electric and Water District) for each of those years.

SB-2025-02 The Narragansett Electric Company's 90 Day NOI Application for the Q143S/R144 Lines Rebuild Project, Providence, North Providence and North Smithfield, Rhode Island

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