Rhode Island Energy Facility Siting Board
Environmental Report – Volume I

Interstate Reliability Project

North Smithfield and Burrillville, Rhode Island

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This document has been reviewed for Critical Energy Infrastructure Information (CEII).

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Glossary

AAL:	Annual Average Load.
AC:	Alternating Current – an electric current which reverses its direction of flow periodically.
ACI:	American Concrete Institute.
ACOE:	United States Army Corps of Engineers.
ACSR:	Aluminum Conductor Steel Reinforced.
ACSS:	Aluminum Conductor Steel Supported.
AIS	Air-Insulated Switchgear.
Ampere (Amp):	A unit of measure for the flow of electric current.
ANSI:	American National Standards Institute.
APL:	Annual Peak Loading.
Arrester:	Provides protection for lines, transformers and equipment from transient over-voltages due to lightning and switching surges by carrying the charge to the ground.
ASF:	Area Subject to Flooding.
ASSF:	Area Subject to Storm Flowage.
Autotransformer:	A transformer with a single winding per phase in which the lower voltage is obtained by a tap on the winding (refer to Power Transformer).
BMPs:	Best Management Practices.
BPS:	Bulk Power System.
Bundle:	Two or more wires joined together to operate as a single phase.
Bus:	An electrical conductor that serves as a common connection point for two or more electrical circuits, typically in a substation or switching station.
CAAA:	Clean Air Act Amendments.
Cable:	A fully insulated conductor usually installed underground, but in some circumstances can be installed overhead.
CCRP:	Central Connecticut Reliability Project.
CEII:	Critical Energy Infrastructure Information.
CELT Report:	ISO-NE annual regional forecast of Capacity, Energy, Loads and Transmission for New England.
Circuit:	A system of conductors (three conductors or three bundles of conductors) through which an electric current is intended to flow and which may be supported above ground by transmission structures or placed underground.
Circuit Breaker:	A switch that automatically disconnects power to a circuit in the event of a fault condition; typically located in substations or switching stations.

CLL:	Critical Load Level.
CL&P:	The Connecticut Light and Power Company, a wholly owned subsidiary of Northeast Utilities.
CO:	Carbon Monoxide.
Conductor:	A metallic wire which serves as a path for electric current to flow.
Conduit:	Pipes, usually PVC plastic, typically encased in concrete, and used to house and protect underground power cables or other subsurface utilities.
CSC:	Connecticut Siting Council.
Davit Arm Structure:	A single-shaft steel pole with an alternating arm configuration each of which supports a phase conductor.
dB:	A decibel is a logarithmic unit of measurement that expresses the magnitude of a sound.
dBA:	Decibel, on the A-weighted scale. A-weighting is used to emphasize the range of frequencies where human hearing is most sensitive.
Demand:	The total amount of electric power required at any given time by an electric supplier's customers.
DR:	Demand resource - a source of capacity whereby a customer reduces the demand for electricity e.g., by using energy-efficient equipment, shutting off equipment, or using electricity generated on site.
DG:	Distributed Generation.
Dielectric Fluid:	A fluid that insulates and cools electrical equipment and does not conduct an electric current.
Distribution Line or System:	Power lines that operate under 69 kV.
Double-Circuit:	Two circuits on one structure.
DPW:	Department of Public Works.
DSM:	Demand Side Management.
Duct Bank (or Ductline):	A group of buried conduits, usually encased in concrete, and used for installation of underground cable.
Duct:	An individual conduit used to house underground power cable (refer to "Conduit").
EFORD:	Equivalent Demand Forced Outage Rate.
EFSB:	Rhode Island Energy Facility Siting Board.
EHS:	Extra high strength.
Electric Field:	A field produced as a result of voltages applied to electrical conductors and equipment; usually measured in units of kilovolts per meter.

Electric Transmission:	Facilities (≥ 69 kV) that transmit electrical energy from generating plants to substations.
ELUR:	Environmental Land Use Restrictions.
EMF:	Electric and magnetic fields.
Fault:	A failure or interruption in an electrical circuit (a.k.a. short-circuit).
FCA:	Forward Capacity Auction.
FCM:	Forward Capacity Market.
FERC:	Federal Energy Regulatory Commission.
FEMA:	Federal Emergency Management Agency.
FHWA:	Federal Highway Administration.
FTE:	Full-time equivalent.
Gauss (G):	A unit of measure for magnetic fields; one G equals 1,000 milliGauss (mG).
Gigawatt (GW):	One gigawatt equals 1,000 megawatts.
GIS:	Gas Insulated Switchgear - this is electrical switching equipment, typically installed in a substation and insulated with SF_6 gas.
Glacial Till:	Type of surficial geologic deposit that consists of boulders, gravel, sand, silt and clay and mixed in various proportions. These deposits are predominantly nonsorted, nonstratified sediment and are deposited directly by glaciers.
Gneiss:	Light and dark, medium to coarse-grained metamorphic rock characterized by compositional banding of light and dark minerals, typically composed of quartz, feldspar and various amounts of dark minerals.
GSRP:	Greater Springfield Reliability Project.
H-frame Structure:	A wood or steel transmission line structure constructed of two upright poles with a horizontal cross-arm.
HPFF:	High Pressure Fluid Filled - a type of underground transmission cable.
HVDC:	High-Voltage Direct-Current.
Hz:	Hertz, a measure of the frequency of alternating current; expressed in units of cycles per second.
ICF:	ICF International.
IEEE:	Institute of Electrical and Electronic Engineers.
Interconnection Queue:	ISO-NE New England Generation Interconnection Queue.
ISO:	Independent System Operator.
ISO-NE:	ISO New England, Inc., the independent system operator of the New England electric transmission system.
IVM:	Integrated Vegetation Management.

kcmil:	One thousand circular mils, approximately 0.0008 square inches, a measure of conductor cross-sectional area.
kV:	Kilovolt - one kV equals 1,000 volts.
kV/ m:	Kilovolts per meter - a measurement of electric field strength.
L&RR Site:	Landfill and Resource Recovery Site. A USEPA-designated National Priorities Listing Superfund Site located on Old Oxford Road in North Smithfield, Rhode Island.
Load:	Amount of power delivered upon demand at any point or points in the electric system; load is created by the power demands of customers' equipment (residential, commercial and industrial).
LTE:	Long-Term Emergency rating.
LSZ:	Landscape Similarity Zone.
mG:	A unit of measure for magnetic fields. One milliGauss - equals 1/1000 Gauss.
MassDOT:	Massachusetts Department of Transportation.
MA EFSB:	Massachusetts Energy Facilities Siting Board.
Monopole:	A single pole supporting overhead utility wire.
MUST:	Siemens' PTI Managing and Utilizing System Transmission (computer program).
MVA:	Megavolt Ampere - measure of electrical capacity equal to the product of the line-to-line voltage, the current and the square root of 3 for three-phase systems; electrical equipment capacities are sometimes stated in MVA.
MVAR:	Megavolt Ampere Reactive - also called MegaVARS - measure of reactive power in alternating current circuits; shunt capacitor and reactor capacities are usually stated in MVARs.
MW:	Megawatt - a megawatt equals 1 million watts.
N-1:	A single event causing the loss of one or more elements (i.e., generator, transmission lines, bus section, etc.).
N-1-1:	Occurrence of two separate and unrelated outages within a short period of time.
NAAQS:	National Ambient Air Quality Standards.
NEEWS:	New England East-West Solution.
NEPOOL:	New England Power Pool.
NERC:	North American Electric Reliability Corporation.

NESC:	National Electrical Safety Code. The NESC is an ANSI standard that covers basic provisions for safeguarding of persons from hazards arising from the installation, operation, or maintenance of 1) conductors and equipment in electrical supply stations, and 2) overhead and underground electric supply and communication lines. It also includes work rules for the construction, maintenance, and operation of electric supply and communication lines and equipment.
NITHPO:	Narragansett Indian Tribal Historic Preservation Officer.
NO_x:	Nitrogen Oxides.
NPCC:	Northeast Power Coordinating Council.
NSTAR:	NSTAR Electric Company, Massachusetts-based, investor-owned electric and gas utility company. A wholly-owned subsidiary of Northeast Utilities.
NTAs:	Non-Transmission Alternatives.
NU:	Northeast Utilities.
O_3:	Ozone.
OATT:	Open Access Transmission Tariff.
OH:	Overhead - electrical facilities carried above-ground on supporting structures.
OPGW:	Optical ground wire – ground wire containing optical fibers.
PAC:	Planning Advisory Committee lead by ISO-NE.
Phase:	Transmission and distribution AC circuits are comprised of three conductors or bundles of conductors that have voltage and angle differences between them; each of these conductors (or bundles) is referred to as a phase.
$PM_{2.5}$:	Fine Particulate Matter.
Power Transformer:	A device that changes or transforms alternating current from one voltage to another voltage.
PPA:	Proposed Plan Application.
PP-3:	ISO-NE Planning Procedure 3, Reliability Standards for the New England Area Bulk Power Supply System.
PP-4:	ISO-NE Planning Procedure 4.
PVC:	Polyvinyl Chloride.
Reactive Power:	A component of power associated with capacitive of inductive circuit elements; its unit of measurement is the VAR.
Rebuild:	Replacement of an existing overhead transmission line with new structures and conductors, generally along the same alignment as the original line.
Reconductor:	Replacement of existing conductors with new conductors, and any necessary structure reinforcements or replacements.

Reinforcement:	Any of a number of approaches to increase the capacity of the transmission system, including rebuilding, reconductoring, uprating, conversion and conductor bundling methods.
RIDEM:	Rhode Island Department of Environmental Management.
RIDFW:	Rhode Island Division of Fish and Wildlife.
RIDOT:	Rhode Island Department of Transportation.
RIEDC:	Rhode Island Economic Development Corporation.
RIGIS:	Rhode Island Geographic Information System.
R.I.G.L:	Rhode Island General Law.
RIHPHC:	Rhode Island Historical Preservation & Heritage Commission.
RINHP:	Rhode Island Natural Heritage Program.
RINHS:	Rhode Island Natural History Survey.
RIRP:	Rhode Island Reliability Project.
ROD:	Record of Decision.
ROW:	Right-of-Way. Corridor of land within which a utility company holds legal rights necessary to build, operate, and maintain power lines.
Schist:	Light, silvery to dark, coarse to very coarse-grained, strongly to very strongly layered metamorphic rock whose layering is typically defined by parallel alignment of micas. Primarily composed of mica, quartz and feldspar; occasionally spotted with conspicuous garnets.
SEMA:	The Southeastern Massachusetts electrical zone.
SF_6:	Sulfur hexafluoride, a gas used as electrical insulation.
Shield Wire:	Wire strung at the top of transmission lines and intended to prevent lightning from striking the transmission circuit. These conductors are sometimes referred to as static wire or aerial ground wire and may contain glass fibers for communication use (refer to "OPGW").
Shunt Reactor:	An electrical reactive power device primarily used to compensate for the capacitance of high voltage underground transmission cables.
SHPO:	State Historic Preservation Officer.
SMP:	Soil Management Plan.
SNETR Study:	Southern New England Transmission Reliability Study (original report that identified the need for the NEEWS projects).
Splice:	A device to connect two or more bare conductors or to connect two or more insulated cables.
Steel Pole Structure:	Transmission line structure consisting of tubular steel pole(s) with arms or other components to support insulators and conductors.

Steel Lattice Tower:	Transmission line structure consisting of a freestanding framework tower.
Substation:	A fenced-in yard containing switches, power transformers, line terminal structures, and other equipment enclosures and structures; voltage changes, adjustments of voltage, monitoring of circuits and other service functions take place in the substation.
Switching Station:	Same as Substation except with no power transformers; switching of circuits and other service functions take place in a switching station.
SWPPP:	Stormwater Pollution Prevention Plan.
Terminal Point:	The substation or switching station at which a transmission line terminates.
Terminal Structure:	Structure typically located within a substation that ends a section of transmission line.
Terminator:	An insulated fitting used to connect underground cables to an overhead line or to a substation bus.
THPO:	Tribal Historic Preservation Officer.
TMDL:	Total Maximum Daily Load. Maximum allowed pollutant load to a water body without exceeding water quality standards.
Transmission Line:	An electric power line operating at 69,000 volts or more.
TO:	Transmission Owner.
TPL:	Transmission Planning Standards.
USDA:	United States Department of Agriculture.
USEPA:	United States Environmental Protection Agency.
USFWS:	United States Fish and Wildlife Service.
USGS:	United Stated Geological Survey.
VIA:	Visual Impact Assessment.
V / m:	Volts per meter - a measure of electric field strength.
VOC:	Volatile Organic Compound.
Voltage Collapse:	A condition where voltage drops to unacceptable levels and cascading interruptions of transmission system elements occur resulting in widespread blackouts.
Voltage:	Electric potential difference between any two conductors or between a conductor and ground.
Wire:	Refer to "Conductor".
Working Group:	Transmission Planners from ISO-NE, National Grid and Northeast Utilities who collaborated to perform the SNETR and NEEWS studies.
WTGH(A):	Wampanoag Tribe of Gay Head (Aquinnah).

WTHPO:	Wampanoag Tribe of Gay Head (Aquinnah) Tribal Historic Preservation Officer.
XLPE:	Cross Linked Polyethylene. A type of underground cable insulation.

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1 INTRODUCTION

1.1 DESCRIPTION OF THE INTERSTATE RELIABILITY PROJECT

The Interstate Reliability Project ("IRP" or the "Project") is a set of proposed improvements to the electric transmission system in Rhode Island, Massachusetts and Connecticut. The IRP will provide for continued reliable transmission system service in these states and will increase the system's ability to meet growing demand for power and comply with federal and regional reliability standards and criteria. At the same time, the IRP will advance a comprehensive regional plan for improving electric transmission reliability in New England. This comprehensive plan is known as the New England East – West Solution ("NEEWS"). NEEWS is a joint undertaking by National Grid and Northeast Utilities ("NU").

The main components of the IRP are three new 345 kV transmission lines between existing substations in Rhode Island, Massachusetts and Connecticut. The IRP facilities in Rhode Island will be constructed, owned, and operated by The Narragansett Electric Company d/b/a National Grid,[1] those in Massachusetts by New England Power Company d/b/a National Grid, and those in Connecticut by The Connecticut Light & Power Company ("CL&P") a wholly-owned subsidiary of NU. The Narragansett Electric Company and New England Power Company will be collectively referred to as "National Grid" or the "Company".

This Environmental Report ("ER") has been prepared in support of an application to the Rhode Island Energy Facility Siting Board ("EFSB") for construction of jurisdictional facilities and for submission with other state and local applications required for the Project. Volume 2 of the ER contains mapping and figures referenced throughout this report and which are not included within the text of the document.

1.2 THE NEEWS PROJECTS AND THE NEEWS STUDY PROCESS

1.2.1 The 2008 SNETR Studies

Beginning in 2004, the Southern New England Regional Working Group (the "Working Group"), led by the ISO New England Inc. ("ISO-NE") and including planners from National Grid and NU, embarked on a coordinated series of studies to evaluate the reliability and performance of the electric transmission system serving Southern New England (an area which includes most of Massachusetts, Rhode Island, and Connecticut). These studies were collectively called the Southern New England Transmission Reliability ("SNETR") studies. The Working Group initially focused on addressing

[1] The Narragansett Electric Company d/b/a National Grid, a subsidiary of National Grid USA, is an electric distribution and transmission company serving approximately 465,000 customers in 38 Rhode Island communities. National Grid USA is a public utility holding company. Other subsidiaries of National Grid USA include operating companies such as New England Power Company, Massachusetts Electric Company, Nantucket Electric Company (in Massachusetts), and Niagara Mohawk Power Corporation (in New York), as well as National Grid USA Service Company, Inc., which provides services such as engineering, facilities construction and accounting.

limitations on east-to-west power transfers across Southern New England, and on power transfers between Connecticut, Rhode Island, and southeastern Massachusetts. However, the scope of the SNETR studies later expanded to include reliability concerns in the Greater Springfield area and Rhode Island, as well as constraints on power transfers from eastern Connecticut across central Connecticut to the concentrated load in southwest Connecticut.

The Working Group's analyses and conclusions were summarized in a report entitled *Southern New England Transmission Reliability Report 1 – Needs Analysis* dated January 2008 ("2008 Needs Analysis"). A copy of this report is provided as Appendix A.[2]

The 2008 Needs Analysis identified five primary deficiencies in the Southern New England electric transmission system:

- **East-West New England Constraints:** Regional east-west power flows across New England are limited due to the potential overloading of existing transmission lines that traverse southern Massachusetts from east-to-west and by potential voltage violations in Southern New England.

- **Connecticut Import Limitations:** Power transfers into Connecticut are limited and will eventually result in the inability to serve load under many contingencies that the system must withstand in order to comply with national and regional reliability standards.

- **East-West Connecticut Constraints:** Load in Connecticut is heavily concentrated in the southwest quadrant of the state, whereas Connecticut's generation resources are concentrated in the eastern part of the state.

- **Rhode Island Reliability:** Transmission system reliability and dependence on local generation are the major concerns for the Rhode Island system. System modeling has demonstrated that a number of overload and voltage violations can occur on the Rhode Island transmission facilities following contingency conditions. These problems are caused by a number of contributing factors, both independently and in combination, including high load growth (especially in southwestern Rhode Island and the coastal communities), and generating unit unavailability.

- **Greater Springfield Reliability:** Overloads and voltage violations on the existing Greater Springfield 115 kV transmission system need to be addressed.

The reliability concerns identified by the 2008 Needs Analysis are illustrated in Figure 1-1.

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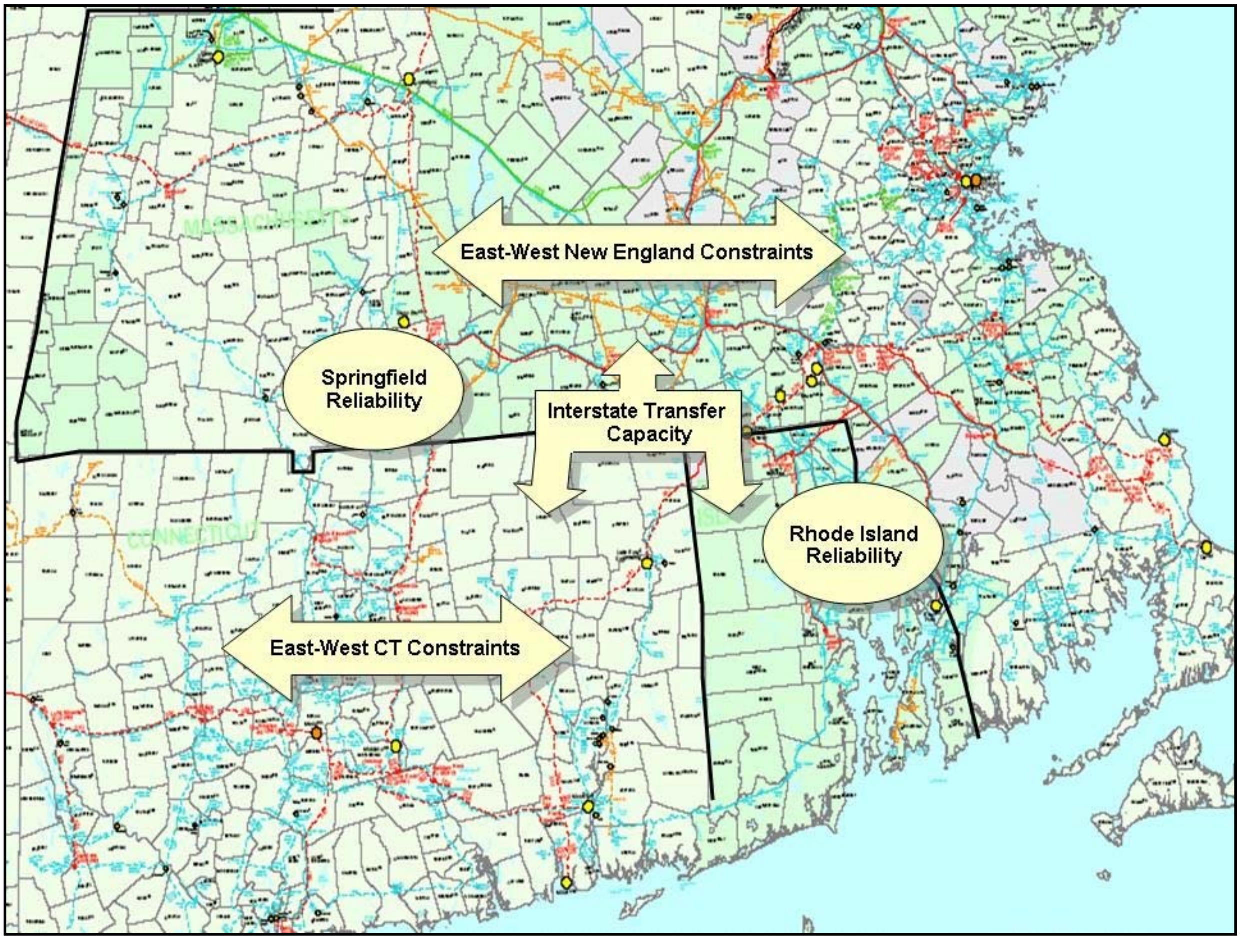
[2] A copy of this report, redacted to avoid disclosure of Confidential Energy Infrastructure Information ("CEII"), is provided in the public record as Appendix A, and an unredacted copy will be provided to the EFSB and to eligible parties who have executed CEII Non-Disclosure Agreements, subject to a Motion for Protective Order.

Figure 1-1: Reliability Deficiencies in the Southern New England Region



1.2.2 The NEEWS Projects

The Working Group then analyzed potential solutions to the needs identified in the 2008 Needs Analysis. The Working Group's conclusions are summarized in a report entitled *New England East-West Solutions (Formerly Southern New England Transmission Reliability) Report 2 – Options Analysis* dated June 2008 ("2008 Options Analysis"). A copy of this report is provided as Appendix B.[3] The 2008 Options Analysis described four interrelated sets of transmission upgrades, including IRP, that would meet the basic performance requirements identified in the 2008 Needs Analysis -- strengthening the transmission system within the southern New England states and increasing the ability to transfer power between eastern and western New England and into Connecticut. These four projects, collectively known as the New England East-West Solution ("NEEWS"), are briefly described below and illustrated conceptually in Figure 1-2.

[3] A copy of this report, redacted to avoid disclosure of CEII, is provided in the public record as Appendix B, and an unredacted copy will be provided to the EFSB and to eligible parties who have executed CEII Non-Disclosure Agreements, subject to a Motion for Protective Order.

- The **Interstate Reliability Project** ("IRP") is a set of improvements to the electric transmission system in Rhode Island, Massachusetts, and Connecticut. The IRP involves the construction and operation of approximately 75 miles (22.5 miles in Rhode Island, 15.4 miles in Massachusetts and 36.8 miles in Connecticut) of new 345 kV transmission lines, 9.2 miles of reconstructed and reconductored 345 kV transmission line in Rhode Island, and upgrades to existing substations and switching stations, including reconstruction of the Sherman Road Switching Station in Rhode Island. The IRP will help provide continued reliable transmission service to these states, and, in particular, will increase the system's ability to meet growing demand for power and comply with the national and regional reliability standards and criteria.

- The **Greater Springfield Reliability Project** ("GSRP") involves the construction of new 345 kV transmission lines along approximately 35 miles of overhead line ROW (23 miles in Massachusetts and 12 miles in Connecticut); the construction, reconstruction, and upgrade of 115 kV transmission lines along approximately 27 miles of overhead line ROW in Massachusetts; and related substation improvements in both Massachusetts and Connecticut. This project was approved by the Massachusetts Energy Facilities Siting Board ("MA EFSB") and the Connecticut Siting Council ("CSC") in 2010. It is currently under construction, with a planned in-service date of December 2013.

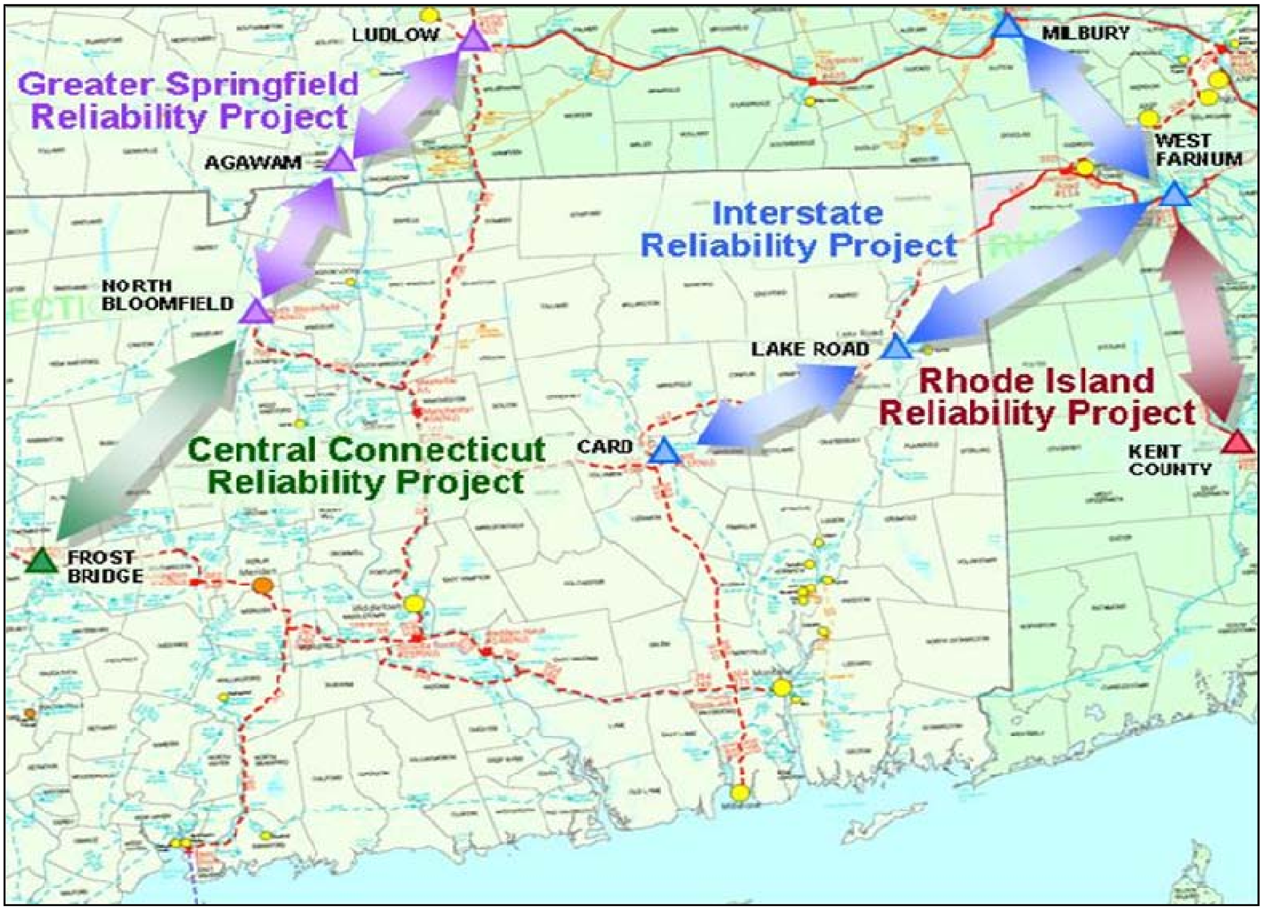
- The **Rhode Island Reliability Project** ("RIRP") involves the construction of a new 345 kV transmission line along 21 miles of existing overhead line ROW, extending from National Grid's West Farnum Substation in North Smithfield, Rhode Island to its Kent County Substation in Warwick, Rhode Island, along with related improvements to existing 115 kV and 345 kV facilities. This project was approved by the EFSB in 2010. It is currently under construction and is expected to be completed and in-service in the second quarter of 2013.

- The **Central Connecticut Reliability Project** ("CCRP") is currently under review by an ISO-NE led study working group. It would include the construction of a new 345 kV transmission line along 38 miles of existing ROW, extending from CL&P's North Bloomfield Substation in Bloomfield to its Frost Bridge Substation in Watertown, together with related improvements to existing 345 kV and 115 kV facilities.

1.2.3 The 2008 Solution Report

In the spring and summer of 2008, National Grid and NU, as Transmission Owners ("TOs"), conducted detailed analyses to select a preferred option for the IRP from the alternatives identified in the 2008 Options Analysis. The detailed analyses assessed the transmission system electrical performance, together with cost, siting, and construction-related factors, to determine the optimal solution to meet the identified needs. This work is described in detail in a report entitled *Solution Report for the Interstate Reliability Project* dated August 2008 ("2008 Solution Report"). A copy of the 2008 Solution Report is provided as Appendix C.

Figure 1-2: NEEWS Projects



1.2.4 The 2011 IRP Updates

Beginning in 2009, the Working Group undertook reassessments of the need for each of the four NEEWS components.[4] In April 2011, ISO-NE released an updated analysis of the need for the IRP, entitled *New England East-West Solution: Interstate Reliability Project Component Updated Needs Assessment* ("2011 Needs Assessment"). This report reflected key changes that have taken place since the 2008 Needs Analysis, including the commitment of approximately 2,000 megawatts ("MW") of new generation resources through ISO-NE's Forward Capacity Auction ("FCA") process, as well as updated CELT load forecasts.[5] The 2011 Needs Assessment confirmed that the issues identified in the 2008 Needs Analysis continued to exist, and identified an additional need for

[4] This analysis was undertaken in compliance with Section 4.2(a) of Attachment K to ISO-NE's Federal Energy Regulatory Commission ("FERC")-approved Open Access Transmission Tariff, which requires it to update its needs assessments as new resources materialize through the Forward Capacity Auction process.

[5] ISO-NE annually publishes its Forecast Report of Capacity, Energy, Loads, and Transmission Report ("CELT Report").

increased transfer capability from western New England to eastern New England. In addition, it examined a Salem Harbor generator retirement scenario.

After the issuance of the 2011 Needs Assessment, the Working Group reassembled to consider which of the options identified in the 2008 Solution Report could be adapted to serve the enhanced need and to develop a solution.[6] The Working Group's analyses and conclusions were presented to the Planning Advisory Committee ("PAC")[7] on November 30, 2011, and are described in detail in the *New England East-West Solution (NEEWS): Interstate Reliability Project Component Updated Solution Study Report* dated February 2012 ("2012 Solution Report"). This report was issued in final form on February 3, 2012. Copies of the 2011 Needs Assessment and the 2012 Solution Report are provided as Appendices D and E.[8]

1.2.5 ISO-NE Proposed Plan Application

National Grid and NU submitted a Proposed Plan Application ("PPA") for the IRP in August, 2008 to ISO-NE. On September 24, 2008, ISO-NE issued a determination that the IRP would have no significant adverse effect on the stability, reliability, or operating characteristics of transmission facilities in New England. A copy of the 2008 ISO-NE determination is attached as Appendix F.

In March 2012, National Grid and NU submitted to the New England Power Pool ("NEPOOL") Stability Task Force ("STF") and Transmission Task Force ("TTF") a revised study report in support of the PPA for the NEEWS projects, reflecting changes to the IRP since 2008. The STF and TTF recommended approval of the revised PPA to the NEPOOL Reliability Committee ("RC"). In April 2012, the RC recommended that ISO-NE issue a determination of no significant adverse effect for the revised PPA. On May 4, 2012, ISO-NE issued a determination that the IRP would have no significant adverse effect on the stability, reliability, or operating characteristics of transmission facilities in New England. A copy of the 2012 ISO-NE determination is attached as Appendix G.

1.2.6 The 2012 IRP Update

In March 2012, ISO-NE undertook to update its needs assessments of all New England reliability projects, including the IRP, in light of new planning information (e.g., load forecasts from the 2012

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6 For this task, the original Working Group, composed of planners from ISO-NE, NU, and National Grid, was expanded by the inclusion of planners from NSTAR Electric Company ("NSTAR"), the Massachusetts electric utility that owns some of the facilities that could be affected by some of the alternative configurations that were being considered.

7 PAC is an ISO-NE advisory committee open to all parties interested in regional system planning activities in New England. ISO-NE is required by its FERC-approved tariff to conduct an open and transparent planning process. Pursuant to this requirement, ISO-NE presents to the PAC the scope of work, assumptions, and draft results for its annual Regional System Plan and for supporting studies, including Needs Assessments and Solution Studies, and considers the comments of the PAC members in developing its final plans and recommendations.

8 Copies of these reports, redacted to avoid disclosure of CEII, are provided in the public record as Appendix D and E, and unredacted copies will be provided to the EFSB and to eligible parties who have executed CEII Non-Disclosure Agreements, subject to a Motion for Protective Order.

CELT Report and the results of FCA-6, held in April 2012). ISO-NE issued a draft 2012 Needs Update to the PAC on July 9, 2012 and is expected to issue a draft 2012 Solutions Update later in July 2012. ISO-NE will finalize these reports after PAC review and comment. National Grid will provide the final version of the 2012 IRP update documents when they become available.

1.3 REPORT PREPARATION AND RESPONSIBILITIES

This ER will support applications to the EFSB and other agencies in connection with the Project. The ER has been prepared by National Grid under the direction of David J. Beron P.E., P.M.P., Lead Project Manager for the Project. Numerous employees and consultants retained by National Grid, including planners, engineers, and legal personnel, contributed to the report. The description of the affected natural and social environments, and impact analyses were prepared by AECOM and other consultants to National Grid including The Public Archaeology Laboratory, Inc. ("PAL") for cultural resources, **edr** Companies ("EDR") for visual resources, Exponent, Inc. for analysis of health effects of electric and magnetic fields ("EMF") and EMF modeling and calculations, Power Engineers, Inc. ("POWER") for engineering and design, ICF International ("ICF") for non-transmission alternatives and New Energy Alliance ("NEA") for constructability review.

1.4 COMPLIANCE WITH EFSB REQUIREMENTS

Compliance with the requirements of Rule 1.6 of the EFSB "Rules of Practice and Procedure" (the "EFSB Rules") is addressed in the Application which is filed with the EFSB herewith.

2 EXECUTIVE SUMMARY

2.1 INTRODUCTION

This ER has been prepared in support of an application to the EFSB for construction of jurisdictional facilities and for submission with other state and local applications required for the Project. The ER has been prepared in accordance with the EFSB Rules to provide information on the potential impacts of the electric transmission system improvements proposed by the Applicant. The ER describes the Project and explains the need for the Project. The ER also 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 3 of this ER. Section 3 summarizes the studies and forecasts completed by ISO-NE, National Grid and NU that support the need for the proposed transmission system improvements. Section 4 provides a detailed description of each of the components of the Project, and also discusses construction practices, ROW maintenance practices, EMF, safety and public health considerations, estimated costs for the Rhode Island project components, and anticipated Project schedule. An analysis of alternatives to the Project, together with reasons for the rejection of each alternative, is presented in Section 5 of this report. A detailed description of the characteristics of the natural and social environment within and immediately surrounding the Project location is included as Sections 6 and 7, respectively. Section 8 of this report identifies the impacts of the Project on the natural and social environments. Section 9 summarizes proposed mitigation measures which are intended to offset impacts associated with the Project. Finally, Section 10 lists the federal, state, and local government agencies that may exercise licensing authority and from which National Grid may be required to obtain approvals prior to constructing the Rhode Island portion of the Project. Volume 2 of this ER, bound separately, contains supporting mapping and figures.

2.2 PROJECT DESCRIPTION AND PROPOSED ACTION

National Grid, in a joint project with NU, is proposing electric transmission system improvements in Rhode Island, Massachusetts and Connecticut. The IRP will expand and significantly reinforce the existing transmission system in the three states. The Rhode Island portion of the IRP involves the following:

- Construct approximately 4.8 miles of new 345 kV transmission line (366 Line) on existing ROWs from the Massachusetts/Rhode Island border in North Smithfield, Rhode Island to the West Farnum Substation in North Smithfield, Rhode Island;

- Construct approximately 17.7 miles of new 345 kV transmission line (341 Line) on existing ROWs from the West Farnum Substation to the Rhode Island/Connecticut border in Burrillville, Rhode Island;
- Reconstruct and reconductor approximately 9.2 miles of an existing 345 kV transmission line (328 Line) from the West Farnum Substation in North Smithfield to the Sherman Road Switching Station in Burrillville, Rhode Island;
- Reconstruct the existing Sherman Road Switching Station;[9]
- Reconstruct and realign approximately 0.25 miles of the existing 345 kV transmission line (3361 Line) from the Sherman Road Switching Station to the NSTAR segment of the 3361 Line at the Massachusetts / Rhode Island border in Burrillville, Rhode Island;
- Reconstruct and realign approximately 0.25 miles of the existing 345 kV transmission line (333 Line) from the Sherman Road Switching Station to the Ocean State Power Generating Plant in Burrillville, Rhode Island;
- Reconstruct and realign approximately 0.25 miles of the existing 345 kV transmission line (347 Line) outside of the Sherman Road Switching Station, and replace and/or modify other 347 Line structures to accommodate the construction of the 341 Line; and
- Replace and/or modify a number of existing structures on the 115 kV transmission line (B-23 Line) to accommodate the construction of the 341 Line.

Other components of the IRP are proposed in Massachusetts and Connecticut.

Figure 2-1 (United States Geological Survey ("USGS") Topographic Map) provides an overview of the Project location in Rhode Island, and Figure 2-2 (Sheets 1-41) provide Project alignment details.

2.3 PURPOSE AND NEED

The Project encompasses a set of proposed improvements to the electric transmission system in Southern New England. The improvements to the transmission system are needed to comply with the national and regional reliability standards and criteria required by the North American Electric Reliability Corporation ("NERC"), the Northeast Power Coordinating Council, Inc. ("NPCC"),[10] and ISO-NE. The need for improvements to the Southern New England transmission system was identified and documented by ISO-NE over the course of a multi-year transmission study, referred to as the SNETR study.

The Project is needed to continue to provide a reliable transmission system throughout the Southern New England geographic area. The Project will also increase the regional transmission system's ability to meet growing demand for power. The Project is part of a comprehensive long-term

[9] The West Farnum Substation has facilities in place to accept the 341 and 366 Lines.

[10] The NPCC regional criteria are available through the NPCC website located at https://www.npcc.org/default.aspx

regional plan, known as NEEWS, for improving electric transmission in New England through extensive coordinated improvements in Rhode Island, Massachusetts and Connecticut.

All National Grid transmission facilities in New England are designed in accordance with the NERC Reliability standards, NPCC criteria, and ISO-NE planning procedures (collectively, the Planning Documents).

In summary, the Project is a regional reliability project that:

- Addresses overloads and voltage performance issues on the regional 345 kV and 115 kV transmission systems;
- Provides Rhode Island with critical additional interconnections to the 345 kV transmission system;
- Increases New England East-West and West-East power transfer capabilities; and
- Increases Connecticut's power import capabilities.

The Rhode Island portion of the IRP is the subject of this filing.

2.4 ALTERNATIVES

In accordance with requirements of the EFSB, the CSC, and the MA EFSB, National Grid and NU evaluated alternatives to the Project. An important goal in the planning and development of the proposed electric transmission system improvements was to ensure that the solutions selected meet the electrical system needs, are the most appropriate in terms of cost and reliability, and that environmental impacts are avoided, minimized and mitigated to the fullest extent possible. Analyses were undertaken to evaluate the feasibility of alternatives to the Project to ensure these objectives were met.

A variety of alternatives were evaluated, including the "No Action" alternative, electrical alternatives, alternative overhead routes, overhead alternatives utilizing the existing ROWs, underground transmission line alternatives, and non-transmission alternatives. Some of the alternatives were eliminated based on feasibility assessments, or the inability of the alternative to address the identified system needs. Other alternatives that were found to be feasible and capable of addressing the identified need were further examined on the basis of estimated costs, operability, environmental impact assessments and reliability assessments. The proposed Project was found to best meet the identified need with a minimum impact on the environment, at the lowest possible cost.

2.5 SUMMARY OF ENVIRONMENTAL IMPACTS AND MITIGATION

Construction of the Project will result in impacts to wetlands and water resources along the Project ROWs. The effects of construction will include temporary and permanent impacts. Temporary impacts will result from the placement of swamp mats for construction access or for construction pads. Swamp mats will be removed after construction is completed. Permanent impacts will result from the placement of fill required for structure installation and reconstruction of the Sherman Road Switching Station.

The proposed transmission line construction may cause a small loss of excavated soil due to water and wind erosion. This may result in minor siltation of water bodies and wetlands. However, these impacts will be short-term and localized. To minimize these impacts, standard Best Management Practices ("BMPs") such as the installation of soil erosion control devices (i.e., strawbales and/or silt fences) and the re-establishment of vegetation will be used during construction.

The Project will be designed and constructed in a manner that minimizes and mitigates the potential for adverse environmental impacts. The Project will have minimal direct impact on geologic, soil, surface water, wetland resources, and rare, threatened, or endangered species within the Project ROWs.

An important goal of the Project's design was to avoid and/or minimize adverse impacts on wetlands and water resources. The initial design aligned proposed structure locations with existing structures on the ROWs. This design approach was based on the assumption that aligning the new structures with existing structures would maximize the use of existing access roads which are already situated to reach existing structures, minimize changes to the visual environment, create an appearance of symmetry, and mimic existing span lengths to reduce the potential clearance violations under certain high wind conditions.

Following this preliminary structure siting, each proposed structure location was further evaluated to assess other factors, such as potential environmental (natural and social) impacts. Detailed constructability field reviews of the entire Project ROWs and proposed structure locations were conducted to assess the constructability of the Project and to identify ways to avoid and/or minimize impacts from construction activities. National Grid sought a Project alignment that would maximize the use of upland areas that do not contain sensitive environmental features for structure locations, construction pads and access roads. However, the Company's ability to avoid all impacts is limited because of the magnitude of the Project and engineering constraints, including minimum and maximum span length criteria, horizontal and vertical clearance standards, and fixed locations where it is necessary to locate angle structures because the ROW alignment changes direction. The Project design reflects the results of National Grid's constructability review and the measures taken to avoid and/or minimize adverse impacts. Where impacts to wetland resource areas cannot be avoided, appropriate mitigation measures will be provided. National Grid is currently preparing a compensatory wetland mitigation plan that is intended to provide compensatory flood storage for lost flood storage volume and compensation for impacts to wetlands, as required for U.S. Army Corps of Engineers ("ACOE") Section 404 and Rhode Island Department of Environmental Management ("RIDEM") permitting.

In addition to these mitigation measures, National Grid will retain the services of an environmental monitor throughout the entire construction phase of the Project. The primary responsibilities of the environmental monitor will be to routinely monitor compliance with all applicable federal, state, and local permit conditions and National Grid construction BMPs. In addition, the environmental monitor will monitor the effectiveness of the BMPs and make adjustments as necessary to maintain compliance with permits and approvals.

2.6 SUMMARY OF SOCIAL IMPACTS AND MITIGATION

2.6.1 Social and Economic

The construction of the Project as described herein will not adversely impact the overall social and economic conditions of the Project area. The Project will provide tax revenue for the towns in which it is located, without requiring any significant increase in municipal services. The Project will result in several hundred full-time equivalent ("FTE") jobs during the construction period, and Project expenditures will have a spin-off benefit for the regional economy.[11] In the long term, the Project will support the area economy by meeting current and projected needs for reliable power in Southern New England.

2.6.2 Land Use

Because the Project is located within established ROWs, it will not require, nor will it lead to, long-term residential or business disruption.

2.6.3 Cultural and Historic Resources

A Historic Architectural Reconnaissance Survey was conducted by PAL to ensure compliance with state and federal historic preservation laws that apply to the Project. The survey included archival research and a Project site walkover investigation to assess historic resources within the study area.

In addition, a Reconnaissance/Phase I(a/b) archaeological survey was conducted to identify areas of low, moderate, and high likelihood to contain potentially significant pre-contact and post-contact period cultural resources. Copies of the technical report *Reconnaissance/Phase I (A/B) Archaeological Survey New England East-West Solution Transmission Project Right-of-Way Massachusetts and Rhode Island* were submitted for review and comment to the Rhode Island Historical Preservation and Heritage Commission and the Massachusetts Historical Commission.

The results and recommendations for the Rhode Island portions of the IRP are detailed in the report *Phase I(c) Intensive Survey New England East-West Solution Transmission 341 and 366 Lines ROW, Rhode Island*. The field investigations were coordinated with the ACOE, the Rhode Island Historical

[11] Based on estimates provided by New Energy Alliance, 78 FTEs are required to construct the 366 Line in both Massachusetts and Rhode Island, 58 FTEs are required to construct the 341 Line, 49 FTEs are required to reconstruct and reconductor the 328 Line, and up to 22 FTEs are required for the Sherman Road Switching Station reconstruction. A May 2011 study by the Brattle Group finds employment impacts ranging from a low of two FTE-year per million dollars invested to a high of 18 FTE-years per million dollars invested. The Brattle Group, *Employment and Economic Benefits of Transmission Infrastructure Investment in the U.S. and Canada,* prepared for the Working Group for Investment in Reliable and Economic Electric Systems ("WIRES").

Preservation and Heritage Commission/State Historic Preservation Office ("RIHPHC"). The Tribal Historic Preservation Officers of the Narragansett Indian Tribe ("NITHPO") and the Wampanoag Tribe of Gay Head (Aquinnah) ("WTHPO") participated in the field investigations. Copies of the referenced technical reports have been provided to these parties.

Following the archaeological investigations, PAL concluded that, with the implementation of site-specific best management and avoidance practices, no historic or cultural properties or resources would be affected by the Project.

2.6.4 Visual Resources

The visual impact analysis performed by EDR for the Project indicates that the proposed transmission lines will have a similar degree of visibility to that of the existing transmission line(s). This is due in large part to the use of existing transmission ROWs.

2.6.5 Noise

Noise generated by construction is generally temporary and intermittent. All construction equipment will be kept in good working condition with appropriate mufflers to minimize noise impacts. During construction, continuous noise sources that may operate during the day, such as generators or air compressors, will be located away from populated areas to the greatest extent practicable.

While most transmission lines do not generate appreciable noise during normal operations, 345 kV transmission lines may be audible under certain weather conditions. Any operational noise associated with the proposed new transmission line would attenuate quickly with distance from the transmission line. Noise could increase somewhat during wet weather; however, in such conditions, there typically would be few receptors near the transmission lines to hear the increase in sound levels.

Noise associated with electric substations generally results from power transformers located within substations. No new transformers or other noise-generating equipment are proposed as a result of the Sherman Road Switching Station reconstruction.

2.6.6 Electric and Magnetic Fields

National Grid developed a plan to optimize the phasing of the new transmission lines on the ROW in order to minimize magnetic fields at the edge of the ROW, subject to constructability and structural constraints. Using optimized phasing, edge of ROW electric and magnetic fields in the years 2015 and 2020 were calculated at projected annual average and annual peak load levels. The post-construction field levels were compared with field levels calculated for the existing arrangement of electric lines on the ROW under the predicted 2015 annual average and annual peak loads. Because of the variations in the physical arrangement and loadings on the lines on the ROW, some edge of ROW electric and magnetic field levels will increase after the Project is completed and some will decrease. The results of the EMF calculations are presented in Sections 7.8 and 8.16 of this report.

2.7 CONCLUSION

Completion of the Project will address the Southern New England electric reliability needs in a cost-effective manner that minimizes environmental and social impacts. Mitigation will be provided for all impacts to state and federal regulated wetland resources. Impacts to rare, threatened, or endangered species will be avoided and/or minimized through appropriate avoidance or minimization techniques. Similarly, impacts to cultural resources will be avoided through investigation and coordination with the ACOE, RIHPHC and Tribal Historic Preservation Officers ("THPOs"). The potential for significant impact to other environmental or social receptors in the Project vicinity is expected to be minimal.

To the extent that impacts cannot be avoided, they will be addressed through mitigation techniques as discussed in Section 9 of this report.

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3 PROJECT NEEDS ANALYSIS

3.1 OVERVIEW

The IRP is one of four interrelated projects developed by ISO-NE, National Grid, and NU, to comprehensively address transmission system reliability issues in Southern New England. The IRP is designed to reinforce the interconnected transmission systems in Rhode Island, Massachusetts, and Connecticut so that they may continue to reliably serve Southern New England under a wide range of system conditions.

The need for IRP was first identified in the 2008 Needs Analysis (Appendix A), and was reconfirmed in the 2011 Needs Assessment (Appendix D). The 2008 Needs Analysis found interdependent limitations on east-to-west power transfers across Southern New England and power transfers between Connecticut, southeast Massachusetts, and Rhode Island. The 2011 Needs Assessment confirmed these limitations while also finding constraints in transferring power from west-to-east across Southern New England. Under certain conditions for which the system must be planned, power generated in the west and needed in the east – or vice versa – cannot be reliably delivered.

The 2008 Needs Analysis and 2011 Needs Assessment focus on power transfers across New England. Only three 345 kV paths connect eastern and western New England. Depending on system conditions, the loss of one of these paths can have a significant impact on the loading of some of the other lines of the transmission system. When two out of the three paths are lost due to N-1-1 contingency events, the remaining 345 kV path and the underlying 115 kV network can experience large power flows resulting in numerous thermal overloads and voltage issues.

The 2011 Needs Assessment shows widespread thermal overloads and voltage issues across the study area under a variety of system conditions for the N-1-1 contingencies tested.[12] Several 345 kV transmission lines in Rhode Island, central and western Massachusetts and Connecticut overload under certain conditions. Rhode Island in particular experiences severe overloads on its 115 kV system during certain N-1-1 events. A thermal transfer capability analysis determined that there will be insufficient generation and transmission resources: (1) to serve eastern New England load under N-1-1 conditions starting in 2011; (2) to serve western New England load under N-1-1 conditions starting in 2017-2018; and (3) to serve Connecticut load under N-1-1 conditions starting in 2014-2015.

Overall, the 2011 Needs Assessment identified reliability-based needs to:

1. Reinforce the 345 kV system into Rhode Island (now);

[12] Contingencies, as specified by NERC, NPCC, and ISO-NE standards and criteria, are usually characterized as an event causing the loss of one or more system elements – generator, transmission line, bus section, etc. Sometimes a single contingency may cause the loss of two elements. A single event causing the loss of one or more elements is referred to as an "N-1" contingency event. The occurrence of two separate and unrelated outages within a short period of time is referred to as an "N-1-1" contingency event.

2. Increase the transmission transfer capability from western New England and Greater Rhode Island into eastern New England (2011);

3. Increase the transmission transfer capability into the state of Connecticut (2014-2015); and

4. Increase the transmission transfer capability from eastern New England and Greater Rhode Island to western New England (2017-2018).

IRP addresses these four reliability needs by creating a new 345 kV transmission path between Massachusetts, Rhode Island, and Connecticut. This new path addresses existing constraints on the transfer of power from east-to-west and from west-to-east within New England. At the same time, it eliminates the potential for the identified transmission overloads in Rhode Island, and also provides needed import capability to Connecticut. IRP will also enable approximately 2,000 MW of generation along the Card Street to West Medway corridor, most of which is relatively new and efficient, to be called upon to serve load reliably in both eastern and western New England, as needed, over the long-term planning horizon.

IRP is designed so that the Southern New England transmission system will continue to adhere to NERC, NPCC, and ISO-NE standards and criteria. NERC develops and enforces mandatory reliability standards for transmission network planning and operations. The objective of the standards is to define the design contingencies and measures used to assess the adequacy of the transmission system performance. The standards are subject to approval by FERC and compliance is mandatory under federal law. The 2011 Needs Assessment was performed in accordance with the following NERC Transmission Planning Standards ("TPL") (with miscellaneous dates): TPL-001, TPL-002, TPL-003, and TPL-004; the NPCC *Regional Reliability Referenced Directory #1 - Design and Operation of the Bulk Power System,* dated December 2009 ("NPCC Directory"); and the ISO-NE *Planning Procedure 3, Reliability Standards for the New England Area Bulk Power Supply System* dated March 2010 ("PP-3").

The following sections of this report contain a more detailed description of the transmission system and the need for the IRP and how that need has evolved over time. Section 3.2 provides a description of the Southern New England transmission system to provide context for the regional needs analysis. Section 3.3 follows with a summary of the analyses undertaken and the results and implications found in the 2011 Needs Assessment, showing a need to reinforce the transmission system in Southern New England. Lastly, Section 3.4 considers the results and implications of the 2011 Needs Assessment in terms of the impacts on customers in Rhode Island.

3.2 THE NEW ENGLAND TRANSMISSION SYSTEM

Transmission lines across New England and beyond are interconnected to form a transmission network, sometimes called a grid or a system. National Grid's transmission system is part of this interconnected transmission network. Thus, National Grid's transmission system in Rhode Island and Massachusetts is part of the larger New England area transmission system. The National Grid transmission system affects and is affected by the generation, load, and transmission configurations of the electric systems operated by neighboring utilities and in neighboring states.

FERC has designated all of New England as a single operating area, and has designated ISO-NE as the independent system operator for the New England control area. As such, ISO-NE is responsible for the reliable operation of New England's power generation and transmission system. ISO-NE also administers the region's wholesale electricity markets, and manages the comprehensive planning of the regional power system. New England's transmission system is planned to be fully integrated and seeks to use all regional generating resources to serve all regional load, independent of state boundaries, utility ownership, and utility service territories. The transmission network is operated as a tightly integrated grid. Therefore, the electrical performance of one part of the system affects all areas of the system.

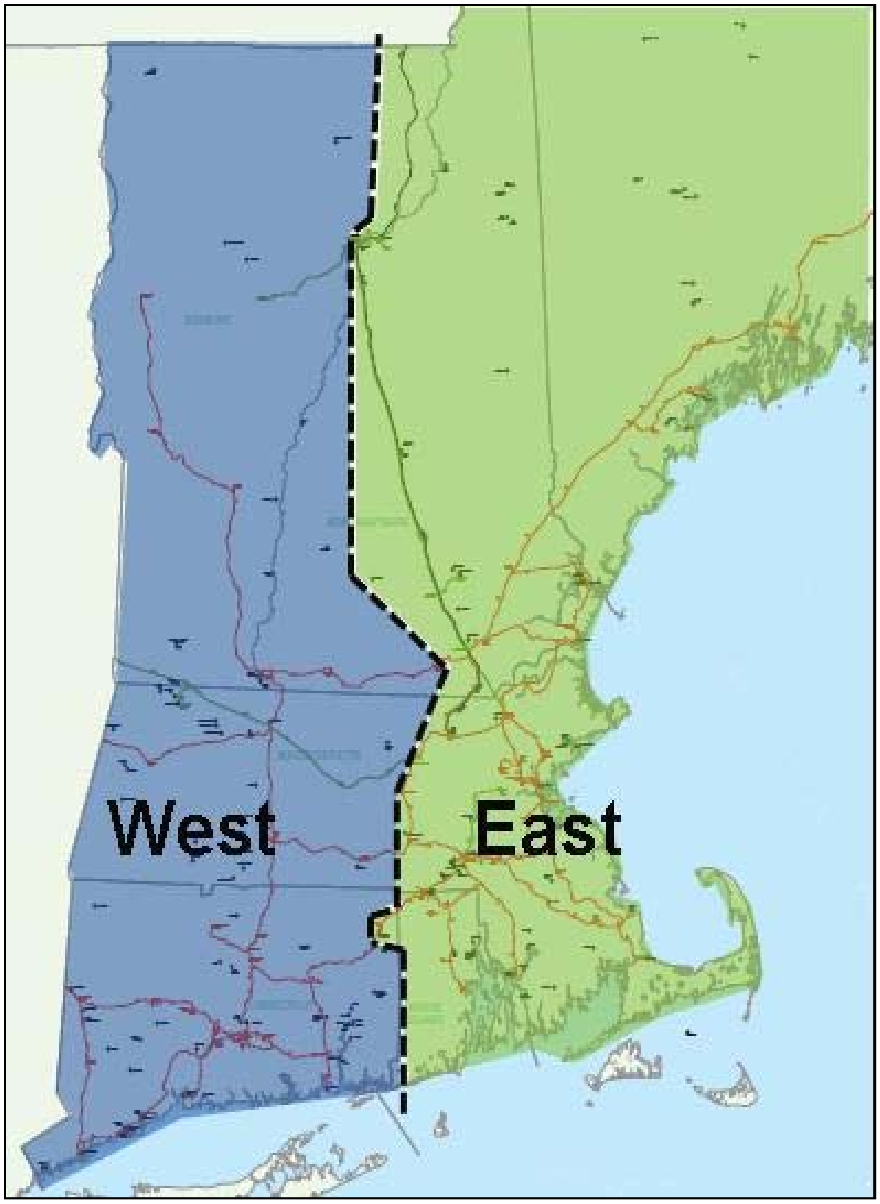
3.2.1 The New England East–West Interface

Historically, New England has been divided into two large operating areas, known as East and West, separated by the New England East-West Interface.[13] This interface, which largely corresponds to the boundaries of the service areas of major electric utilities, divides New England approximately in half, separating the major load centers of the southeast Massachusetts and Boston areas from those in the Connecticut area. This interface is important in that the New England transmission system performance is materially dependent on the power that flows across it. The New England East-West Interface roughly follows the Connecticut and Rhode Island border and then continues in a northerly direction through the rest of New England. The general location of this interface is depicted in Figure 3-1.

Figure 3-2 illustrates the 345 kV network in Southern New England, as it will be constituted with the completion of GSRP and RIRP, both of which are now under construction. Only three 345 kV transmission lines cross the New England East-West Interface: the 330 Line between the Card Street Substation and the Lake Road Switching Station in Connecticut; the 302 Line between the Millbury No. 3 Switching Station in Millbury, Massachusetts and the Carpenter Hill Substation in Charlton, Massachusetts; and, further to the north, the 380 Line between the Amherst Substation in Amherst, New Hampshire and the Scobie Pond Substation in Londonderry, New Hampshire. Two 230 kV transmission lines and a few 115 kV transmission lines also cross the interface. Most of these 230 kV and 115 kV transmission lines run long distances and have relatively low thermal capacity. Therefore, they do not add significantly to the transfer capability across the interface.

[13] The term "interface" is used to describe both the imaginary boundary between two electrical operating areas and the set of transmission facilities that can be used to transfer power reliably, within defined limits, from one such area to another.

Figure 3-1: New England East-West Interface

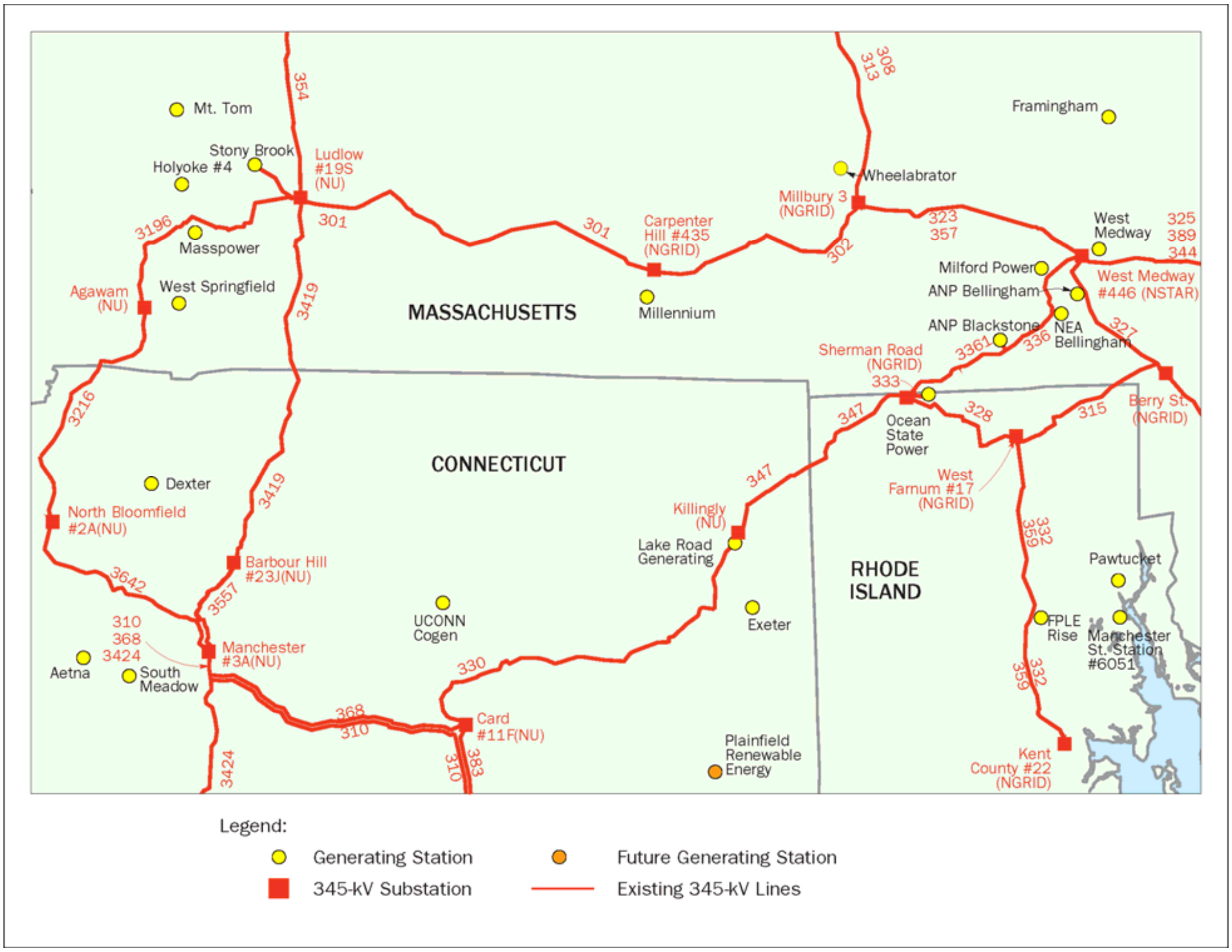


3.2.2 The 345 kV Card Street to West Medway Corridor

One of the three main paths across the New England East-West Interface is the transmission path along the Card Street to West Medway corridor. This corridor extends from CL&P's Card Street Substation in Lebanon, Connecticut to the Lake Road Switching Station and the Killingly Substation (both in Killingly, Connecticut), across the Connecticut/Rhode Island state border to National Grid's Sherman Road Switching Station in Burrillville, Rhode Island, and from there to NSTAR's West Medway Substation in Medway, Massachusetts. It provides the only direct 345 kV tie between

Connecticut and Rhode Island,[14] and one of only two 345 kV ties between Rhode Island and Massachusetts.

Figure 3-2: 345 kV System - Geographic Overview



The Card Street to West Medway corridor serves as a super highway, transporting power from Connecticut resources to serve load in Rhode Island and southeast Massachusetts and also transporting power from southeast Massachusetts resources to Rhode Island and Connecticut load centers. This super highway connects four large efficient base load generating stations to the 345 kV transmission network at various locations along this transmission corridor (see Table 3-1).

[14] In addition, southeastern Connecticut is tied to southwest Rhode Island by a 115 kV transmission line of very limited capability.

Table 3-1: Generation Resources Located Between Card Street and West Medway Substations

Generating Station	Location	FCA-4 Summer Capacity Supply Obligation (MW)
Lake Road Generating	Dayville, Connecticut	752
Ocean State Power	Burrillville, Rhode Island	541
ANP Blackstone	Blackstone, Massachusetts	444
NEA Bellingham	Bellingham, Massachusetts	274
Total		**2,011**

Under various system conditions, the generating stations along the Card Street to West Medway corridor cannot all be dispatched at the same time because of the potential for overloading one or more of the transmission lines making up the New England East-West Interface in the event of a contingency.

3.3 2011 NEEDS ASSESSMENT

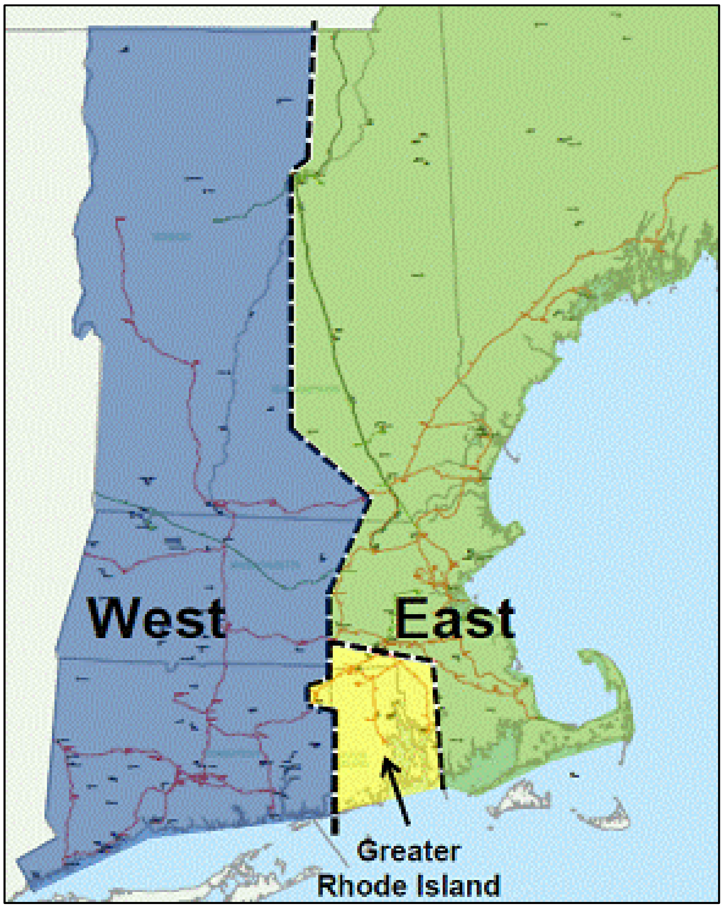
3.3.1 Study Description

As discussed in Section 1 of this Report, the Working Group first identified the need for new 345 kV transmission facilities to serve Southern New England in the 2008 Needs Analysis. After the 2008 Needs Analysis was completed, more than 2,000 MW of new generation resources and demand resources were added in Connecticut and other areas west of the New England East-West Interface. ISO-NE is required by Section 4.2(a) of Attachment K to its FERC-approved Open Access Transmission Tariff ("OATT") to update its needs assessments as new resources materialize through the FCA process. Therefore in 2009, ISO-NE undertook a reassessment of the need for IRP. The re-evaluation of IRP was substantially completed in the summer of 2010, presented to the PAC in August and November of 2010, and finalized in April 2011.

The objective of the 2011 Needs Assessment was to update the analysis of the reliability-based transmission needs identified in the 2008 Needs Analysis, specifically with respect to the IRP component of NEEWS. The Working Group updated the analysis of system needs for the Southern New England transmission system using a study area consisting of the three Southern New England states: Massachusetts, Rhode Island, and Connecticut. For purposes of this study, the Southern New England transmission system was split into three sub-areas (eastern New England, western New England, and Greater Rhode Island) based on relatively weak transmission system connections among these sub-areas.[15] The three sub-areas are shown in Figure 3-3 below. The Greater Rhode Island area was treated as part of western New England when evaluating eastern New England reliability, and was treated as part of eastern New England when evaluating western New England reliability. This treatment reflects existing constraints on the delivery of generation located in Greater Rhode Island, both when moving power eastward as well as when moving power westward.

[15] These sub-areas were defined for the purpose of the 2011 Needs Assessment, and should not be confused with the thirteen sub-areas of the region's bulk electric power system used by ISO-NE for modeling and planning purposes.

Figure 3-3: New England Sub-Areas



The 2011 Needs Assessment identified and addressed three general areas of concern:

- **Transmission Planning Standards and Criteria:** The study assessed the ability of the transmission system serving eastern New England, western New England, Greater Rhode Island, and Connecticut to comply with NERC, NPCC, and ISO-NE transmission planning standards and criteria over the 10-year planning horizon.
- **Transmission Transfer Capability:** The study assessed the ability of existing and planned FCA-cleared generation located in western New England to serve load in eastern New England, and the ability of existing and planned FCA-cleared generation located in eastern New England to serve load in western New England, given the existing transmission constraints.
- **Salem Harbor Non-Price Retirement Requests:** The study assessed the impact on transmission system reliability of the proposed 2014 retirement of the Salem Harbor Generating Station (approximately 750 MW).

To address compliance with transmission planning standards and criteria, as well as the impact of the Salem Harbor Generating Station retirement, the Working Group undertook a series of detailed steady state load flow analyses. These analyses assessed compliance with thermal and voltage standards under base case conditions and following contingency events, for five scenarios: a West-to-East Scenario, an East-to-West Scenario, a Connecticut Reliability Scenario, a Rhode Island Reliability Scenario, and a Salem Harbor Retirement Scenario. The methodology, assumptions, and results of the steady state thermal and voltage analyses are summarized in Section 3.3.2 below and are set forth in detail in pages 41-57 of the 2011 Needs Assessment.

As part of the 2011 Needs Assessment, ISO-NE also undertook a Transmission Transfer Capability Analysis to determine whether the transmission system could serve load reliably under three scenarios: an eastern New England Import Scenario, a western New England Import Scenario, and a Connecticut Import Scenario. The methodology, assumptions, and results of the transmission transfer capability analysis are summarized in Section 3.3.3 below and are set forth in detail in pages 65-71 of the 2011 Needs Assessment.

Finally, the 2011 Needs Assessment included an Extreme Contingency Analysis, involving limited stability studies to examine how the transmission system would perform per the NERC, NPCC, and ISO-NE Standards and Criteria. A generator torsional impact ("Delta-P") analysis was also performed involving limited studies to determine the mechanical stress put on local generators during system contingency events. The results of the Delta-P testing are set forth in detail in pages 58-60 of the 2011 Needs Assessment and the results of the extreme contingency testing are set forth in pages 57-58 of the 2011 Needs Assessment.

3.3.2 Steady State Analysis

The 2011 Needs Assessment was performed in accordance with the NERC, NPCC, and ISO-NE planning standards and criteria in the 10-year planning horizon. The steady state voltage and loading criteria, solution parameters, and contingency specifications used in the analysis are consistent with these documents.

A total of four base cases, representing a number of possible generation dispatch and availability conditions, were modeled for study years 2015 and 2020. These four cases were used to study five possible scenarios: the East-to-West Scenario, the West-to-East Scenario, the Connecticut Reliability Scenario, the Rhode Island Reliability Scenario, and the Salem Harbor Retirement Scenario. For each scenario, the system was tested with all transmission lines in-service (N-0) and under N-1 and N-1-1 contingency events for 2015 and 2020 load conditions. System adjustments allowed in power-flow simulations between the first and second contingency for N-1-1 events are listed in ISO-NE PP-3.

3.3.2.1 Steady State Analysis Assumptions

The assumptions used in the steady state modeling are set forth in detail in Section 3 of the 2011 Needs Assessment, and are summarized below.

Load Forecast Assumptions

In accordance with ISO-NE planning practices, the modeled load was based on the summer peak 90/10 demand forecast in ISO-NE's 2010 CELT Report. These values were 31,810 MW for all of New England in 2015 and 33,555 MW in 2020 (system losses included). In comparison, the summer peak 90/10 demand forecast in the 2011 CELT Report is 31,705 MW for 2015 and 33,750 MW for 2020. The change between the 2010 and 2011 CELT forecast is less than 1%.

Demand Resource Assumptions

Demand resources ("DR"), both passive and active, were modeled in the base case as capacity resources at the levels of the most recent FCA – in this instance, FCA-4. The amounts of demand resources modeled in the 2015 and 2020 base cases are listed in Tables 3-2 and 3-3 below.[16]

In comparison, cleared passive DR values for the years 2014-2015 from FCA-5 were up by 2.9% from the FCA-4 values, while the cleared active DR values went down by almost 15% from FCA-4 values. In aggregate, cleared DR (both active and passive DR) in FCA-5 went down by approximately 4.5% compared to the FCA-4 values.

Table 3-2: FCA-4 Passive DR Values

Load Zone	Passive DR Values (MW)
Maine	152
Vermont	72
Northeast Massachusetts and Boston	263
Southeast Massachusetts	140
West Central Massachusetts	150
Rhode Island	85
Connecticut	424

Table 3-3: FCA-4 Active DR Values

Dispatch Zone	Active DR Values (MW)	Dispatch Zone	Active DR Values (MW)
Bangor Hydro	76	Springfield, Massachusetts	36
Maine	203	Western Massachusetts	45
Portland, Maine	135	Lower Southeast Massachusetts	65
New Hampshire	64	Southeast Massachusetts	106
New Hampshire Seacoast	10	Rhode Island	77
Northwest Vermont	35	Eastern Connecticut	48
Vermont	19	Northern Connecticut	63
Boston, Massachusetts	212	Norwalk-Stamford, Connecticut	70
North Shore Massachusetts	83	Western Connecticut	208
Central Massachusetts	86		

[16] Appendix A of the 2010 CELT Load Forecast in Table 7-4.

Base Case Transmission and Generation Assumptions

All transmission projects with ISO-NE PPA approvals as of the June 2010 Regional System Plan Project listing were included in the base case load flows for steady state modeling. These projects included two NEEWS projects - the GSRP and the RIRP. The CCRP, which is being re-evaluated, was not included. IRP was not included either as it was the subject of the study.

The base case included all existing generators and all new generators that have accepted a Forward Capacity Market ("FCM") Capacity Supply Obligation as of the FCA-4, with the exception of the Vermont Yankee Nuclear Plant, which was excluded from the base case because of the significant uncertainty concerning its continued operation after 2012.

The Salem Harbor Generating Station, located in Salem, Massachusetts, was assumed to be in service in the base case, and modeled as out-of-service only in the Salem Harbor Retirement Scenario. In May 2011, the owners of the Salem Harbor Generating Station confirmed that it will be retired in 2014. ISO-NE has directed the New England transmission owners not to include Salem Harbor Generating Station in any future reliability studies for any year after 2014.

Generation Dispatch Cases

Four generation dispatch cases were developed to reflect a range of possible stressed conditions on the Southern New England transmission system. These dispatch cases are shown in Table 3-4.

Table 3-4: Generation Dispatch Scenarios

Scenario	Generators Out-of-Service
New England West-to-East	• Hydro-Quebec Phase II • Seabrook Generating Station
New England East-to-West and Connecticut Reliability	• Millstone Units 2 and 3 • Berkshire Power (as a proxy for EFORD)[2]
Rhode Island Reliability	• RISE Generating Station • Franklin Square / Manchester Street 09 Combined Cycle
Salem Harbor Retirement[1]	• Hydro-Quebec Phase II • Seabrook Generating Station

[1] The base case for this scenario assumes that all generation at Salem Harbor Generating Station is retired in 2014, and that New Brunswick import levels are increased to compensate.
[2] EFORD – equivalent demand forced outage rate

The New England East-to-West and West-to-East Scenarios stressed transfers in each direction across the New England East-West Interface to determine the capability needed on the bulk transmission system to serve demand on either side of the interface. The Salem Harbor Retirement Scenario replicated the New England West-to-East Scenario for a base case that reflects the retirement of the Salem Harbor Generating Station and a corresponding increase in the import level from New Brunswick in order to compensate.

The Rhode Island Reliability and Connecticut Reliability Scenarios stressed conditions in local areas to determine the capability needed on the transmission system to serve demand in the local area. To accomplish this, the Rhode Island Reliability Scenario modeled two Rhode Island generators out-of-service. The Connecticut Reliability Scenario was modeled using the same generator dispatch case as was used for the New England East-to-West Scenario; however, for the Connecticut Reliability Scenario, the Connecticut load zone[17] was used as the region under study.

Each of the four generation dispatch cases assumes that the two largest generating units or supply sources in the area of interest are out-of-service. These cases were developed in compliance with ISO-NE's PP-3 and the standards set forth in NPCC's Directory which require that reliability assessments be based on load and generating conditions that reasonably stress the system. In the 2011 Needs Assessment, and in many other area studies conducted under PP-3, the system was stressed using base cases that have the largest and most critical generating units or stations in an area unavailable. Assuming the unavailability of more than one generating unit recognizes that units may be out-of-service over an extended period of time for any one of a number of reasons, such as economics, equipment failure, fuel supply, or maintenance.[18] Furthermore, in coming years, heightened environmental restrictions on fossil-fueled generating stations could affect the continuous operation of generating units or result in the closure of one or more units at a generating station.

In general, modeling existing generators as out-of-service in planning studies is not conducted simply to assure that the system will be able to do without those generators in specific system conditions, but rather to test the performance of the system under stresses that it may be required to withstand, whether from the unavailability of those specific generators or for other reasons. Generating units assumed to be unavailable or otherwise out-of-service should not be confused with the loss of a generating unit as a contingency. The former is a base case assumption – the system as represented before any contingency is applied. The latter is one of many contingencies specified by the NERC, NPCC, and ISO-NE standards, criteria, and procedures.

3.3.2.2 Steady State Results – Overview

Overall, the steady state analysis found numerous thermal overloads and a lesser number of voltage performance issues across New England under N-1 and N-1-1 contingency events. These transmission system performance issues occurred under all generator dispatch scenarios: when the system attempted to deliver power from western New England to serve load in eastern New England; when it attempted to deliver power from eastern New England to serve load in western New England; and when supplying load under stressed conditions to Connecticut and Rhode Island. Overall, thermal overloads and voltage performance issues increased substantially in number

[17] The Connecticut load zone is electrically defined in Table 2-5 of the 2011 Needs Assessment.

[18] Historically, multiple generating units have been unavailable in New England even on peak days. ISO-NE notes that there have been five occasions over the past ten years when 2,500 MW or more of generation has been out of service during the peak day of June, July, or August.

between 2015 and 2020. Additionally, the number of thermal overloads under the New England West-to-East Scenario increased substantially under the Salem Harbor Retirement Scenario.

Figure 3-4 provides a graphic summary of the thermal overloads under N-1 conditions in 2020; similarly, Figure 3-5 provides a graphic summary of the thermal overloads under N-1-1 conditions in 2020. The worst case loading levels are shown for each transmission line that is loaded to 95% or more of its thermal capability under at least one contingency. Performance issues resulting from the Salem Harbor Retirement Scenario are not depicted in Figures 3-4 and 3-5.

3.3.2.3 Results: New England West-to-East Scenario

The New England West-to-East Scenario, with the Hydro Quebec Phase II high-voltage direct-current ("HVDC") line and the Seabrook Generating Station assumed to be out-of-service, illustrates the effect of high New England west-to-east transfers to serve demand in the east with generation from the west. A summary of the results of the N-1 and N-1-1 contingency analyses are shown in Table 3-5 below. Detailed results are contained in Tables 5-1, 5-6, 5-7, 5-8, and 5-9 in the 2011 Needs Assessment.

As shown in Table 3-5, under N-1 conditions, there are no thermal overloads in 2015, although four different transmission system elements would be loaded between 95% and 100%. By 2020, six elements would be overloaded and an additional two would be loaded between 95% and 100%. The N-1 study indicated no voltage performance issues.

The N-1-1 contingency analysis shows 19 overloaded elements in 2015, with an additional four elements loaded between 95% and 100%; by 2020, 36 elements are overloaded and an additional six are loaded between 95% and 100%. In addition, the analysis shows three voltage performance issues under N-1-1 conditions in 2015 and six in 2020.

Table 3-5: Thermal Overloads and Performance Issues: New England West-to-East Scenario

Year	N-1 Contingencies			N-1-1 Contingencies		
	Elements Loaded 95%-100%[1]	Thermal Overloads	Voltage Performance Issues	Elements Loaded 95%-100%[1]	Thermal Overloads	Voltage Performance Issues
2015	4	0	0	4	19	3
2020	2	6	0	6	36	6

[1] Although transmission lines loaded between 95% and 100% are not technically overloaded, they are indicative of problems that may occur just beyond the study horizon.

Figure 3-4: New England N-1 Thermal Overload Summary

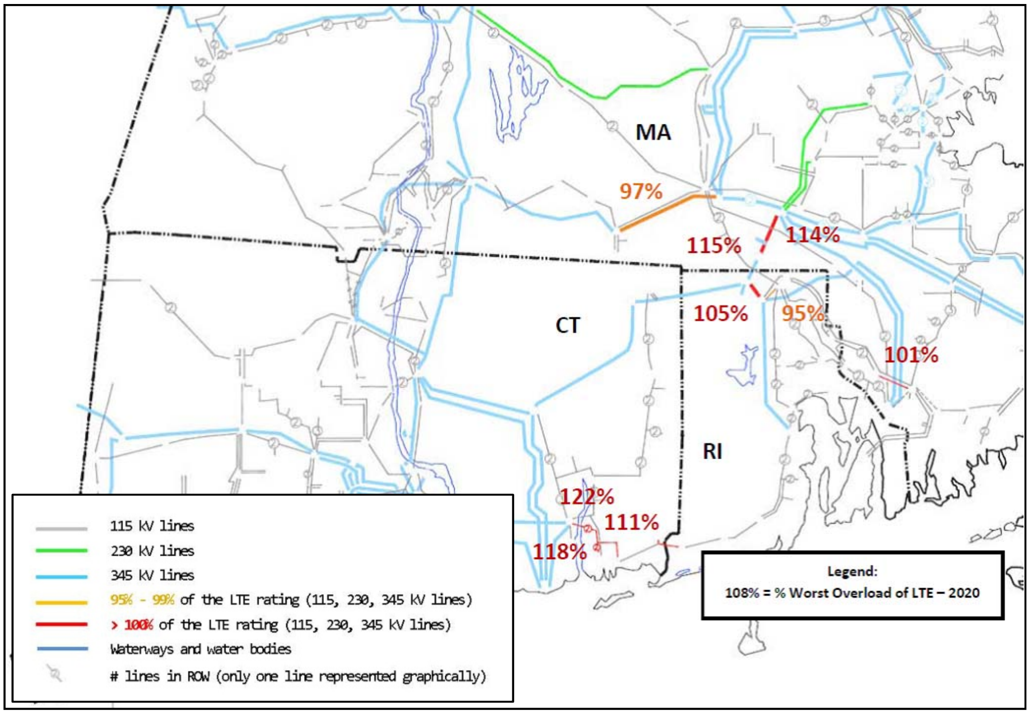
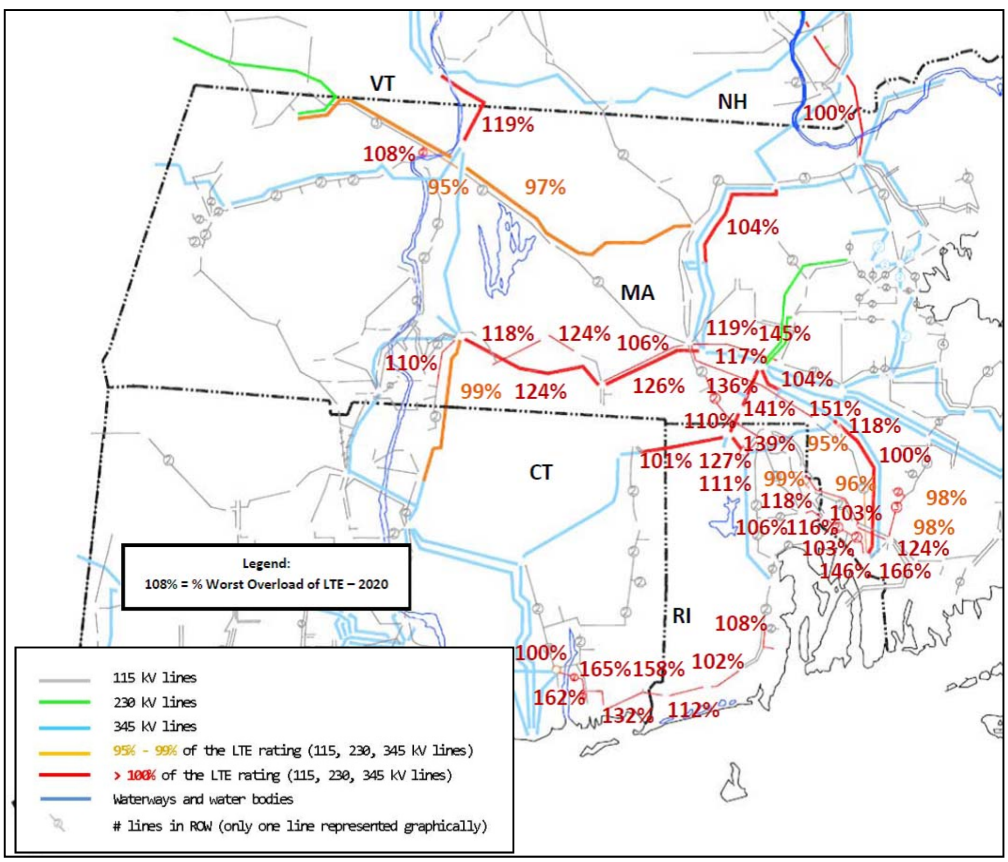


Figure 3-5: New England N-1-1 Thermal Overload Summary



3.3.2.4 Results: New England East-to-West Scenario

The New England East-to-West Scenario, with the Millstone Units 2 and 3 assumed to be out-of-service and the Berkshire Power Plant modeled offline to reflect the EFORD for western Massachusetts generation, illustrates the effect of high New England east-to-west transfers to serve demand in the west with generation from the east. A summary of the results of the N-1 and N-1-1 contingency analyses is shown below in Table 3-6; detailed results are contained in Tables 5-2, 5-10, 5-11, and 5-12 in the 2011 Needs Assessment.

As shown in Table 3-6, no thermal or voltage performance issues were observed in western New England under N-1 contingency conditions in 2015. However, by 2020, one element is loaded to 97% of its thermal capability under N-1 contingency conditions.

Under N-1-1 contingency conditions, thermal overloads occur on two transmission lines in western New England in 2015, and three additional elements are loaded to within 95% to 100% of their ratings. By 2020, ten transmission lines are overloaded and two additional elements are loaded to within 95% to 100% of their ratings. In addition, the N-1-1 study showed four voltage performance issues in 2020.

Table 3-6: Thermal Overloads and Performance Issues: New England East-to-West Scenario

Year	N-1 Contingencies			N-1-1 Contingencies		
	Elements Loaded 95%-100%[1]	Thermal Overloads	Voltage Performance Issues	Elements Loaded 95%-100%[1]	Thermal Overloads	Voltage Performance Issues
2015	0	0	0	3	2	0
2020	1	0	0	2	10	4

[1] Although transmission lines loaded between 95% and 100% are not technically overloaded, they are indicative of problems that may occur just beyond the study horizon.

3.3.2.5 Results: Connecticut Reliability Scenario

The Connecticut Reliability Scenario uses the same generator dispatch case as the New England East-to-West Scenario; however, the Connecticut load zone, rather than western New England, was used as the region under study. A summary of the results of the N-1 and N-1-1 contingency analyses is shown below in Table 3-7; detailed results are contained in Tables 5-15 and 5-16 in the 2011 Needs Assessment.

As shown in Table 3-7, the Connecticut load zone experiences no thermal or voltage issues under N-1 conditions in either 2015 or 2020. Under N-1-1 conditions, a single voltage performance issue is identified in 2015; by 2020, three thermal elements are overloaded, and one is loaded to within 95% to 100% of its rating, and three voltage issues are identified.

Table 3-7: Thermal Overloads and Performance Issues: Connecticut Reliability Scenario

Year	N-1 Contingencies			N-1-1 Contingencies		
	Elements Loaded 95%-100%[1]	Thermal Overloads	Voltage Performance Issues	Elements Loaded 95%-100%[1]	Thermal Overloads	Voltage Performance Issues
2015	0	0	0	0	0	1
2020	0	0	0	1	3	3

[1] Although transmission lines loaded between 95% and 100% are not technically overloaded, they are indicative of problems that may occur just beyond the study horizon.

3.3.2.6 Results: Rhode Island Reliability Scenario

The Rhode Island Reliability Scenario was used to assess load serving capability in Rhode Island. This scenario stressed conditions in the Rhode Island load zone by reducing Rhode Island generation to require the system to deliver generation resources from outside the sub-area. In particular, the RISE Generating Station and the Manchester Street 09 combined cycle unit were assumed to be out-of-service. A summary of the results of the N-1 and N-1-1 contingency analyses is shown below in Table 3-8; detailed results are contained in Tables 5-3, 5-13, and 5-14 in the 2011 Needs Assessment.

As shown in Table 3-8, Rhode Island experiences no thermal or voltage performance issues under N-1 conditions in 2015. In 2020, a single thermal element overloads under N-1 conditions.

Under N-1-1 contingency conditions, thermal overloads occur on five elements in 2015, with an additional two elements loaded to within 95% to 100% of their rating. By 2020, eight transmission system elements are overloaded under N-1-1 conditions, with an additional three elements loaded to within 95% to 100% of their ratings.

Table 3-8: Thermal Overloads and Performance Issues: Rhode Island Reliability Scenario

Year	N-1 Contingencies			N-1-1 Contingencies		
	Elements Loaded 95%-100%[1]	Thermal Overloads	Voltage Performance Issues	Elements Loaded 95%-100%[1]	Thermal Overloads	Voltage Performance Issues
2015	0	0	0	2	5	0
2020	0	1	0	3	8	0

[1] Although transmission lines loaded between 95% and 100% are not technically overloaded, they are indicative of problems that may occur just beyond the study horizon.

3.3.2.7 Results: Salem Harbor Retirement Scenario

The New England West-to-East Scenario, as described in Section 3.3.2.3, was re-analyzed for the retirement of Salem Harbor Generating Station, scheduled for 2014. To compensate for the permanent loss of the Salem Harbor generator, imports from New Brunswick were assumed to increase. A summary of the results of the N-1 and N-1-1 contingency analyses is shown below in

Table 3-9; detailed results are contained in Tables 5-4, 5-5, 5-17, 5-18, 5-19 and 5-20 in the 2011 Needs Assessment.

A comparison of Tables 3-5 and 3-9 demonstrates that the retirement of the Salem Harbor Generating Station will worsen the thermal and voltage concerns identified in the New England West-to-East Stress Scenario. In 2020, under N-1 conditions, the number of potentially overloaded elements increases from six to seven, and the number of voltage performance issues increases from none to two. Under N-1-1 conditions, potentially overloaded elements increase from 36 to 38, while voltage performance issues increase from six to nine.

Table 3-9: Thermal Overloads and Performance Issues: Salem Harbor Retirement Scenario

Year	N-1 Contingencies			N-1-1 Contingencies		
	Elements Loaded 95%-100%[1]	Thermal Overloads	Voltage Performance Issues	Elements Loaded 95%-100%[1]	Thermal Overloads	Voltage Performance Issues
2020	2	7	2	7	38	9

[1] Although transmission lines loaded between 95% and 100% are not technically overloaded, they are indicative of problems that may occur just beyond the study horizon.

3.3.3 Transmission Transfer Capability Analysis

3.3.3.1 Purpose

Transfer capability is the measure of the ability of interconnected transmission systems to transfer power in a reliable manner from one area to another. The ability of the transmission system within a defined area to reliably serve customer demands is predicated on the amount of local generation available and the capacity of the transmission network to import power from the surrounding areas. A system that can accommodate large power transfers generally allows lower system reserve requirements, provides adequate emergency backup of supply resources, permits economic interchange of power, and assures the system will remain reliable under contingency conditions.

The Working Group performed a set of transmission transfer capability analyses for eastern New England, western New England, and Connecticut to identify the required transfer capability into each of these sub-areas. This analysis involved two steps: determining the transmission transfer capability across each interface and then comparing projected area peak load with area generation and potential imports to assess resource adequacy.

3.3.3.2 Determining Transmission Transfer Capabilities

Transfer capability across a specific interface depends on the power flow that all the transmission elements crossing the interface can carry without exceeding thermal capability, causing system instability, or exceeding voltage limits under various contingency conditions.

Since system conditions such as load and the amount and location of available generation can vary significantly from day to day and from hour to hour, transfer capabilities across an interface are properly expressed as a range of values. This range of values will always be much lower than the sum of the thermal capacities of all of the transmission elements that make up the interface. That is, the system must be designed for the potential contingent loss of any single element of the interface, and for the overlapping loss of a second element within thirty minutes of the first. When such contingent events occur, the power that was flowing on the element lost from service automatically flows over the remaining elements of the interface. Accordingly, system operators monitor the power flow on each element of the interface, as well as the total power flow across the interface, in order to make sure that the interface will not become overloaded in the event of a contingency. When power flow on one or more elements of the interface, or on the interface as a whole, approaches the limit of their capability, generation may be re-dispatched to reduce the flow on that element or elements.

For the 2011 Needs Assessment, the Working Group used the Siemens PTI Program Managing and Utilizing System Transmission ("MUST") computer program to determine transfer limits for eastern New England, western New England, and Connecticut under both N-1 and N-1-1 conditions. Details of this analysis can be found in Section 5.2.6 of the 2011 Needs Assessment. The Working Group concluded that, under N-1-1 conditions, the import limit range for eastern New England is 1,250 to 1,350 MW. Under N-1-1 conditions, the import limit range for western New England is 2,250 to 3,000 MW, and the import limit range for Connecticut is 1,750 to 2,400 MW.

3.3.3.3 Assessing Resource Adequacy

Having established the import limit ranges for eastern New England, western New England, and Connecticut, ISO-NE assessed resource adequacy for each area by summing up the total resources available within that area (local generation plus demand response, minus generation outages) and then subtracting the resource requirement of that area (area load minus imports). If there is a surplus (positive value) afterwards, then the import region has sufficient resources in a given year. If there is a deficit (negative value) afterwards, then the import region has insufficient resources in a given year.

The transmission transfer capability analysis shows that there will be insufficient resources to serve eastern New England load under N-1-1 conditions starting in 2011. Further, there will be insufficient resources to serve western New England load under N-1-1 conditions starting in 2017-2018, and there will be insufficient resources to serve Connecticut load under N-1-1 conditions starting in 2014-2015. Specifically:

- Transfer capability from western to eastern New England is already deficient in 2011 by 446 to 546 MW. This deficiency will grow to between 1,762 to 1,862 MW in 2020 without transmission system improvements. With the impending retirement of the Salem Harbor Generating Station, the need for additional eastern New England import capability will be even greater.

- A need for additional transfer capability from eastern to western New England can be reasonably forecasted to occur between 2017 and 2018. This need would be advanced if any generation resources in western New England retire.
- A need for additional transmission transfer capability into Connecticut can be reasonably forecasted for between 2014 and 2015. This need would be advanced if any generation resources in Connecticut retire.

3.4 THE 2012 IRP UPDATE

In March 2012, ISO-NE undertook to update its needs assessments of all New England reliability projects, including the IRP, in light of new planning information (e.g., load forecasts from the 2012 CELT Report and the results of FCA-6, held in April 2012). ISO-NE issued a draft 2012 Needs Update to the PAC on July 9, 2012 and is expected to issue a draft 2012 Solutions Update later in July 2012. ISO-NE will finalize these reports after PAC review and comment. National Grid will provide the final version of the 2012 IRP update documents when they become available.

3.5 NEED IMPLICATIONS FOR RHODE ISLAND

In addition to confirming the needs shown in the 2008 Needs Analysis, the 2011 Needs Assessment documented a previously unrecognized problem of insufficient transmission facilities to allow New England resources in the west to serve load needs in the east. While ISO-NE's analysis focuses on Southern New England as a whole, particularly on the need to improve the integration of the electric supply system serving the three Southern New England states and enhance the reliability of the transmission system for the benefit of the entire New England area, it also demonstrates the need for additional transmission facilities to specifically benefit the Rhode Island transmission system and to provide reliable power to the residents and businesses of Rhode Island.

The limitations of the Rhode Island transmission system are characterized by:

- limited ties to the New England 345 kV transmission system;
- limited generation; and
- a relatively large pocket of load southwest of Providence.

As can be seen in Figure 3-2, there are a limited number of 345 kV ties between the Rhode Island transmission system and the New England 345 kV transmission system.

Maintaining Rhode Island's connection to the larger New England 345 kV transmission system is of particular importance in light of the fact that Rhode Island also has limited generation resources, particularly in the relatively large pocket of load located southwest of Providence.

Because of these factors, on a heavy load day, the Rhode Island transmission system can experience significant transmission line overloads and low system voltages under certain N-1-1 contingencies. The IRP would address this issue by creating new 345 kV transmission paths into Rhode Island, both from the east (via the new 366 Line from the Millbury No. 3 Switching Station) and from the west (via the new 341 Line from the Lake Road Switching Station). With these new 345 kV lines in place, the thermal overloads and low system voltages that could have occurred in the previously described scenario are eliminated.

3.6 CONCLUSION

The IRP has been under study by the Working Group for nearly eight years, during which time the evolving analyses have taken into account multiple changes in system conditions. The 2011 Needs Assessment reinforced that this three-state project is necessary for New England transmission system reliability. N-1 steady state analysis showed thermal overloads and performance issues. N-1-1 steady state analysis testing showed widespread thermal overloads and performance issues across the study area. The 2011 Needs Assessment concluded that there will be inadequate resources to reliably serve anticipated load in eastern New England by 2011; in western New England by 2017/18; and in Connecticut by 2014/2015. Additionally, west-to-east thermal and voltage performance issues will become worse with the retirement of the Salem Harbor Generating Station. At the same time, the Project will resolve the multiple reliability issues within Southern New England.

4 PROJECT DESCRIPTION AND PROPOSED ACTION

4.1 INTRODUCTION

In this section of the ER, the overall scope of the IRP is identified, and the individual project components and facilities comprising the Project are described. This section of the ER also details National Grid's construction and ROW maintenance practices, safety and public health considerations, estimated Project costs, and the anticipated schedule for the Project.

4.2 SCOPE OF THE INTERSTATE RELIABILITY PROJECT

The IRP consists of the construction of three new 345 kV transmission lines, known as the 366 Line, the 341 Line, and the 3271 Line (see Figure 1-3). The 366 Line will extend approximately 20.2 miles (4.8 miles in Rhode Island) from the Millbury No. 3 Switching Station in Millbury, Massachusetts to the West Farnum Substation in North Smithfield, Rhode Island. The 341 Line will extend approximately 17.7 miles from the West Farnum Substation to the Rhode Island/Connecticut border and will continue for approximately 7.6 miles through northeastern Connecticut to the Lake Road Switching Station in Killingly, Connecticut. The third new 345 kV line (the 3271 Line) will be constructed between the Lake Road Switching Station and the Card Street Substation in Lebanon, Connecticut. The existing 345 kV 328 Line will be reconstructed and reconductored between the Sherman Road Switching Station in Burrillville, Rhode Island and the West Farnum Substation, a distance of 9.2 miles. The existing Sherman Road Switching Station will be reconstructed and the existing switching station facility will be retired.

4.3 DESCRIPTION OF THE RHODE ISLAND COMPONENTS OF THE INTERSTATE RELIABILITY PROJECT

The components of the Project in Rhode Island that are jurisdictional to the EFSB are listed in Table 4-1 and described in the following sections.

Table 4-1: Rhode Island Components of the Interstate Reliability Project

Project Component	Total Length (MA, CT, RI) (Miles)	Rhode Island Length (Miles)	Rhode Island Towns	Description of Rhode Island Component
Proposed 366 Line (345 kV transmission line)	20.2	4.8	North Smithfield	Construct approximately 4.8 miles of new 345 kV transmission line from Massachusetts/Rhode Island border to the West Farnum Substation.[1]
Proposed 341 Line (345 kV transmission line)	25.3	17.7	North Smithfield and Burrillville	Construct approximately 17.7 miles of new 345 kV transmission line from the West Farnum Substation to RI/CT border.[2]
Existing 328 Line (345 kV transmission line)	9.2	9.2	North Smithfield and Burrillville	Reconstruct and reconductor approximately 9.2 miles of existing 345 kV transmission line from the Sherman Road Switching Station to the West Farnum Substation.
Existing 333 Line (345 kV transmission line)	0.25	0.25	Burrillville	Reconstruct and realign approximately 0.25 miles of existing 345 kV transmission line in the vicinity of the Sherman Road Switching Station.
Existing 3361 Line (345 kV transmission line)	0.25	0.25	Burrillville	Reconstruct and realign approximately 0.25 miles of existing 345 kV transmission line in the vicinity of the Sherman Road Switching Station.
Existing 347 Line (345 kV transmission line)	0.25	0.25	Burrillville	Reconstruct and realign approximately 0.25 miles of existing 345 kV transmission line in the vicinity of the Sherman Road Switching Station and replace certain other structures along the 347 Line.
Existing B-23 Line (115 kV transmission line)	NA	NA	North Smithfield	Replace certain structures along existing 115 kV transmission line.
Former K11/L12 Line structures	NA	NA	North Smithfield	Remove double-circuit steel towers which previously supported the K11 and L12 69 kV transmission lines.
Existing T172N Line (115 kV transmission line)	NA	NA	North Smithfield	Replace structures along existing 115 kV transmission line.
Sherman Road Switching Station	N/A	N/A	Burrillville	Construct a new 345 kV switchyard with air insulated switchgear and retire the existing facilities.

[1] Total length of proposed line in Massachusetts and Rhode Island is 20.2 miles with termination points at the Millbury No. 3 Switching Station and the West Farnum Substation.

[2] Total length of proposed line in Rhode Island and Connecticut is 25.3 miles with termination points at the West Farnum Substation in North Smithfield, Rhode Island and the Lake Road Switching Station in Killingly, Connecticut. Another new 345 kV line (the 3271 Line) will then continue through Connecticut for 29.3 miles from the Lake Road Switching Station to the Card Street Substation in Lebanon, Connecticut.

4.3.1 Construct New 345 kV Transmission Line (366 Line) from the Rhode Island/ Massachusetts Border to the West Farnum Substation

National Grid proposes to construct a new transmission line (the 366 345 kV Line) from the Millbury No. 3 Switching Station in Millbury, Massachusetts, to the West Farnum Substation on Greenville Road in North Smithfield, a total distance of approximately 20.2 miles, of which approximately 4.8 miles are in Rhode Island.[19] The Rhode Island portion of the 366 Line will be constructed within existing ROWs, parts of which have been held by National Grid and used for transmission purposes since the early 1900s. The width of the existing ROWs varies, but is generally 250 to 270 feet.

Within Rhode Island, Approximately 3.7 miles of the ROW is occupied by the Q143 and R144 115 kV transmission lines, and by unused double-circuit steel lattice towers that previously supported the K11 and L12 69 kV transmission lines. The unused steel lattice towers will be removed as part of the Project. Approximately 1.1 miles of the ROW are occupied by the S171N and T172N 115 kV transmission lines.

The route of the 366 Line from the Massachusetts/Rhode Island border to the West Farnum Substation is shown on Figure 2-1. Typical cross-sections of the ROW with the 366 Line are shown on Figure 4-1 (Map Sheets RI-366-1 to RI-366-6).

The 366 Line will be constructed primarily with direct embedded tubular steel H-frame tangent structures (Figure 4-2) and 3-pole tubular steel structures on reinforced concrete foundations at angle and dead-end locations (Figure 4-3). The conductors of the transmission line will be 1590 kcmil ACSR 54/19 “Falcon” twin bundled conductor per phase. One of the two shield wires of the 366 Line will be 3/8 inch 7 strand EHS galvanized steel and the other shield wire will be optical ground wire (“OPGW”) to support high speed relaying and communications requirements. The structure height will range from 60 to 115 feet with a typical structure height of 85 to 90 feet. Structure heights vary in order to provide adequate clearance to the ground or to obstacles over which the line is crossing. Wherever possible the new structures will be placed adjacent to existing structures of the Q143S/R144 and S171N/T172N structures. Preliminary design indicates that a total of 52 structures will be required to support the 366 Line in Rhode Island.

Brush mowing and selective tree removal will be performed along the ROWs as necessary to facilitate construction access and installation of soil erosion and sediment controls as described in Section 4.4.1. Tree removal ranging from 100 to 125 feet in width will be required along the 1.1-mile segment of the S171N/T172N ROW (refer to Figure 2-2 map sheets 39-41), and approximately 95 feet in width will be cleared along the Q143/R144 ROW from the Massachusetts/Rhode Island border to 0.32 miles southeast of Old Great Road in North Smithfield (refer to Figure 2-2 map sheets 33-36) to provide proper clearances from vegetation to the new 366 Line (see Figure 4-1).

[19] The West Farnum Substation has facilities in place to accept the 341 and 366 Lines. Modifications and improvements at West Farnum substation were permitted as part of the RI Reliability Project (EFSB Docket No. SB-2008-2).

4.3.2 Construct New 345 kV Transmission Line (341 Line) from the West Farnum Substation to the Rhode Island/Connecticut Border

National Grid proposes to construct the 341 Line in Rhode Island from the West Farnum Substation to the Rhode Island/Connecticut border, a distance of approximately 17.7 miles. As described in Section 4.2, this 345 kV transmission line will continue into Connecticut and terminate at the Lake Road Switching Station. The Rhode Island portion of the 341 Line will be constructed within an existing ROW held by National Grid and used for transmission purposes since the 1960s. The existing ROWs typically range from 300 to 700 feet wide.

Approximately 9.2 miles of this ROW, from the Sherman Road Switching Station to the West Farnum Substation, is occupied by the existing 328 Line, a 345 kV transmission line that will be reconstructed and reconductored as part of this Project (see Section 4.3.3 below). The ROW is also occupied by the B-23 115 kV transmission line for the first 3.4 miles west of the West Farnum Substation. From the Sherman Road Switching Station to the Rhode Island/Connecticut border the ROW is occupied for approximately 8.7 miles by the 347 Line, an existing 345 kV transmission line.

The route of the 341 Line from the West Farnum Substation to the Rhode Island/Connecticut border is shown on Figure 2-1. Typical cross-sections of the ROWs with the 341 Line are shown on Figure 4-1 (Map Sheets RI-341-1 to RI-341-5).

The 341 Line in Rhode Island will be constructed primarily with direct embedded tubular steel H-frame tangent structures (Figure 4-2) and 3-pole tubular steel structures on reinforced concrete foundations at angle and dead-end locations (Figure 4-3). Single pole davit arm structures on reinforced concrete foundations will be used at two locations due to ROW constraints (Figure 4-4). The transmission line conductors of the 341 Line will be 1590 kcmil ACSR 54/19 “Falcon” twin bundled conductor per phase. One of the shield wires of the 341 Line will be 3/8 inch 7 strand EHS galvanized steel and the other shield wire will be OPGW. The structure heights will range from 60 to 125 feet with a typical structure height of 85 to 90 feet. Wherever possible the new structures will be placed adjacent to existing structures on the ROWs. Preliminary design indicates that a total of 141 structures will be required to support the 341 Line.

Tree removal will be required along the full length of the ROWs from the West Farnum Substation to the Rhode Island/Connecticut border to provide proper clearances from vegetation to the 341 Line. The width of tree removal will vary from 75 to 115 feet. Brush mowing will be performed along the ROWs as necessary to facilitate construction access and installation of soil erosion and sediment controls as described in Section 4.4. Refer to Figure 4-1, cross-sections.

4.3.3 Reconstruct and Reconductor 345 kV Transmission Line (328 Line) from the Sherman Road Switching Station to the West Farnum Substation

National Grid proposes to reconstruct and reconductor the existing 328 Line from the Sherman Road Switching Station in Burrillville to the West Farnum Substation in North Smithfield, a distance of approximately 9.2 miles, to increase the capacity of the line. This will involve the removal of the existing structures, overhead conductors and shield wires, and the installation of new structures, conductors and shield wires.

The 328 Line will be constructed primarily with direct embedded tubular steel H-frame tangent structures (Figure 4-2) and 3-pole tubular steel structures on reinforced concrete foundations at angle and dead-end locations (Figure 4-3). One location may require the use of a single pole davit arm structure on a reinforced concrete foundation due to ROW constraints (Figure 4-4). The new conductors will be 1590 kcmil ACSR 54/19 “Falcon” twin bundled conductor per phase. Both shield wires of the 328 Line will be 3/8 inch 7 strand EHS galvanized steel. Typical structure height will be 85 to 90 feet. Preliminary design indicates that a total of 75 structures will be required to support the reconstructed 328 Line.

The route of the 328 Line from the Sherman Road Switching Station to the West Farnum Substation is shown on Figure 2-1. Figure 4-1 (Map Sheets RI-341-3 to RI-341-5) shows typical cross-sections of the ROWs.

4.3.4 Reconstruct the Sherman Road Switching Station

The existing Sherman Road Switching Station will be reconstructed and the existing switching station will be retired. The Sherman Road Switching Station is located at 1573 Sherman Farm Road, Burrillville, Rhode Island, and is situated on National Grid fee-owned property of approximately 40.7 acres. As identified in the 2012 Solution Report (Appendix E) the rebuild of the Sherman Road Switching Station is required in order to address thermal capacity issues, short-circuit duty related issues, asset conditions in the station, and to meet NPCC requirements.

Work at the existing Sherman Road Switching Station will involve installation of equipment with upgraded power transfer capability. The reconstruction of the Sherman Road Switching Station entails building a completely new 345 kV switching station with Air Insulated Switchgear (“AIS”) in a breaker-and-a-half configuration (Figure 4-5). New terminal line structures within the station yard will be erected to a height up to 105 feet tall. A new control building (45 feet wide and 90 feet long) will also be installed and the new switching station will be constructed in conformance with NPCC protection standards. The upgrades will include the construction of the two new 345 kV bays adjacent to the existing switching station on undeveloped land owned by National Grid to the northwest of the existing yard. The existing station yard will be expanded to the northwest by an area of approximately 180 feet in width and 540 feet in length. The construction of the bays adjacent to the existing switching station will allow for the continued operation of the existing station during construction. Once the new bays are in place and all transmission lines have been switched over, the existing ring bus will be removed. The proposed design includes a realigned swale that maintains the hydraulic connectivity between the existing upper wetland and the larger lower wetland. Additionally, the swale emulates the existing intermediate wetland (which is to be impacted) by including a slower flowing, wider intermediate segment of channel with a more gradual slope, thus reducing erosion potential and providing sediment removal functions. The area around the yard will be graded to match adjacent topography with 1.5:1 engineered slopes, and retaining walls to minimize grading impacts. Slopes will either be riprap, loamed and seeded, or stabilized by other engineered techniques. The internal driveway in the yard will also be crowned to convey rainfall sheet runoff into the adjacent aggregate surfacing. Any run-off from remaining portions of the station yard and adjacent areas will be conveyed to the proposed swale and/or to other existing swales surrounding the station yard. Access to the reconstructed switching station will be by way of the existing paved access drive (with slight modifications) located off of the paved access driveway shared with the Ocean State Power Generating Plant.

As part of this work, certain segments of the existing 333, 3361, and 347 345 kV Lines will need to be realigned on National Grid property in the vicinity of the switching station, in order to tie into the rebuilt station. New transmission line structures installed outside of the station yard will range in height from 90 to 100 feet. Realignment of the existing transmission lines with the new 345 kV bays will necessitate additional tree removal outside the existing cleared width of the ROW in uplands and wetlands located on the station property.

4.3.5 Reconstruct and Realign Existing 345 kV Transmission Line (3361 Line)

Approximately 0.25 miles of the existing 3361 345 kV Line outside of the Sherman Road Switching Station will be realigned as a result of the reconstruction of the Sherman Road Switching Station. The 3361 Line will require the installation of one single-pole self-supporting steel structure and one 3-pole self-supporting steel structure on concrete foundations. One existing wood 6-pole structure will be removed.

4.3.6 Reconstruct and Realign Existing 345 kV Transmission Line (333 Line)

Approximately 0.25 miles of the existing 333 345 kV Line between the Sherman Road Switching Station and Ocean State Generating Plant will be realigned as a result of the reconstruction of the Sherman Road Switching Station. This will require the installation of two single-pole self-supporting steel structures on concrete foundations, and the removal of one existing steel A-Frame structure.

4.3.7 Reconstruct and Realign Existing 345 kV Transmission Line (347 Line)

Approximately 0.25 miles of the existing 347 Line will be realigned as a result of the reconstruction of the Sherman Road Switching Station. This will require the installation of one single-pole self-supporting steel structure and two 3-pole self-supporting steel structures on concrete foundations. One existing wood 6-pole structure and one wood 2-pole structure will be removed. In addition, several 347 Line guyed-angle structures will be reconstructed as self-supporting 3-pole structures to accommodate the construction of the 341 Line.

4.3.8 Modifications to Existing 115 kV Transmission Line (B-23 Line)

To accommodate the construction of the 341 Line and reconstruction of the 328 Line, the existing B-23 115 kV transmission line will require certain structure modifications in North Smithfield. Seven structures will be rebuilt and three structures will require guy modifications.

4.3.9 Modifications to Existing 115 kV Transmission Line (T172N)

To accommodate access on the ROW for the construction of the 366 Line, the existing T172N 115 kV transmission line will require certain structure modifications in North Smithfield. Two structures will be rebuilt with taller wooden H-frame structures to increase conductor clearance.

4.4 CONSTRUCTION AND MAINTENANCE PLAN OVERVIEW

4.4.1 Transmission Line Construction Sequence

The new 341 and 366 Lines will be constructed using conventional overhead electric transmission line construction techniques. Detailed constructability reviews were conducted in the field by National Grid, its consultants, and a construction contractor, as described in Section 9.1, to assess structure design and location, determine access for construction and maintenance purposes, and avoid or minimize environmental impacts.

The transmission line will be constructed in a progression of activities that will normally proceed as described below. The construction equipment required for these activities is described in Table 4-2.

Table 4-2: Typical Construction Equipment

Construction Phase	Typical Equipment Required	
Vegetation Removal and ROW Mowing	• Grapple trucks • Track-mounted mowers • Chippers • Log forwarders • Brush hogs, skidders • Bucket trucks	• Motorized tree shears • Chain saws • Box trailers • Low-bed trailers, flatbed trucks • Bulldozers, excavators • 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 • Graders	• 10-wheel trucks with grapples • Cranes • Pick-up trucks • Low-bed trailers • Stake body trucks
Removal and Disposal of Existing Transmission Line Components	• Cranes • Flatbed trucks • Pullers with take-up reels • Excavators • Vacuum trucks	• Backhoes • Trucks with welding equipment • Dump truck • Storage containers
Installation of Foundations and Structures	• Backhoes • Bulldozers • Front-end loaders • ATVs • Tracked carriers or skidders • Concrete trucks • Excavators • Rock drills mounted on excavators or tracked equipment • Cranes	• Cluster drills with truck mounted compressors • Aerial lift equipment • Tractor trailers • Bucket trucks • Large-bore foundation drill rigs • Hand-held equipment such as shovels, pumps, and vibratory tampers • Dump trucks • Generators, air compressors
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 • Hydro-seeders

4.4.1.1 Removal of Vegetation and ROW Mowing in Advance of Construction

Along the majority of the ROWs and at proposed structure sites, tree removal, tree pruning or other vegetative management may be required prior to construction. These activities will be limited to those areas necessary to provide access to existing and proposed Project structure locations, to facilitate safe equipment passage, to provide safe work sites for personnel within the ROWs, and to maintain safe clearances between vegetation and transmission line conductors for reliable operation of the transmission facilities. In the future, the vegetation on the ROWs will be managed in accordance with National Grid's *Right-of-Way Vegetation Management Plan*, (refer to Appendix H of this report) and subsequent updates.

Prior to vegetation removal and mowing, the boundaries of wetlands will be clearly marked to prevent unauthorized vehicular encroachment into wetland areas. Existing access routes along the ROWs will be used by the tree 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 forested wetlands, to prevent wetland disturbance, and to provide a stable platform for equipment operation. Swamp mats consist of timbers that are bolted together and placed over wetland areas to distribute equipment loads and minimize impacts to the wetland and soil substrates (Figure 4-6). Swamp mat roads placed in wetlands for vegetation removal will be placed, used for vegetation removal, and then removed by the clearing contractor. Corduroy (log) roads will be used on a limited basis to facilitate tree removal.

Tree removal operations, where required, will include the removal of all tall growing woody species within the targeted portions of the ROWs. Tall growing trees just outside the maintained ROWs edges will be assessed for their potential to damage the transmission line. To ensure reliability, these "danger trees" may have to be pruned or removed.

Generally, trees that are removed will be cut close to the ground, leaving the stumps and roots in place. This has the benefit of reducing soil disturbance and erosion. In locations where grading is required for access road improvements or at structure sites, stumps will be removed. Small trees and shrubs within the ROWs will be mowed as necessary with the intent of preserving roots and low-growing vegetation to the extent practical. This Project will span more than one growing season; therefore, additional mowing of access routes and structure work sites may be required as this vegetation re-generates. Brush, limbs, and cleared trees will be chipped and removed from the site.

In certain environmentally sensitive areas such as wetlands, it may be necessary and desirable to leave felled trees and snags and allow them to decompose in place rather than to disturb soft organic substrates. Where the ROWs cross streams and brooks, vegetation along the stream bank will be selectively cut to minimize the disturbance of bank soils and the potential for project related soil erosion.

4.4.1.2 Installation of Soil Erosion and Sediment Controls

Following the vegetation removal and maintenance activities, proper soil erosion and sediment control devices, such as straw bales, siltation fencing, and/or chip bales, will be installed 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 *Wetland BMP Manual: Techniques for Avoidance and Mitigation*, and National Grid's *ROW Access, Maintenance and Construction Best Management Practices (EG-303)* (Appendix I).

The installation of these sediment control devices will be supervised by National Grid'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 National Grid's Construction Supervisor (see Section 4.4.5 below). The soil erosion and sediment controls will be installed between the work area and environmentally sensitive areas such as wetlands, streams, drainage courses, roads and adjacent property when work activities will disturb soils and result in a potential for soil erosion and sedimentation. The devices will function to mitigate construction-related soil erosion and sedimentation, and will also serve as a physical boundary to delineate resource areas and to contain construction activities within approved areas.

Where dewatering is necessary during excavations for structures within or adjacent to wetland areas, water will be pumped into appropriate dewatering basins. At all times, dewatering will be performed in compliance with National Grid's *ROW Access, Maintenance and Construction Best Management Practices (EG-303).* The basin and all accumulated sediment will be removed following dewatering operations and the area will be seeded and mulched. Soil erosion and sediment controls will be used to contain excess soils, prior to removal of the excess soils from the work sites.

Staging areas, equipment storage, and refueling stations will be situated at least 100 feet from wetlands except in cases where equipment such as a drill rig or dewatering pump cannot be moved. Where structures requiring concrete foundations are located near wetlands, proper soil erosion and sediment controls will be installed to prevent impacts to these areas.

Swamp mats, soil erosion and sediment controls, and other measures will be implemented, as appropriate, in accordance with BMPs, in resource areas temporarily disturbed by construction. Herbaceous vegetation in disturbed areas will be restored using a native wetland or conservation seed mix. In areas of tree removal, enhancements are proposed as mitigation for important wildlife features lost as a result of tree removal and construction activities. Potential enhancement activities may include: seeding, planting native shrub species, leaving snags and placing woody debris, and slash or stone piles to create wildlife cover.

4.4.1.3 Construction of Access Road Improvements and Work Pads, and Road Maintenance

Access roads are required along the ROWs to provide the ability to construct, inspect and maintain the existing and proposed transmission line facilities. For the Project, existing access roads will require maintenance or upgrading to support the proposed construction activities. For example, clean gravel or trap rock will be necessary to stabilize and level the roads for construction vehicles. It will be necessary to improve existing access roads in certain locations within the ROWs to facilitate new construction.

Several of the existing and proposed access roads cross or intersect streams located within National Grid's existing ROWs. These stream crossings have been evaluated in order to determine if the crossings require the replacement or installation of culverts. National Grid is proposing to correct drainage problems that have been observed on the ROWs, which involves separating the access roads from the areas subject to storm flowage ("ASSFs") and stream channels that have been diverted from their original courses over time. National Grid will either install a culvert to direct the flow under the access road, construct a parallel channel, or install a water bar or parallel channel to redirect the flow off access roads and back to natural channels.

Access across wetlands and streams, where upland access is not available, will be accomplished by the temporary placement of swamp mats. Such temporary swamp mat access roads will be removed following completion of construction and areas will be restored to re-establish pre-existing topography and hydrology as necessary. Swamp mats or similar matting may also be used to cross land in active agricultural use.

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. Crushed stone aprons will be used at all access road entrances to public roadways to clean the tires of construction vehicles and minimize the migration of soils off-site.

Upland work pads will be created 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 as required and mulched to allow vegetation to re-establish. In wetlands, these work pads will be created with temporary swamp mats and will be removed after the completion of construction activities.

Typical access roads are 20 feet wide with a travel lane of approximately 16 feet wide to accommodate the vehicles and equipment needed to construct the new 345 kV transmission line facilities. National Grid is planning to use the existing network of access roads to the greatest extent practicable. New access roads will be located to avoid or minimize disturbance to water resources, follow the existing contours of the land as closely as possible, and where practicable, avoid severe slopes. In addition, access roads will be constructed to avoid significantly altering existing drainage patterns. New access roads will be established over native soils if practicable; unstable soils may be removed and replaced with imported clean fill material.

To the extent that National Grid has or can obtain rights, off-ROW access roads will be used to gain access to the ROWs and to avoid and/or minimize impacts to wetlands and watercourses, and other environmental resources on the ROWs. Off-ROW access roads will be improved to the same or similar standards as the on-ROW access roads.

4.4.1.4 Removal and Disposal of Existing Transmission Line Components

In order to accommodate the construction of the 366 Line, National Grid will remove approximately 17 existing steel lattice structures which previously supported the K11 and L12 69 kV transmission lines along the ROW between West Farnum Substation and the Rhode Island/Massachusetts border. In addition, National Grid proposes to reconstruct and reconductor the existing 328 Line from the

Sherman Road Switching Station to the West Farnum Substation. This will require the removal of the existing 328 Line structures.

National Grid proposes to recycle as much of the removed material as possible. Those components not salvaged and any debris that cannot be recycled will be removed from the ROWs to an approved off-site facility. Handling of such materials will be performed in compliance with applicable laws and regulations and in accordance with National Grid's policy and procedures.

4.4.1.5 Installation of Foundations and Structures

The majority of proposed structures are direct embedment steel pole H-frame structures, which do not require reinforced concrete foundations. Excavation for direct embedment structures will be performed using a soil auger or standard excavation equipment depending on field conditions. Excavations will range from approximately 10 to 20 feet in depth, with diameters typically between 3 and 5 feet. A steel casing will be placed vertically into the hole and backfilled. The poles will be field assembled and inserted by cranes into the embedded steel casings. The annular space between the pole and the steel casing will then be backfilled with crushed stone.

Structures at dead end or angle locations will require reinforced concrete caisson foundations, typically 15 to 30 feet deep, with diameters of between 6 and 10 feet. These structures may include H-frames, 3-pole structures and monopoles (monopole configuration is depicted in Figure 4-4). Caissons will be constructed by drilling a vertical shaft, installing a steel reinforcing cage, placing steel anchor bolts, pouring concrete, and backfilling as needed. Dead-end and angle structures will be lifted by a crane and placed on the anchor bolts.

In order to accommodate the construction of the new and rebuilt lines, temporary wood pole structures will be installed to support the 328 and 347 Line conductors in certain locations. Once the new transmission line structures are completed, the temporary wood pole structures will be removed.

Excavated material will be temporarily stockpiled next to the excavation; however this material will not be placed directly into resource areas. If the stockpile is in close proximity to wetlands, the excavated material will be enclosed by staked straw bales or other sediment controls. Additional controls, such as watertight mud boxes, will be used for saturated stockpile management in work areas in wetlands (i.e., swamp mat platforms) where sediment-laden runoff would pose an issue for the surrounding wetland. Following the backfilling operations, excess soil will be spread over unregulated upland areas or removed from the site in accordance with National Grid policies and procedures. Dewatering may be necessary during excavations or pouring concrete for foundations. At all times, dewatering will be performed in compliance with National Grid's *ROW Access, Maintenance and Construction Best Management Practices (EG-303).*

Rock that is encountered during foundation excavation will generally be removed by means of drilling with rock coring augers rather than a standard soil auger. This method allows the same drill rig to be used and maintains a constant diameter hole. However, in some cases, controlled blasting may be used to break up the rock. If blasting is performed, heavy mats will be used to contain the blast materials. Blasting activities will be performed in accordance with federal, state, and local regulations.

4.4.1.6 Installation of Conductor and Shield Wire

Following the erection of transmission structures, insulators will be installed on the structures. The insulators isolate the energized power conductors from the structure. Shield wire, OPGW, and power conductors will then be installed using stringing blocks and wire stringing equipment. The wire stringing equipment is used to pull the conductors from a wire reel on the ground through stringing blocks attached to the structure to achieve the desired sag and tension condition. During the stringing operation, temporary guard structures or boom trucks will be placed at road and highway crossings and at crossings of existing utility lines. These guard structures are used to ensure public safety and uninterrupted operation of other utility equipment by keeping the wire away from other utility wires and clear of the traveled way at these crossing locations.

Construction of temporary wire stringing and pulling sites will be required and will involve some grading and import of gravel to provide a level work space for equipment and personnel, or to establish remote wire stringing set-up sites at angle points in the transmission line.

In instances where there is an expansive wetland, large watercourse, open water body or otherwise sensitive environmental resource, alternate means will be assessed for stringing the lead ropes and wire to avoid and/or minimize crossing of these water resources. Alternative means for stringing wire/conductor could include the following:

- Placing the wire pulling ropes during the initial tree clearing and vegetation removal phase of the Project;
- Using aerial installation via a helicopter;
- Using a boat to gain access across open water bodies;
- Crossing with a one-time installation of swamp mats/mat bridge in conjunction with the use of low-pressure equipment; and
- Implementing methods for casting the lead rope/wire to pull the conductor over the resource that is to be avoided.

Helicopters may be used for line stringing or other activities. The final decision regarding helicopter use for any Project activity will be made during the construction phase when more detailed information is known and in consultation with the selected contractor.

4.4.1.7 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 bar/diversion channel/rock ford), 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 soils 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. Where authorized by property owners, permanent gates and access road blocks will be installed at key locations to restrict access onto the ROWs by unauthorized persons or vehicles. Regulated environmental resource areas that are temporarily disturbed by construction will be restored in accordance with applicable permit conditions to pre-construction conditions.

4.4.2 Sherman Road Switching Station Construction Sequence

The general sequence of events that will take place during the reconstruction of the Sherman Road Switching Station is described in the following sections.

4.4.2.1 Site Preparation

The limit of disturbance will be surveyed and staked in the field, and the wetland flagging will be refreshed. Tree removal will be required within the station yard expansion area. Tree removal at the station will occur as part of the tree removal activities associated with the adjacent ROW work. Once the vegetation removal is complete, soil erosion and sediment controls will be installed along the proposed limit of disturbance. Soil erosion control and other engineered stabilization measures will be provided along the downgradient side of stockpiles created during grading operations to prevent sediment migration. A crushed stone tracking pad will then be installed at the entrance to the existing and proposed station yards to minimize equipment tracking of dirt onto the local roadway. Modifications will be made to the existing gate and perimeter fence line to accommodate construction equipment. Stumps and unsuitable overburden will be removed from within the station expansion area and will be properly disposed of. Excavation and processing of on site material for use as structural fill and to establish sub-grade elevations will occur. Materials will be imported onto the site to establish the desired site grades and backfill for underground utilities, foundations and above-ground structures.

4.4.2.2 Yard Construction

The new station yard expansion will be constructed to dimensions of approximately 180 feet in width and 540 feet in length, increasing the total yard footprint to approximately 460 feet by 540 feet. The grading and sloping along the perimeter of the station yard will extend beyond the limits of the proposed fence line. Earth work and grading will be necessary to create a level surface for equipment installation.

The new and existing station yard grades will be raised approximately 2 feet to mitigate yard flooding conditions, reduce frost heave activity, provide additional cover for underground utilities, and provide additional cover over shallow ledge. The grades within the existing yard will be raised approximately 2 feet, once the new equipment is installed in the new yard and the existing equipment is decommissioned and removed from the site. The 2 foot increase in elevation will allow the ground grid, conduits and cable trench to be installed above the groundwater level.

Excavation, drilling or pneumatic hammering would be the preferred methods to remove rock that may be encountered at the site. If extensive bedrock is encountered during construction, provisions for blasting would be considered and developed, in accordance with controlled blasting techniques. A certified blasting specialist would develop site-specific blasting procedures, taking into account the existing field conditions and nearby structures, and conforming to state regulations. The controlled blasting plan would be provided to the local Fire Marshal for approval. Blasting techniques would be designed to loosen only the material that must be removed and to avoid fracturing other rock. Blast material would be crushed on site for use as structural fill for remaining portions of the yard.

A new ground grid will be required in the area of the yard expansion. The expansion area of the yard will be cut and filled to bring the yard to required grades. The new and existing yard will be filled with 24 inches of clean processed gravel and 6 inches of aggregate surfacing to improve grounding and drainage. This will be extended outside the perimeter fence as an apron for fence grounding installation. A paved driveway will be installed within the yard to provide access to the new control building, and the station yard will be enclosed in a chain link perimeter security fence.

4.4.2.3 Yard Equipment

Within the switching station yard, a number of concrete foundations will be installed to support the electrical equipment. A ground grid will be installed under the layer of clean process gravel. Disconnect switches, circuit breakers, transmission A-frame structures, bus, and other required electrical equipment will be installed in the new switchyard. Construction of the 45-foot wide by 90-foot long equipment enclosure building with a foundation and an emergency generator are also proposed. Run-off from the building roof will be infiltrated in the stone surface of the switching station yard.

4.4.2.4 Transmission Line Structures

As part of the construction, some existing transmission structures will need to be removed from the footprint of the existing station yard. New transmission structures will be installed adjacent to the new bays within the station yard expansion area. These structures will be shifted to the northwest expansion area of the station. As part of this work, certain segments of the existing 333, 3361, 328 and 347 Lines will need to be realigned, in order to tie into the rebuilt station. Several sets of structures in the ROW to the northeast of the yard will also be replaced.

4.4.2.5 Removal and Retirement of Existing Switching Station Yard Equipment

After energization of the new switching station, the existing station yard equipment, including the existing ring bus, will be removed. The electrical equipment within the existing station yard will be removed, including removal of the above-ground structures. Existing equipment will be re-used elsewhere or sent for processing at a recycling facility. Materials that are not salvageable will be disposed of off-site and in compliance with applicable regulations.

4.4.2.6 Construction Staging Areas

Construction staging areas for the Sherman Road Switching Station will be established on site and within the limits of disturbance shown on the Project plans, making use of the existing station yard, to the extent feasible. All construction staging areas will be sited and designed in an effort to avoid additional tree removal and impacts to environmentally sensitive areas.

4.4.2.7 Rehabilitation of Impacted Areas

All areas impacted by construction of the Sherman Road Switching Station will be covered with stone, seeded with grass, landscaped, mulched, or paved as appropriate. Topsoil stripped from initial vegetation removal activities will be stockpiled on the site and used as appropriate in areas where vegetation is to be established. Impacted upland areas will be stabilized with a New England conservation/wildlife seed mixture, or equivalent. Areas temporarily impacted within wetlands will be re-graded to establish pre-construction contours and seeded with a New England "Wetmix" or equivalent. Wetland enhancements and a landscape plan for the station expansion will be developed to mitigate for permanent and temporary construction-related wetland impacts.

4.4.3 Project Construction Traffic

Intermittent construction-related traffic associated with transmission line and switching station construction will occur over the entire construction period. Construction equipment typically will gain access to the ROWs from public roadways crossing the ROWs in various locations along the route. Because each of the construction tasks will occur at different times and locations over the course of the construction, traffic will be intermittent at these entry roadways. Traffic will consist of vehicles ranging from pick-up trucks to heavy construction equipment.

National Grid's contractors will coordinate closely with the Rhode Island Department of Transportation ("RIDOT") to develop acceptable traffic management plans for work within state highways. National Grid will coordinate with local authorities for work on local streets and roads. At locations where construction equipment must be staged in a public way, the contractors will follow a pre-approved work zone traffic control plan.

4.4.4 Project Construction Work Hours

Proposed construction work hours for the Project will be 7 a.m. to 7 p.m. Monday through Friday when daylight permits and 7 a.m. to 5 p.m. on Saturdays. For certain activities, there will be exceptions to these standard work hours. For example, some work tasks such as concrete pours and transmission line stringing, once started, must be continued through to completion and may go beyond normal work hours. If blasting is required for foundation construction, the hours for that operation are generally limited as dictated by the local Fire Marshal or other local officials.

In addition, the nature of transmission line construction requires line outages for certain procedures such as transmission line connections, equipment cutovers, or stringing under or over other transmission lines. These outages are dictated by the system operator, ISO-NE, and can be very limited based on regional system load and weather conditions. 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 Sundays and holidays.

The Towns of North Smithfield and Burrillville each have codified regulations limiting construction work hours. National Grid is seeking relief from the work hour restrictions for the tasks described above. Prior to the start of construction, National Grid will notify abutting property owners, municipal officials, DPWs and police and fire chiefs of the details of planned construction including the normal work hours.

4.4.5 Environmental Compliance and Monitoring

All Project personnel will be required to be trained on Project environmental requirements and permit conditions prior to the start of construction. Refresher training is held on a yearly and as-needed basis. National Grid will conduct regular (weekly or bi-weekly) construction progress meetings to reinforce the contractor's awareness of these issues in addition to daily "permit to work" meetings. Pre-construction "look aheads" will take place in the field with appropriate Project personnel. National Grid environmental staff, and the assigned environmental monitor, will attend these meetings to provide feedback to construction personnel.

During the construction process, National Grid will retain the services of an environmental monitor to ensure and report on compliance with all federal, state, and local permit requirements and National Grid policies and procedures. At regular intervals and during periods of prolonged precipitation, the monitor will inspect all locations to determine whether the environmental controls are functioning properly and to make recommendations for correction or maintenance, as necessary.

In addition to retaining the services of an environmental monitor, National Grid 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 and appropriate work methods.

4.4.6 ROW Vegetation Maintenance

Once the proposed transmission lines are operational, vegetation along the ROWs will continue to be managed: 1) to provide clearance between vegetation and electrical conductors and supporting structures so that safe, reliable delivery of power to consumers is assured, and 2) to provide access for necessary inspection, repair, and maintenance of the facilities. All vegetation maintenance is carried out in strict compliance with National Grid's *Right-of-Way Vegetation Management Plan*.

Vegetation maintenance of the ROWs under and adjacent to the new transmission lines will be accomplished with methods identical to those currently used in maintaining vegetation along the existing ROWs. These methods include hand and mechanical cutting and selective application of herbicides. Herbicides are applied by licensed applicators to select target species and are never applied in areas of standing water or within designated protective buffer areas associated with wells, surface waters, and agricultural areas. National Grid currently utilizes a four- to five-year vegetation maintenance cycle on its transmission ROWs.

National Grid's vegetation removal and maintenance methods, as described in the management plan noted above, encourage the growth of low-growing shrubs, ferns, wildflowers and grasses, thus helping to stabilize the cleared areas against soil erosion and providing some degree of natural control of tall-growing vegetation.

4.5 SAFETY AND PUBLIC HEALTH CONSIDERATIONS

National Grid will design, build, and maintain the facilities for the Project so that the health and safety of the public are protected. This will be accomplished through adherence to all federal, state and local regulations, and industry standards and guidelines established for protection of the public. Specifically, the Project will be designed, built, and maintained in accordance with the National Electrical Safety Code ("NESC") and other applicable electrical safety codes. 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").

Practices that will be used to protect the public during construction will include, but not be limited to, establishing traffic control plans for construction traffic to maintain safe driving conditions, restricting public access to potentially hazardous work areas, and using temporary guard structures at road and electric line crossings to prevent accidental contact with the conductor during installation.

Following construction of the facilities, all transmission structures and substation facilities will be clearly marked with warning signs to alert the public to potential hazards if climbed or entered. Trespassing on the ROWs will be inhibited by the installation of gates and/or barriers at entrances from public roads where approved by owners of properties upon which easements are located.

A discussion of the current status of the health research relevant to exposure to EMF is attached as Appendix J. This report was prepared by Exponent, Inc.

4.6 HAZARDOUS SUBSTANCES

4.6.1 Sherman Road Switching Station

There are two substances used at switching stations that are classified as potentially hazardous by United States Environmental Protection Agency ("USEPA"). One is sulfur hexafluoride ("SF_6"), a gas which is used as an insulator in the circuit breakers and switches at the Sherman Road Switching Station. The second is battery acid, which is contained in the control house batteries.

SF_6 emissions are regulated by the USEPA and its transport is regulated by the U.S. Department of Transportation ("DOT"). SF_6 is a colorless, odorless and nonflammable gas that is commonly used in lieu of insulating oil. When gas equipment is used outdoors, any release concentration would be insignificant when exposed to the atmosphere.

Although SF_6 emissions are regulated by the USEPA, there is no risk of general public exposure because the circuit breakers and switches are located inside the fenced Sherman Road Switching Station yard. The circuit breakers and switches are installed and maintained by trained technical staff and they are checked for integrity during bi-monthly operation and maintenance inspections by National Grid personnel. Alarms are in place to alert National Grid personnel in the event of a significant leak.

Battery (hydrochloric) acid is contained in the control house batteries. The battery acid has three levels of containment. The first containment level is the polycarbonate battery housing. The second level is a shallow berm surrounding the battery rack area. Finally, the battery rack is housed inside the control building which provides further containment and protects the batteries from exposure to the elements. In the unlikely event of a leak of acid from batteries, the leak will be contained behind the berm until clean-up can begin. In addition, hydrogen gas vapors from a leaking battery will be detected by sensors. If gases reach a 2 percent concentration, alarms are sounded in the National Grid control center and personnel will respond.

4.6.2 Transmission Line

Paint used on the K11/L12 structures contains lead, chromium, and cadmium. These structures will be removed in accordance with applicable state and federal regulations.

The Landfill & Resource Recovery ("L&RR") Superfund site located in North Smithfield extends onto and beyond the National Grid ROWs. Soil and groundwater in the vicinity of the L&RR site will be handled in accordance with RIDEM and USEPA approvals and pending Environmental Land Use Restrictions ("ELURs").

4.7 PROJECT COMMUNITY OUTREACH

At the beginning of the Project, National Grid developed a comprehensive and proactive public outreach process to establish and maintain communications with stakeholders (e.g., project abutters, residents, businesses, and local and state officials). This process included opportunities for public education and communication regarding the need for the Project, the permitting and siting processes, the development of detailed construction plans, the dissemination of construction updates and outreach during construction, and follow-up outreach after Project completion. The process was designed to engage the community, facilitate transparency throughout the Project, foster public participation, and solicit feedback from stakeholders. It includes:

- Early and comprehensive outreach to Project abutters, federal, state and local officials, and the business community;
- Project Open Houses in communities along the route;
- A Project Website providing background information on the Project, Project updates, and contact information;
- A 1-800 Project Hotline; and
- Comprehensive communications during Project construction.

4.7.1 Neighborhood Outreach

National Grid has been engaged with residents and community members living in the towns along the Project ROWs since the fall of 2007. Communications with neighborhood residents included mailings to property owners along the route; visits with property owners adjacent to the ROWs; and Open House events held in November 2008 and September 2011.

During door-to-door outreach with property owners directly abutting the ROWs, if the owner was not home a door hanger was left behind with a Project fact-sheet and contact information. On the occasions when the property owner was home, National Grid personnel discussed the Project, the permitting timeline, the potential impact to their particular property and the construction timeline. Special requests for landscape plantings and specific post-construction restoration measures were documented and kept in a Project database.

To address individual landowners' specific concerns about the Project, National Grid may consider structure relocation (if possible within engineering constraints) to minimize impacts on abutting properties. National Grid may also offer funding for post-construction landscape restoration; propose post-construction installation of gates and guardrails at street crossings to deter unauthorized access to the ROWs; and prepare visual simulations to show proposed post-construction conditions including gates, guardrails and landscaping.

4.7.2 Open Houses

National Grid initially held Open Houses in communities along the Project route in November 2008. After ISO-NE completed its 2011 reassessment of the need for the IRP, National Grid held Open Houses for Massachusetts residents in Sutton and Uxbridge in September 2011; and for residents in Rhode Island the Open House was held in Burrillville in September 2011. These Open Houses provided interactive information about the need for the Project, its location, its benefits, and what to expect during each phase of Project construction. They also provided residents with an opportunity to express concerns and questions regarding the Project. Key communications tools included:

- Google Earth™ route simulations that allowed stakeholders to view their property or area of interest in relation to the Project;
- Videos on the need for and proposed scope of the Project; and
- Individual tables providing information on the proposed route, Project need and benefits, proposed schedule, visual impacts and buffers, EMF, tree clearing and vegetation maintenance, public involvement, the environment, construction, and post-construction restoration. At each table, an expert in that subject matter was designated to respond to questions and concerns from the public.

4.7.3 Government, Business, and Civic Leaders/Groups

National Grid is committed to keeping government, business and civic leaders apprised of the Project. To this end, National Grid provided briefings to state and local officials in 2006 and 2007; held informational forums for local officials, businesses and large commercial and industrial customers in 2008; and met again with municipal officials following the 2011 Needs Assessment.

Throughout the planning cycle, National Grid has held formal and informal meetings with business and community leaders, including local chambers of commerce, economic development councils, and non-governmental organizations.

4.7.4 Project Website

A website for the IRP is available at http://www.interstatereliability.com. This website provides Project information, including background, updates, and contact resources. Interested parties can sign up to receive Project updates by email. National Grid will keep the website up-to-date for the duration of the Project.

4.7.5 Project Hotline

A toll free number (800-559-0241) has been designated as the Project Hotline for the IRP. The Project Hotline number is listed in all Project outreach materials including factsheets, subsequent mailings, and the website. Prior to construction, a refrigerator magnet with this number will be provided to all abutters within a 300-foot radius of the Project so it is readily available should any questions or concerns arise during construction.

4.7.6 Construction Communication Plan

A critical element of National Grid's communication plan includes outreach during construction to inform residents, fire, police, emergency personnel, and municipal officials as to work schedules, work locations, and construction activities.

Recognizing the varying needs of its stakeholders, National Grid is developing various communication methods to inform audiences throughout construction, including, as needed: work area signage; advance notification of scheduled construction; personal contact with residents and businesses along the transmission line ROWs; and regular email updates to residences and local officials that will include information on upcoming construction activity.

National Grid will designate an ombudsman for the Project who will be responsible for continuing this outreach during construction and who will provide a consistent point of contact for the public. As noted above, the Project website will be kept up-to-date during the construction phase and a bi-weekly status update email will be sent to those who have provided an email address and who have expressed an interest in receiving such updates.

4.8 ESTIMATED PROJECT COSTS

National Grid prepared study grade estimates of the costs associated with its portion of the Project. Study grade estimates are prepared prior to detailed engineering plans using historical cost data, data from similar projects, and other stated assumptions of the Project engineer. The accuracy of study grade estimates is expected to be ±25 percent. Estimated costs in 2011 dollars include costs of materials, labor and equipment. The estimated cost of the IRP in Rhode Island, Massachusetts, and Connecticut, is $542 million as stated in the ISO-NE 2012 Solution Report (Appendix E). The estimated cost of the Rhode Island Project components are presented in Table 4-3.

Table 4-3: Estimated Cost of Rhode Island Project Components

Project Components	Total Estimated Rhode Island Project Cost ($M)[1]
New 366 345 kV Transmission Line MA/RI Border to the West Farnum Substation	$26.8
Removal of Existing 69 kV Towers	$0.9
Realign Existing 347 345 kV Line at the Sherman Road Switching Station	$2.7
New 341 345 kV Transmission Line from the West Farnum Substation to RI/CT Border	$74.9
Reconstruct and Reconductor 328 345 kV Transmission Line	$41.6
3361 Line Realignment at the Sherman Road Switching Station	$3.4
333 Line Realignment at the Sherman Road Switching Station	$2.9
Reconstruction of the Sherman Road 345 kV Switching Station	$27.6
Total Estimated Cost in RI	**$180.8**

[1] Study grade estimates (± 25%) in 2011 dollars. Estimated costs include costs of materials, labor and equipment.

Annual operation and maintenance activities for transmission lines include periodic ROW vegetation management, helicopter patrol, and miscellaneous route inspections. Since the ROWs are occupied by existing transmission lines, any increase in operation and maintenance costs will be nominal.

4.9 PROJECT SCHEDULE

National Grid anticipates starting construction of the facilities in early 2014, and having the facilities in service by late 2015. In order to construct certain components of the Project, it is necessary to schedule outages on existing transmission lines and other facilities. Outages are required so that the construction crews can safely work near adjacent facilities. The scheduling of outages for the Project requires final approval by ISO-NE. The work must be scheduled and sequenced so as to minimize reliability risks and to reduce the possibility of interrupting electric supply to customers.

This schedule is based on time duration estimates of Project permitting and licensing, detailed engineering, materials acquisition, and construction. A high level schedule of major Project tasks is shown in Table 4-4, below.

Table 4-4: Project Schedule

Activity	2011				2012				2013				2014				2015			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preliminary Engineering[1]	■	■	■	■	■															
Licensing / Permitting				■	■	■	■	■	■	■	■	■								
Detailed Engineering					■	■	■	■	■	■	■	■								
Materials Procurement											■	■	■	■	■	■				
Construction													■	■	■	■	■	■	■	■

[1] Begun in 2008

5 PROJECT ALTERNATIVES

5.1 INTRODUCTION

This section describes the alternatives considered to address the needs identified in the 2011 Needs Assessment. The evaluation process involved multiple distinct assessments, each of which is discussed below. First, the Working Group consisting of National Grid, NU, and ISO-NE undertook a detailed assessment of alternative transmission solutions. The Working Group process culminated in the release of the 2012 Solution Report (included as Appendix E).

In parallel with the development of the 2012 Solution Report, National Grid and NU engaged an expert consultant, ICF, to study the potential for non-transmission alternatives ("NTAs") such as new generation, energy efficiency, demand response programs, and distributed generation, either alone or in combination, to address the needs identified in the 2011 Needs Assessment. National Grid also engaged POWER Engineers to evaluate alternatives to constructing some or all of the proposed Project underground. Finally, the Company assessed and compared all of the available options for meeting the identified need. National Grid's overriding goal throughout the planning and design phases of the Project has been to select the alternative that best meets the Project need, with a minimum impact on the environment, at the lowest possible cost.

Section 5.2 discusses the alternative of taking no action at all to improve the Southern New England electric transmission system. Section 5.3 describes the Working Group process and the analysis of various overhead transmission alternatives, and Section 5.4 describes potential NTAs. Sections 5.5 and 5.6 describe alternative overhead routes using new ROWs and the existing Project ROWs respectively. Section 5.7 describes the Company's consideration of underground transmission alternatives. Section 5.8 describes alternatives to the expansion of the Sherman Road Switching Station.

5.2 NO ACTION ALTERNATIVE

Under the No Action Alternative, no improvements would be made to the existing electric supply system serving Southern New England. The Company would not pursue any new facilities or resources, but instead would continue to rely upon the existing system configuration.

The No Action Alternative was rejected because it would not resolve the regional electric reliability problems that ISO-NE and the transmission system owners have been studying for nearly eight years. Under the No Action Alternative, the electric supply system in the region, particularly in Massachusetts, Rhode Island, and Connecticut, would not comply with national and regional reliability standards and criteria. Compliance with these standards is mandatory under federal law. In addition, the No Action Alternative would be inconsistent with ISO-NE's determination that the IRP is needed to fully integrate generation resources with loads throughout Southern New England by relieving existing transmission constraints on the transfer of power from east to west and from west to east across the region. Furthermore, under the No Action Alternative, the thermal and voltage issues that presently exist at current load levels would continue and would be exacerbated by future increases in power demand. Accordingly, the Company rejected the No Action Alternative because it would not provide a solution to the existing and projected transmission reliability needs in the New England service area.

5.3 ELECTRICAL ALTERNATIVES

5.3.1 The NEEWS Working Group – Identification of Transmission Alternatives

As documented in the 2012 Solution Report, the Working Group identified five alternative transmission line solutions that could resolve the reliability issues identified in the 2011 Needs Assessment. These alternative transmission options, which are variants of Options A and C-2 from the 2008 Solution Report, were designated as Options A-1, A-2, A-3, A-4, and C-2.1.[20]

Interstate Options A-1, A-2, A-3, and A-4 connect the Millbury No. 3 Switching Station in Massachusetts, the West Farnum Substation and/or the Sherman Road Switching Station in Rhode Island, and the Card Street Substation and the Lake Road Switching Station in Connecticut. These four options are identical within Connecticut, but have different configurations in Massachusetts and Rhode Island.

In contrast, Option C-2.1 connects the Millbury No. 3 Switching Station with the Carpenter Hill Substation in Massachusetts and the Manchester Substation in Connecticut. It also requires a separate 345 kV connection between the Sherman Road Switching Station and the West Farnum Substation, both in Rhode Island.

These options are described below, and illustrated in Figure 5-1 to 5-5. Table 5-1 summarizes the key elements of each option. With the exceptions noted in the following sections, all new and rebuilt transmission lines in Massachusetts and Rhode Island are located in existing National Grid and NU ROWs.

[20] The 2008 Options Analysis and 2008 Solution Report considered a number of alternative transmission line options to resolve the reliability issues identified in the 2008 Needs Analysis. Two of these options – Options A and C-2 – were determined to have better system performance, to be easier to construct, and to cost less than the other options. The transmission line options identified by the Working Group in 2011 are based on these two options. The Option A-1 variant of Option A is the recommended solution as proposed by NU, National Grid, NSTAR, and ISO-NE.

Table 5-1: Summary of Primary Elements in Massachusetts, Rhode Island, and Connecticut

Primary Feature	Option A Series				Option C-2.1
	A-1	A-2	A-3	A-4	
Mileage of Components					
New 345 kV Transmission Line	74.7	72.2	74.7	83.7	84.1
Reconductor / Rebuild Existing 345 kV Transmission Lines	9.2	0.2	8.7	0	0
Reconductor / Rebuild /Uprate Existing 115 kV Transmission Lines	0	0	0	0	15.4
New Substations/Switching Stations					
Rebuild Switching Station at Sherman Road[1]	AIS	GIS	AIS	AIS	AIS
New Switching Station at Uxbridge	--	--	AIS	--	--
New 345 kV Switchyard at Carpenter Hill	--	--	--	--	Yes
Modified Substations/Switching Stations					
Upgrade the Millbury No. 3 Switching Station	Yes	Yes	Yes	Yes	Yes
Modifications to CT Stations (Card Street, Lake Road, Killingly)	Yes	Yes	Yes	Yes	--
Expand Manchester Substation	--	--	--	--	Yes
New Bay at the West Farnum Substation	--	--	--	Yes	--

[1] Air-Insulated Switchgear ("AIS") is used at the Sherman Road Switching Station for Options A-1, A-3, A-4 and C-2.1. The more compact Gas-Insulated Switchgear ("GIS") is used for Option A-2 because an AIS would not fit on the site in this configuration. See Section 5.5 of the 2012 Solution Report.

5.3.2 Interstate Option A-1 (Proposed Project)

Option A-1, which is the proposed IRP, creates a new 345 kV connection between the Millbury No. 3 Switching Station, the West Farnum Substation, the Lake Road Switching Station, and the Card Street Substation and reinforces an existing 345 kV connection between the West Farnum Substation and the Sherman Road Switching Station. Option A-1 is illustrated in Figure 5-1. Key components of Option A-1 include:

- A new 20.2-mile 345 kV transmission line from the Millbury No. 3 Switching Station to the West Farnum Substation;
- A new 25.3-mile 345 kV transmission line from the West Farnum Substation to the Lake Road Switching Station;
- A new 29.2-mile 345 kV transmission line from the Lake Road Switching Station to the Card Street Substation;
- Reconstruction and reconductoring of the existing 328 345 kV transmission line between the Sherman Road Switching Station and the West Farnum Substation (approximately 9.2 miles) of; and
- Upgrades to the Millbury No. 3 Switching Station, the Lake Road Switching Station, and the Card Street Substation, and reconstruction of the Sherman Road Switching Station.

Figure 5-1: Option A-1 (Proposed Project)

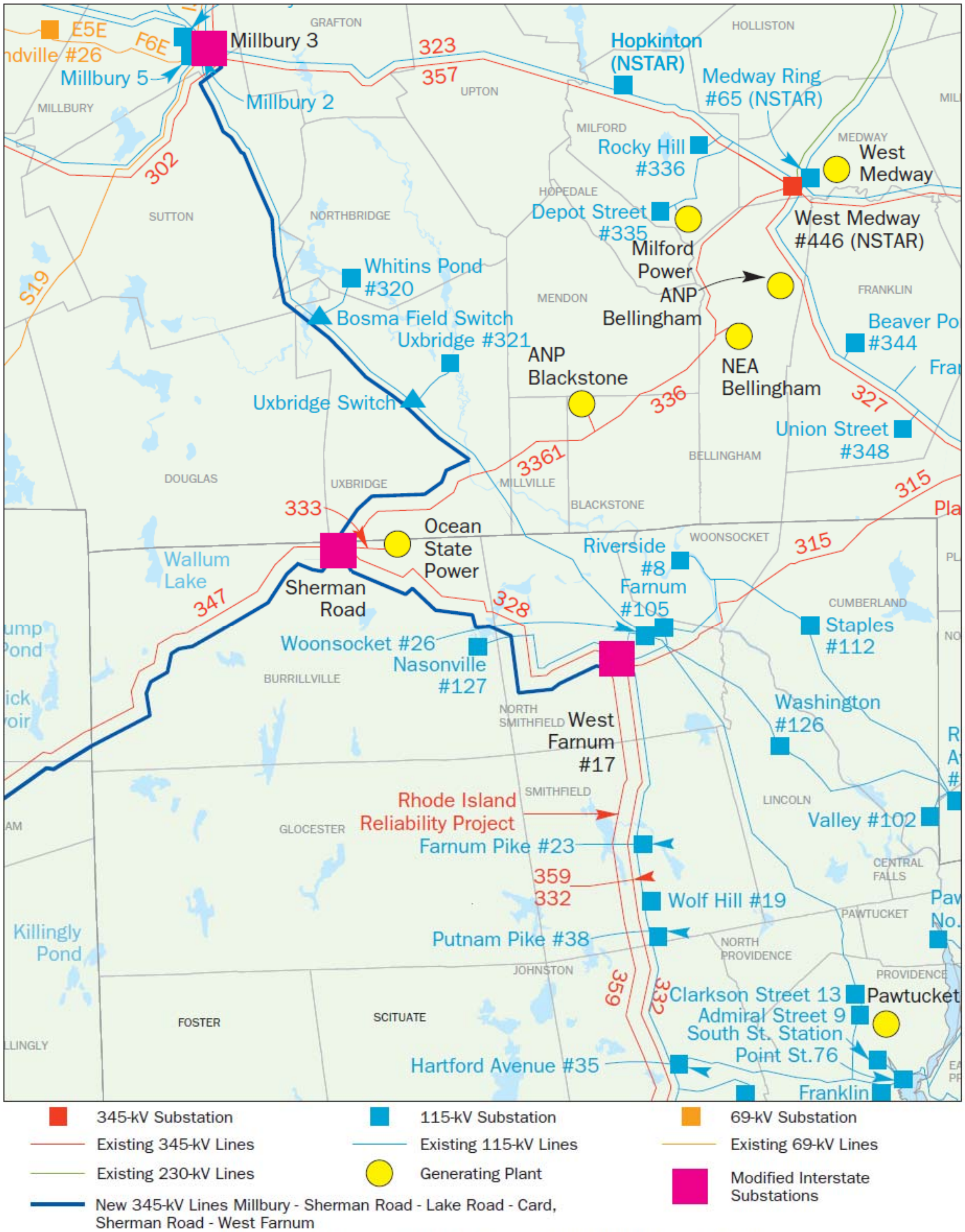
Note: Common upgrades at W. Medway and on the 336 line are not shown on map.

5.3.3 Interstate Option A-2

Option A-2 creates a new 345 kV connection between the Millbury No. 3 Switching Station, the Sherman Road Switching Station, the Lake Road Switching Station, and the Card Street Substation and it also adds a new 345 kV connection between the West Farnum Substation and the Sherman Road Switching Station. Option A-2 is illustrated in Figure 5-2. Key components of Option A-2 include:

- A new 17.7-mile 345 kV transmission line from the Millbury No. 3 Switching Station to the Sherman Road Switching Station along existing National Grid and NSTAR ROWs;
- A new 16.2-mile 345 kV transmission line from the Sherman Road Switching Station to the Lake Road Switching Station;
- A new 29.2-mile 345 kV transmission line from the Lake Road Switching Station to the Card Street Substation;
- A new 9.2-mile 345 kV transmission line from the Sherman Road Switching Station to the West Farnum Substation;
- Rebuilding of 0.2 miles of the 345 kV transmission line from the Sherman Road Switching Station to Ocean State Power, both in Burrillville, Rhode Island; and
- Upgrades to the Millbury No. 3 Switching Station, the Lake Road Switching Station, and the Card Street Substation. The Sherman Road Switching Station would be rebuilt using GIS technology.

Figure 5-2: Option A-2



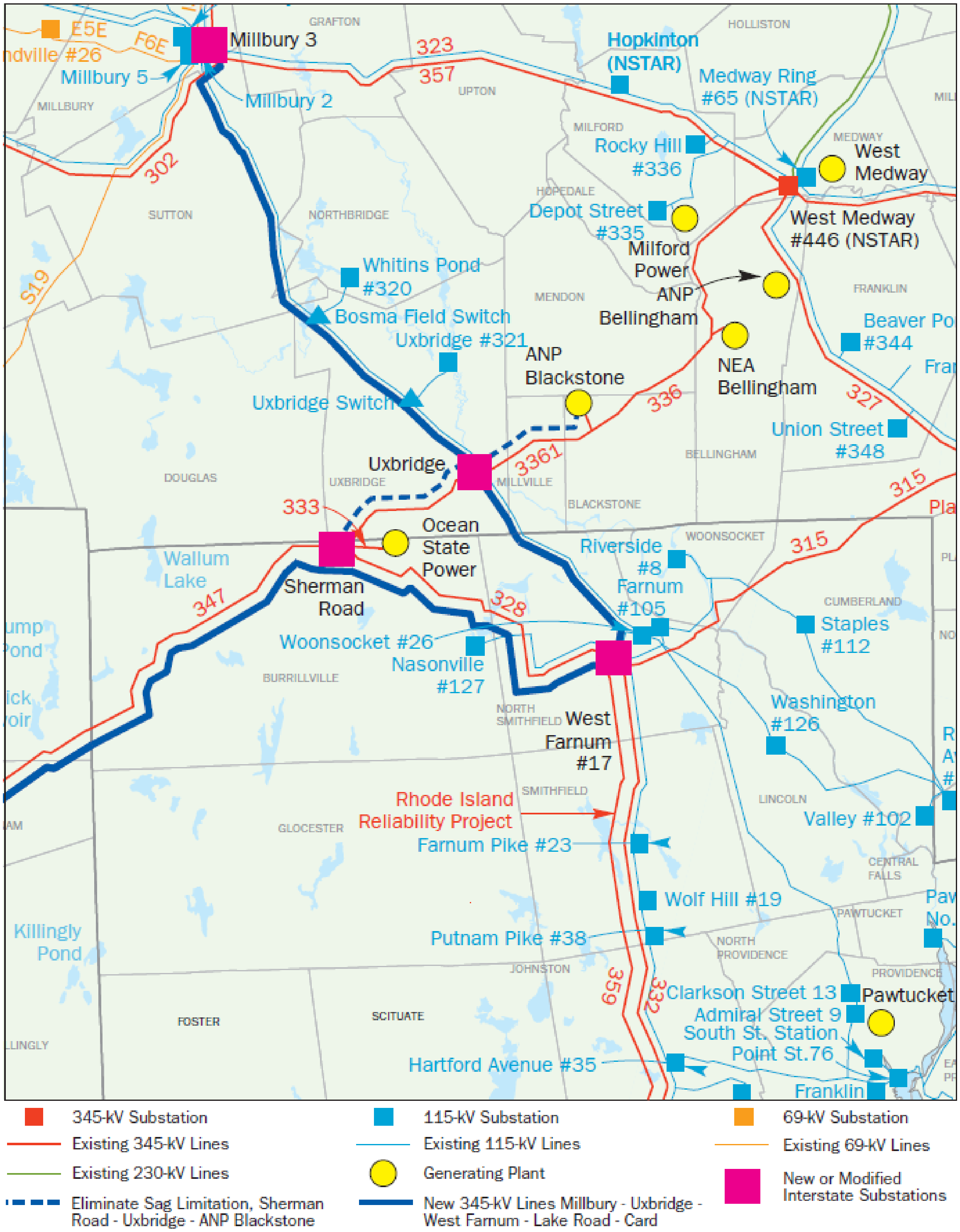
Note: Common upgrades at W. Medway and on the 336 line are not shown on map.

5.3.4 Interstate Option A-3

Option A-3 creates a new 345 kV connection between the Millbury No. 3 Switching Station, the West Farnum Substation, the Lake Road Switching Station, and the Card Street Substation, with a new switching station located in Uxbridge between the Millbury No. 3 Switching Station and the West Farnum Substation. The Uxbridge Switching Station also creates an interconnection with NSTAR's 3361 345 kV transmission line between the ANP Blackstone Substation and the Sherman Road Switching Station. Option A-3 is illustrated in Figure 5-3. Key components of Option A-3 include:

- A new 345 kV switching station in Uxbridge located at the intersection of National Grid's ROW and NSTAR's 3361 Line;
- A new 13.5-mile 345 kV transmission line from the Millbury No. 3 Switching Station to the new Uxbridge Switching Station;
- A new 6.7-mile 345 kV transmission line from the new Uxbridge Switching Station to the West Farnum Substation;
- A new 25.3-mile 345 kV transmission line from the West Farnum Substation to the Lake Road Switching Station;
- A new 29.2-mile 345 kV transmission line from the Lake Road Switching Station to the Card Street Substation;
- Increased conductor clearances on approximately 8.7 miles of existing 345 kV transmission lines between the Sherman Road Switching Station, the new Uxbridge Switching Station, and the ANP Blackstone Substation; and
- Upgrades to the Millbury No. 3 Switching Station, the Lake Road Switching Station, and the Card Street Substation, and reconstruction of the Sherman Road Switching Station.

Figure 5-3: Option A-3



Note: Common upgrades at W. Medway and on the 336 line are not shown on map.

5.3.5 Interstate Option A-4

Option A-4 creates a new 345 kV connection between the Millbury No. 3 Switching Station, the West Farnum Substation, the Lake Road Switching Station, and the Card Street Substation. It also adds a new 345 kV transmission line between the West Farnum Substation and the Sherman Road Switching Station. Option A-4 is illustrated in Figure 5-4. Key components of Option A-4 include:

- A new 20.2-mile 345 kV transmission line from the Millbury No. 3 Switching Station to the West Farnum Substation;
- A new 25.3-mile 345 kV transmission line from the West Farnum Substation to the Lake Road Switching Station;
- A new 29.2-mile 345 kV transmission line from the Lake Road Switching Station to the Card Street Substation;
- A new 9.2-mile 345 kV transmission line from the West Farnum Substation to the Sherman Road Switching Station; and
- Upgrades to the Millbury No. 3 Switching Station, the Lake Road Switching Station, and the Card Street Substation, and reconstruction of the Sherman Road Switching Station.

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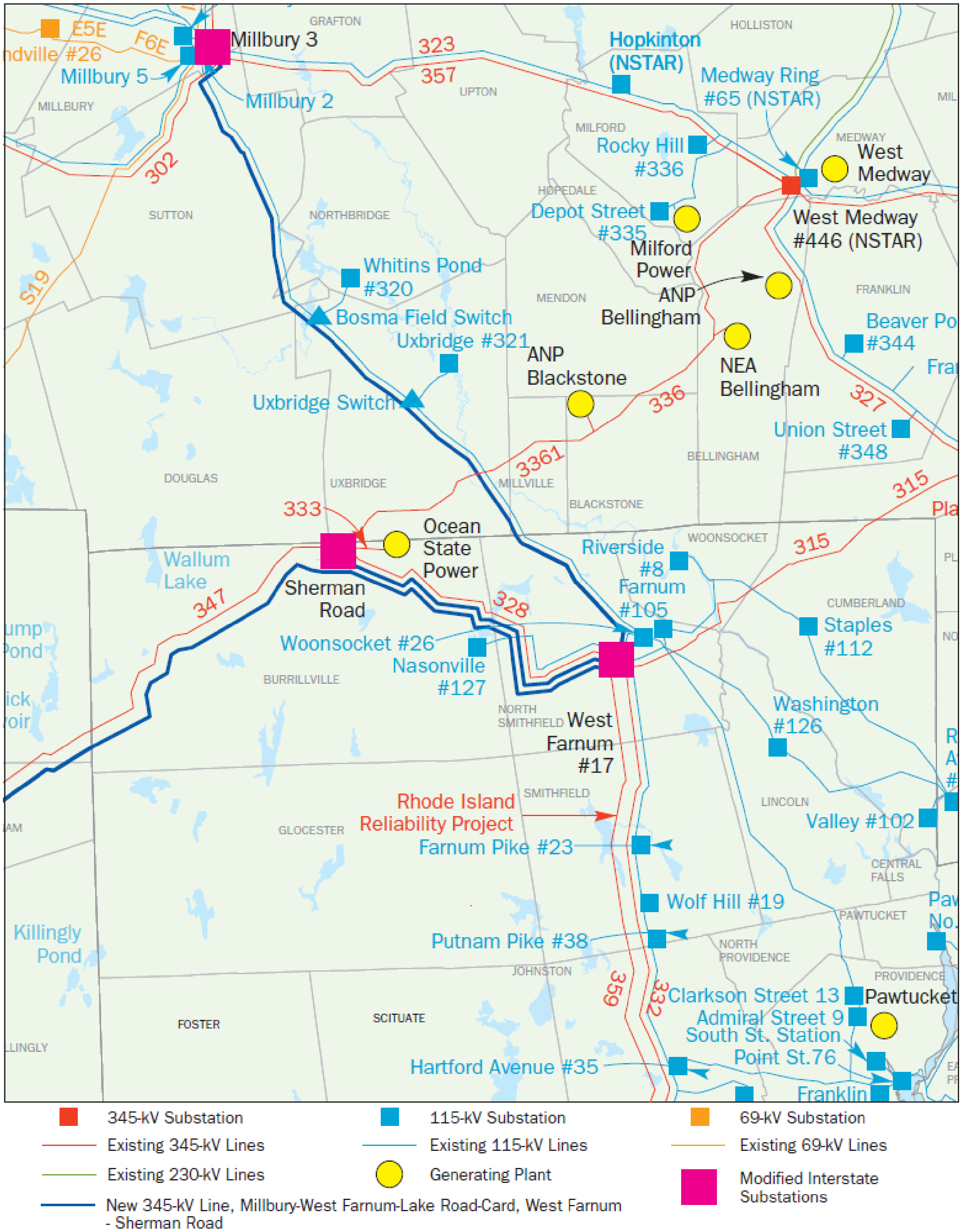
Figure 5-4: Option A-4



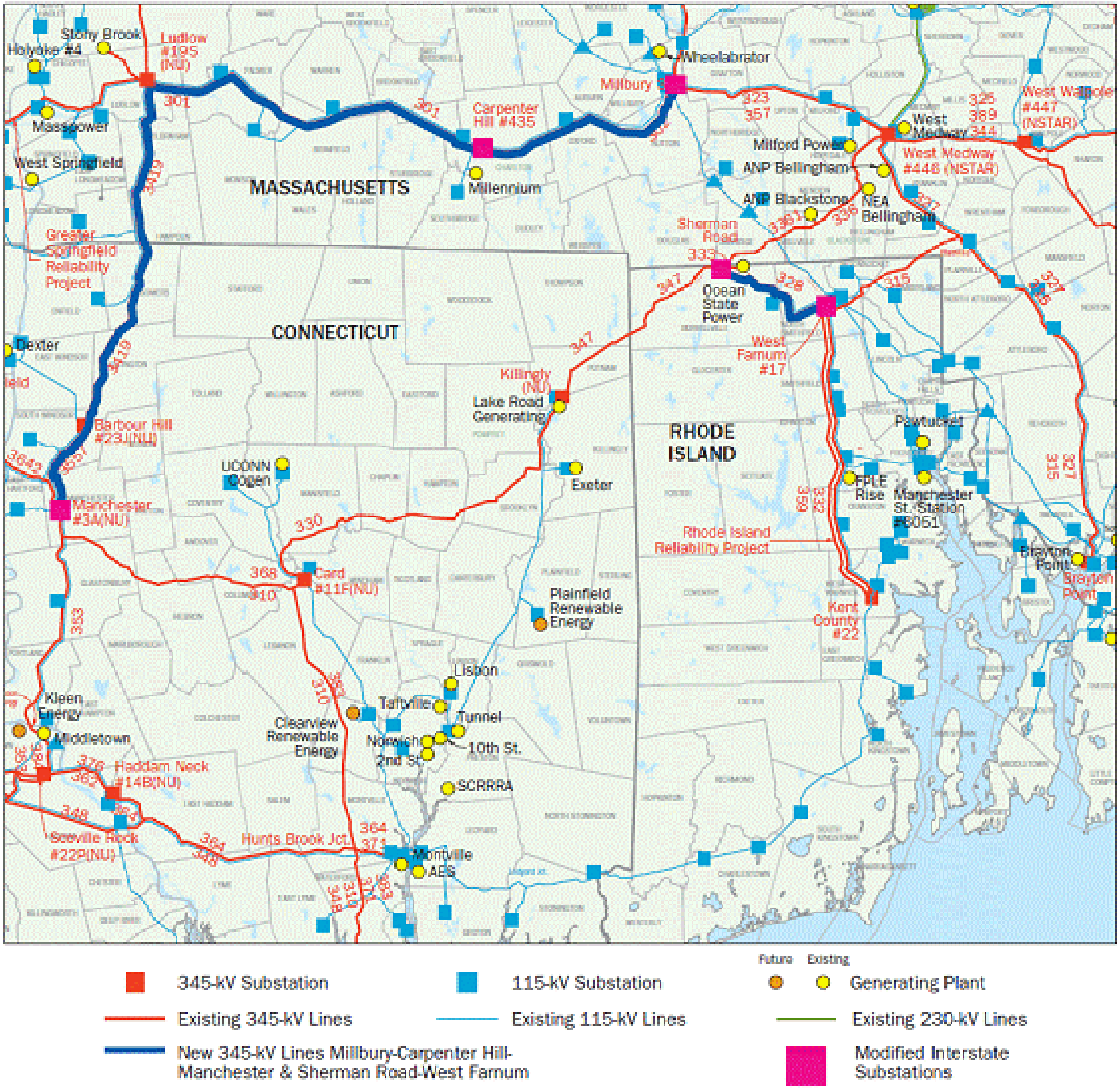
Note: Common upgrades at W. Medway and on the 336 line are not shown on map.

5.3.6 Interstate Option C-2.1

Option C-2.1 creates a new 345 kV connection between the Millbury No. 3 Switching Station, the Carpenter Hill Substation, and the Manchester Substation in Connecticut. It also adds a new 345 kV connection between the West Farnum Substation and the Sherman Road Switching Station. Option C-2.1 is illustrated in Figure 5-5. Key components of Option C-2.1 include:

- A new 16.0-mile 345 kV transmission line from the Millbury No. 3 Switching Station to the Carpenter Hill Substation;
- A new 59.1-mile 345 kV transmission line from the expanded Carpenter Hill Substation to NU's Manchester Substation in Manchester, Connecticut;
- A new 9.2-mile 345 kV transmission line from the West Farnum Substation to the Sherman Road Switching Station;
- Upgrades to the Manchester Substation, the Carpenter Hill Substation, the Millbury No. 3 Switching Station, and the Sherman Road Switching Station; and
- Upgrades to various area 115 kV transmission lines.

Figure 5-5: Option C-2.1



Note: Common upgrades at W. Medway and on the 336 line are not shown on map.

5.3.7 Assessment of Interstate Overhead Transmission Options

The Working Group undertook a comparison of the five overhead transmission options based on their electrical performance, cost, and impact on the natural and human environment. The Working Group evaluated the electrical performance of the five options under a broad range of system conditions and a variety of generation dispatches that stressed the transmission system. National Grid and NU were closely involved in this assessment, and ensured that it properly balanced reliability, cost, and environmental impacts. The Working Group's assessment is documented in the 2012 Solution Report, and is summarized below.

5.3.7.1 Electrical Performance

Electrical performance factors were used to compare the overall system benefits provided by each of the five options. The system upgrades associated with each option were designed to resolve all of the thermal and voltage issues identified in the 2011 Needs Assessment for the Southern New England transmission system over the 2015 to 2020 planning horizon. Each option was evaluated for its ability to improve the reliability and performance of the transmission system in the following areas:

- Improving the capability of the transmission system to move power into and within the load centers of Southern New England, specifically increasing the transfer capability across the following interfaces:
  - New England East-West interface
  - New England West-East interface
  - Connecticut import interface;
- Eliminating projected transmission line overloads and voltage performance issues following a contingency event;
- Providing acceptable short-circuit performance;
- Preventing degradation in stability performance during faults at major 345 kV switchyards in Southern New England;
- Minimizing generator torsional impact (Delta-P values) along the Card Street to West Medway corridor; and
- Maximizing ability for future expansion.

A detailed comparison of the electrical performance of the five options is provided in Section 7.2 of the 2012 Solution Report. In summary, the evaluation demonstrated that all five options would provide a level of electrical system performance that would meet design requirements for satisfying NERC, NPCC, and ISO-NE reliability standards and criteria. Options A-1, A-2, A-3, and A-4 provided generally comparable results with respect to transfer capability, transmission line loading, voltage performance, short-circuit impact, and generator torsional impact. Option C-2.1 was clearly inferior to the A-series options with respect to transfer capability, transmission line loading, and generator torsional impact, but performed better with respect to short-circuit impacts. Option A-1 was found to provide more system flexibility and expandability than any of the other options.

5.3.7.2 Cost

The Working Group prepared conceptual grade cost estimates (-25%/+50%) for each of the five IRP options, using a process consistent with ISO-NE procedures as defined in Attachment D of the ISO-NE Planning Procedure 4, *Procedure for Pool-Supported PTF Cost Review* ("PP-4").[21] Table 5-2 below summarizes the estimated cost of each option. Detailed cost estimates for each option are provided in Section 7.3 and Appendix I of the 2012 Solution Report (Appendix E).

Table 5-2: Conceptual Cost Estimates (in $ Millions) for Overhead Transmission Options (Massachusetts, Rhode Island, and Connecticut)

Option	Option A-1	Option A-2	Option A-3	Option A-4	Option C-2.1
Substations	$131	$168	$175	$148	$164
Transmission Lines	$411	$375	$378	$422	$550
Total	**$542**	**$543**	**$553**	**$570**	**$714**

Cost estimates in 2011 dollars

Options A-1, A-2, A-3, and A-4 are roughly comparable in cost, with Options A-1 and A-2 having the lowest cost estimate. Option C-2.1 is substantially more expensive than the other four options. Its estimated cost exceeds that of the A-Series options by $144 million to $172 million, or more than 25%.

5.3.7.3 Environmental Impacts

Section 7.4 of the 2012 Solution Report presents a two-stage comparison of the natural and human environmental impacts of the five overhead transmission line options. First, the A-series options are compared with Option C-2.1. Compared to the four A-series options, Option C-2.1 is longer overall and traverses more wetlands, watercourses, upland and wetland forests, parkland, and rare species habitat. Additionally, in Rhode Island, Connecticut, and Massachusetts, there are 942 residences within 500 feet of the C-2.1 centerline, as opposed to a range of 478 to 536 residences for the A-series options. Based on these factors, the 2012 Solution Report concludes that Option C-2.1 would have a greater potential for impacts to natural and human environmental resources than any of the A-series options.

Additional analysis was required to compare the four A-series options, due to their general similarities. This analysis evaluated potential for impacts in only Massachusetts and Rhode Island, since the four A-series options have identical facilities, and hence identical impacts, within Connecticut. Table 5-3 summarizes certain natural and human environmental characteristics of the

[21] http://www.iso-ne.com/rules_proceds/isone_plan/pp4_0_attachment_d.pdf

four A-series options that have the potential for environmental impacts within Massachusetts and Rhode Island.

Table 5-3: Environmental Impact of A-Series Options: Massachusetts and Rhode Island

Feature		Option A-1	Option A-2	Option A-3	Option A-4
New 345 kV Transmission Lines					
New 345 kV Transmission Line Length	Miles	37.9	35.6	37.9	46.9
Upland Forest Tree Removal	Acres	149.5	165.9	149.5	149.5
Wetland Forest Tree Removal	Acres	19.2	7.25	19.2	19.2
Upland Forest Tree Removal (Rare Species)	Acres	1.4	12.4	1.4	1.4
Forested Wetland Tree Removal (Rare Species)	Acres	2.1	0.6	2.1	2.1
Watercourse Crossings	Number	53	50	53	61
Parkland Traversed	Miles	2.1	2.1	2.1	3.2
Residences within 500 feet of Route Centerline	Number	319	265	319	319
Substations and Switching Stations					
Rebuilt Switching Station at Sherman Road		Yes	Yes	Yes	Yes
New AIS Switching Station at Uxbridge		No	No	Yes	No
Wetlands (permanently affected)	Acres	0.3	0.3	2.4	0.3
Upland Forest (permanently affected)	Acres	2.7	2.7	16.6	2.7

Source: Table 7-11 of 2012 Solution Report

As can be seen from Table 5-3, the work affecting the natural and human environment associated with the new 345 kV transmission line is identical for Options A-1 and A-3. However, the addition of a new 345 kV switching station on an undeveloped site in Uxbridge would create additional environmental impacts for Option A-3 relating to permanent wetland impacts and tree removal. Option A-1 is therefore superior to Option A-3 from the standpoint of natural and human environment impacts.

Table 5-3 indicates that the potential for natural and human environment impacts associated with the new 366 Line and substation work would be similar for Options A-1 and A-4, since they would occupy the same ROW. However, Option A-4 requires construction of a second new 345 kV transmission line, along a 9.2-mile ROW segment between Sherman Road and West Farnum. This would result in twice as many new foundations along this ROW segment, as well as additional work pads and roads to access structures for the second 345 kV transmission line, resulting in increased impacts to wetlands. Option A-1 is therefore superior to Option A-4 from the standpoint of natural and human environment impacts.

Table 5-3 indicates that the potential for natural and human environment impacts associated with Options A-1 and A-2 would be similar, with some features favoring A-1 and others favoring A-2.

One distinguishing difference between Options A-1 and A-2 is the work in rare species habitat. Along the Option A-2 route, for 3.4 miles of the NSTAR 3361 ROW between Sherman Road and Uxbridge, a presently-vegetated area approximately 75-feet wide would have to be cleared of trees to accommodate the new 345 kV transmission line. Much of this area is also within estimated habitat of rare species. Overall, development of Option A-2 would require 13.0 acres of tree removal within designated rare species habitat (12.4 acres of upland tree removal and 0.6 acres of wetland tree removal), while development of Option A-1 would require only 3.5 acres of tree removal within designated rare species habitat (1.4 acres of upland tree removal and 2.1 acres of wetland tree removal). The 12.4 acres of upland forest tree removal required by Option A-2 has much greater potential for taking of habitat and represents a serious environmental disadvantage as compared to Option A-1. Because preservation of known species habitat is a key concern of state regulatory agencies, the 2012 Solution Report concluded that Option A-1 is preferred from the standpoint of potential natural and human environment impacts.

5.3.8 Conclusions of the Working Group

Option A-1 emerged from the comparison process as the Working Group's preferred solution. In reaching this conclusion, the Working Group noted that its electrical performance testing demonstrated that the A-series options, as a group, performed slightly better than Option C-2.1. All the A-series options performed well electrically; however, future system expandability and flexibility considerations favored Option A-1 over the other A-series options.

The Working Group also noted that the A-series options are less expensive than Option C-2.1. Specifically, the estimated cost of Option C-2.1 is more than 25% greater than the estimated cost of the most expensive A-series option. The Working Group noted that the cost estimates for the four A-series options are within 5% of each other.

Finally, the Working Group concluded that Option A-1 is the preferred option from an environmental perspective. Option C-2.1 would have greater impacts on the natural and human environment than each of the A-series options. Option A-1 has a clear advantage over Option A-3, which requires a new switching station in Uxbridge, and over Option A-4, which requires the placement of two new 345 kV transmission lines along a 9.2-mile ROW segment between the Sherman Road Switching Station and the West Farnum Substation. The Working Group found that Options A-1 and A-2 have offsetting environmental advantages and disadvantages; however, Option A-2 would require 9.5 more acres of upland forest tree removal within designated rare species habitat than Option A-1. Overall, the reduced potential environmental impacts of Option A-1, combined with considerations of future system expandability, flexibility, and cost, led the Working Group to choose Option A-1 as the preferred IRP option.

5.4 NON-TRANSMISSION ALTERNATIVES

National Grid and NU engaged an expert consultant, ICF, to assess the potential for NTAs to defer or displace the full IRP. ICF's assumptions, methodology and findings are discussed briefly below, and detailed in a report titled *Assessment of Non-Transmission Alternatives to the NEEWS Transmission Projects: Interstate Reliability Project* dated December 2011 ("NTA Report"). A copy of the NTA Report is attached as Appendix K.[22]

The NTA Report focused on relieving the numerous thermal overloads identified in the 2011 Needs Assessment using reasonably available NTAs, including generation in the ISO-NE New England Generation Interconnection Queue ("Interconnection Queue"), utility-funded energy efficiency, demand response programs, and distributed generation. As discussed below, ICF determined that the development of the Massachusetts, Rhode Island, and Connecticut generation currently in ISO-NE's Interconnection Queue, combined with aggressive pursuit of demand resources in Massachusetts, Rhode Island, and Connecticut would eliminate some but not all of the potential thermal overloads identified in the 2011 Needs Assessment. The NTA Report considered the possibility of addressing the resource shortfall with active demand response.[23] The report concluded that the resulting hypothetical NTA would require unprecedented levels of active demand resources and would have capital costs ranging from $15.1 billion to $43.5 billion, depending on the assumed cost of active demand response.

5.4.1 ICF Methodology

In order to determine whether the addition of new demand and/or supply resources could provide a reliability solution equivalent to that of the IRP, the effect of such additions were tested in the same way that the reliability performance issues were found in the first instance, and in the same way that the proposed transmission improvements have been proven to be a solution: by running power-flow models to determine if reliability performance issues would be eliminated by the addition of the extra resources. To accomplish this, ICF first obtained from ISO-NE the power flow simulation data used

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[22] A copy of the report, redacted to avoid disclosure of CEII, is provided in the public record as Appendix K, and an unredacted copy will be provided to the EFSB and to eligible parties who have executed CEII Non-Disclosure Agreements, subject to a Motion for Protective Order.

[23] Resources for reducing customer demand are classified as either "passive" or "active." Passive demand resources are principally designed to save electric energy use and are in place at all times without requiring direction from the ISO. They include energy efficiency measures and distributed generation. Distributed generation refers to small customer-owned generators, the output of which reduces demand for utility-supplied power. Active demand-response resources are designed to induce lower electricity use at times of high wholesale prices or when system reliability is jeopardized, by offering customers payments in return for reducing consumption.

to evaluate the need for the IRP. It then translated that data so that it would be compatible with ICF's own power-flow simulation software, which is different from that employed by ISO-NE. ICF ran the ISO-NE power flow cases on its software and determined that the results of the pre-IRP power-flow simulations agreed with those of the 2011 Needs Assessment and that the results of its post-IRP simulations agreed with those that ISO-NE had obtained in the course of preparing the 2012 Solution Report.

ICF then projected the generation and demand-side resources that could be made available in Southern New England within the 5- to 10-year planning horizon (2015 and 2020), and simulated the operation of the New England transmission grid assuming the non-transmission resources were substituted for the IRP. Three NTA options were examined – passive demand resources, including energy efficiency and passive distributed generation,[24] new generation, and a combination of new generation and passive demand resources. The potential NTAs were tested using power-flow simulations, under assumptions consistent with the 2011 Needs Assessment. The ICF analysis focused on evaluating the performance of the NTAs in eliminating thermal overloads. Additional modeling would be required to determine if any particular NTA resolved or aggravated the pre-IRP voltage performance issues.

The primary power flow cases assumed that the Salem Harbor Generating Station remains in service through 2020; the retirement of the Salem Harbor Generating Station was addressed in a sensitivity analysis. Thus, the results tend to understate the capacity additions or demand reductions required in eastern New England.

5.4.2 Critical Load Level Analysis

ICF began its assessment of NTAs by conducting a critical load level ("CLL") analysis for the Southern New England states. The CLL is the demand level above which reliability performance issues begin to occur. Above this load level, upgrades of the electric supply system would need to be made to continue to support demand. The identified reliability performance issues resolved by IRP occur in three different sub-regions – eastern New England, western New England, and Rhode Island - under three different and mutually exclusive dispatch scenarios. Therefore, ICF determined a reasonable estimate of the CLL for Southern New England by first determining a sub-regional CLL for each of the three sub-regions and then totaling them to develop an estimate of the Southern New England CLL.[25] ICF determined that the incremental demand reduction required to achieve the CLL for 2015 was 3,400 MW, which amounts to 15% of the peak load predicted for that year. For 2020, the required incremental demand reduction is 5,300 MW, which amounts to 22% of the 2020 predicted peak load.

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[24] Energy efficiency programs and passive distributed generation (including passive renewables and distributed generation developed based on state net metering incentives) were included in ICF's estimates of passive demand resources.

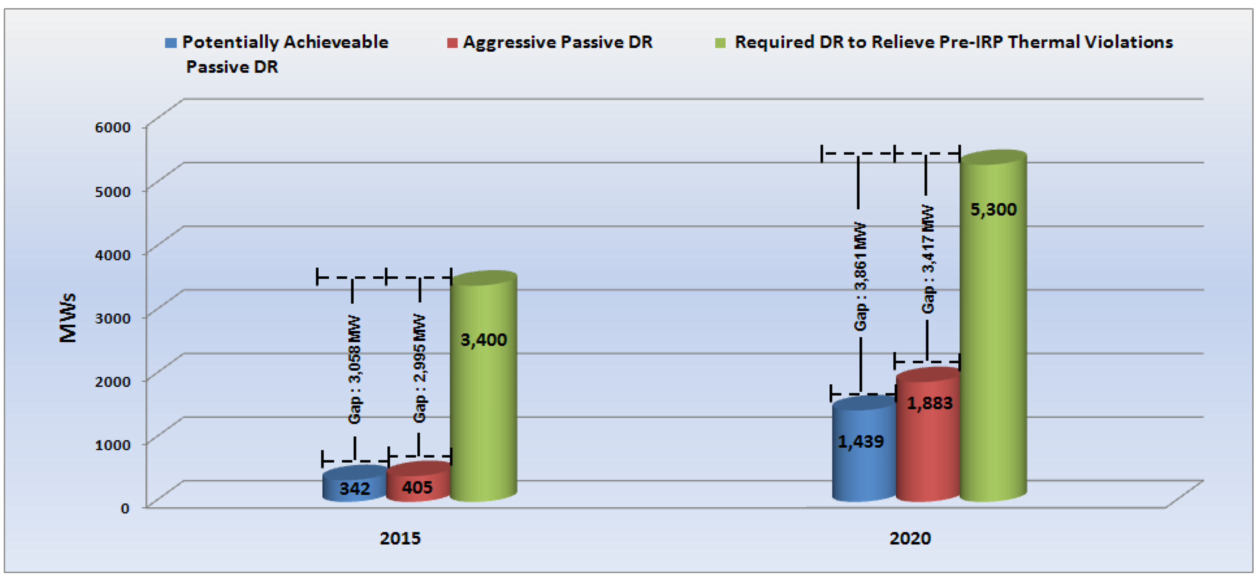
[25] ICF also conducted CLL analyses for Connecticut, treating the state first as an importing area and then as an exporting area. The Connecticut loads are included in the CLL for Western New England.

5.4.3 Assessment of Demand-Side Alternatives

After identifying the CLL for each sub-region and for Southern New England as a whole, ICF assessed whether it would be possible to reduce the peak demand to the CLL by relying entirely on demand resources. ICF analyzed the potential for incremental passive demand-side resources beyond those reflected in the 2011 Needs Assessment, which incorporated the demand measures embedded in the ISO-NE load forecasts and those procured through the ISO-NE FCA-4, held in August 2010.

Most demand resources result from programs sponsored by utilities under regulatory oversight. As such, they are subject to regulatory approvals at the state level, and also are frequently backed with state or ratepayer funding. Therefore, ICF first estimated achievable passive demand resource levels by examining the relevant programs in place in each of the three states in the study area and projecting two different potential future resource levels – a Reference DR Case and an Aggressive DR Case. The Reference DR Case assumed that utilities in each state would achieve incremental summer peak demand reductions equivalent to 100% of their current program goals each year until 2020. The Aggressive DR Case assumed that this level of summer peak demand reductions would be significantly exceeded. Neither case came close to reducing the demand level to the CLL. Figure 5-6 illustrates the gap between the CLL and the achievable passive demand resources for filling it.

Figure 5-6: Comparison of Achievable Incremental Passive DR to CLL Load Reduction in Southern New England – 2015 and 2020



5.4.4 Assessment of New Proposed Generation Alternatives

To determine if an NTA solution could be developed from new generation resources, ICF first reviewed the proposed projects in the Interconnection Queue as of April 1, 2011 to identify potential facilities in Southern New England that could be included in such a solution. The generation resources available in the Interconnection Queue, totaling 2,851 MW, were grouped into three categories based on their likelihood of being constructed:

- **Category 1:** Facilities with completed interconnection agreements (427 MW). These facilities have gone through various studies and all the steps in the approval process and were considered very likely to be developed.
- **Category 2:** Facilities with PPA approval in accordance with Section I.3.9 of the ISO-NE Transmission, Markets, and Services Tariff, excluding Category 1 facilities (1,904 MW).
- **Category 3:** All remaining facilities in the Interconnection Queue (520 MW). Units in Category 3 were considered to have the lowest probability of being developed.

Having identified and classified all potential generation resources in Southern New England, ICF undertook power-flow analyses to assess the ability of these resources to address the thermal conditions identified in the 2011 Needs Assessment. This analysis was performed first on a sub-regional basis to isolate the effects of alternate dispatch conditions; subsequently, sub-regional results were aggregated to determine the implications for Southern New England. In analyzing each sub-region, generation facilities from Category 1 were added to the 2015 and 2020 base power-flow cases, and the cases were analyzed under N-1 and N-1-1 contingency conditions similar to those analyzed in the 2011 Needs Assessment. The results were compared to those from the 2011 Needs Assessment, and any remaining or new thermal overloads were noted. If thermal overloads remained in any of the base power-flow cases, generation facilities from Category 2 were added to those cases and the contingency analysis and review of results repeated. The process was repeated with Category 3 resources if thermal overloads persisted after the addition of Category 2 resources.

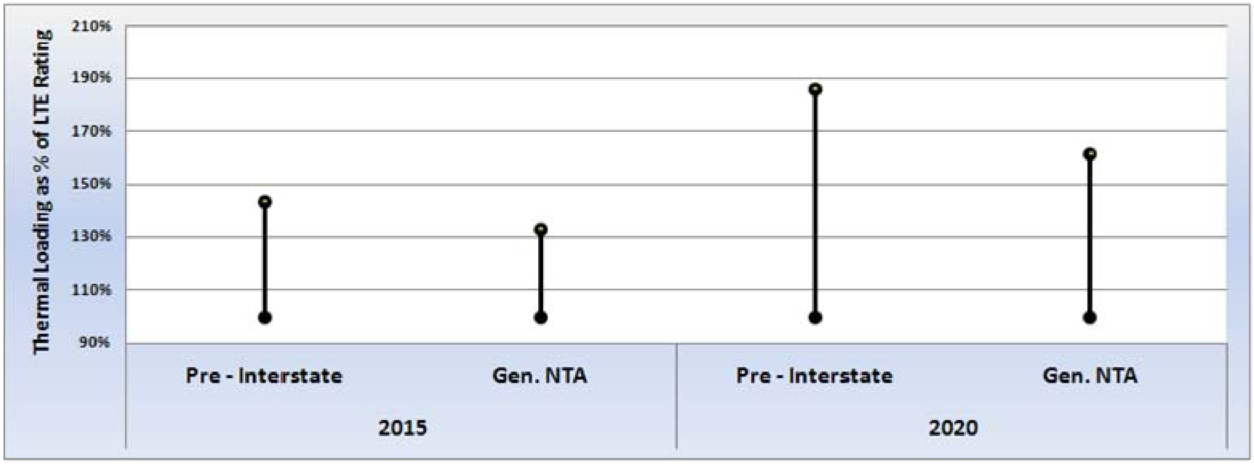
ICF modeled the Southern New England system with the addition of these generation resources, but without the IRP. The results of the simulation showed that no feasible generation NTA is available for Southern New England. The generation NTA would leave unresolved many of the thermal overloads addressed by the IRP. Table 5-4 summarizes the results of this simulation.

Table 5-4: Summary of Thermal Overloads for Generation NTA

	Number of Thermal Overloads			Number of Elements Overloaded		
Year	Needs Assessment	Generation NTA	% Reduction	Needs Assessment	Generation NTA	% Reduction
2015	206	90	56%	20	17	15%
2020	6,029	2,817	53%	53	31	42%

The severity of the remaining thermal overloads is shown in Figure 5-7. The generation NTA was more effective in reducing the number of overloads than the severity of overloads. Many of the most severe overloads still remained. In 2015, some transmission facilities exceeded their thermal limit ratings by 30%. In 2020, some thermal overloads were more than 60% higher than the rating of the facilities.

Figure 5-7: Range of Thermal Overloads in Southern New England – Generation NTA



5.4.5 Assessment of Combined Generation and Demand-Side Alternatives

Following its demand-side-only and generation-only analyses, ICF sought to develop a feasible NTA solution that combined generation with demand-side resources, including active demand response. As a first step, ICF supplemented the passive demand resources identified in its demand-side-only analysis with queued generation to develop a combined generation and passive demand resource NTA. ICF then analyzed the combination to determine if it would provide a feasible NTA solution. Having found that it would not, ICF considered whether the further addition of active DR resources could provide a solution. It determined that this would require an unprecedented level of growth in active DR resources, and that the cost of such an approach would be considerably higher than the cost of the IRP.

Table 5-5 summarizes the generation and passive demand resources used to develop two combination NTAs: the "Reference Combination NTA" and the "Aggressive Combination NTA". ICF used a sub-regional analysis to identify the generation and demand resources included in the combination NTAs. For each sub-region (Eastern New England, Western New England, and Rhode Island), ICF first assumed that all passive demand resources in the Reference DR case would be available, and then added generation as required to resolve the remaining thermal overloads in that sub-region. This resulted in the Reference Combination NTA. ICF repeated this process using the Aggressive DR case, resulting in the Aggressive Combination NTA.

Table 5-5: Reference and Aggressive Combination NTAs

Year	Reference Combination NTA		Aggressive Combination NTA	
	New Generation	New Passive DR	New Generation	New Passive DR
2015	896 MW	342 MW	896 MW	405 MW
2020	1,790 MW	1,439 MW	1,790 MW	1,883 MW

Power-flow simulations assuming the addition of these combinations of resources showed many remaining thermal overloads. Although the Reference Combination NTA reduced the number of thermal overloads compared to those shown in the 2011 Needs Assessment, in 2015, multiple contingencies would still cause 77 overloads on 16 facilities when the Reference Combination NTA is implemented. In 2020, there would still be 124 thermal overloads using the Reference Combination NTA. The results of the simulations are shown in Table 5-6.

Table 5-6: Summary of Thermal Overloads for Reference Combination NTA

Year	Number of Thermal Overloads			Number of Elements Overloaded		
	Needs Assessment	Combination NTA	Percent Reduction	Needs Assessment	Combination NTA	Percent Reduction
2015	206	77	63%	20	16	20%
2020	6,029	124	98%	53	19	64%

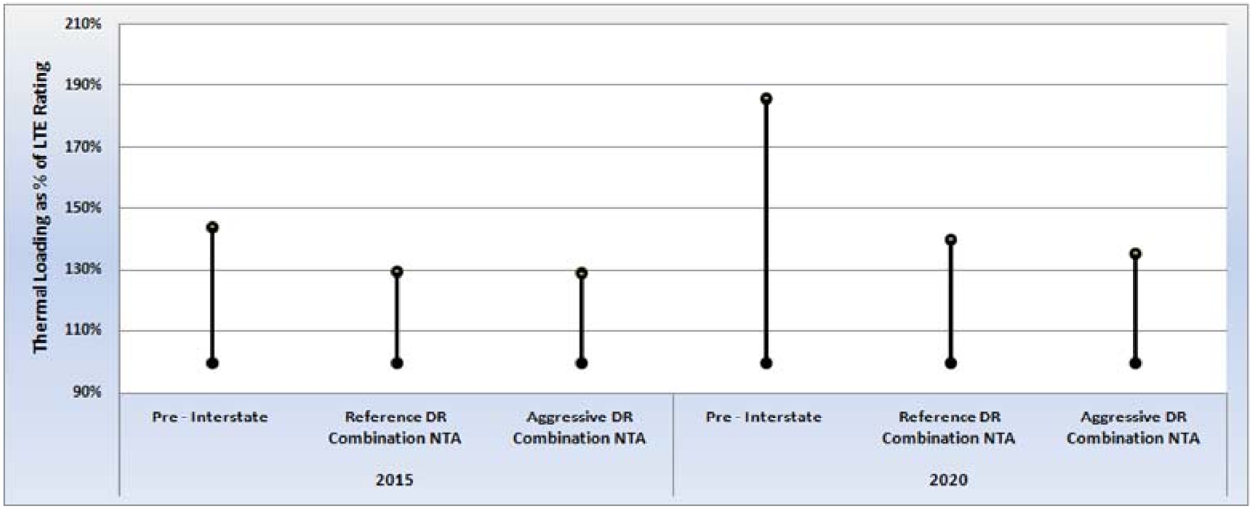
As shown in Table 5-7, the Aggressive Combination NTA slightly reduces the remaining thermal overloads as compared to the Reference Combination NTA.

Table 5-7: Summary of Thermal Overloads for Aggressive Combination NTA

Year	Number of Thermal Overloads			Number of Elements Overloaded		
	Needs Assessment	Combination NTA	Percent Reduction	Needs Assessment	Combination NTA	Percent Reduction
2015	206	72	65%	20	15	25%
2020	6,029	84	99%	53	17	68%

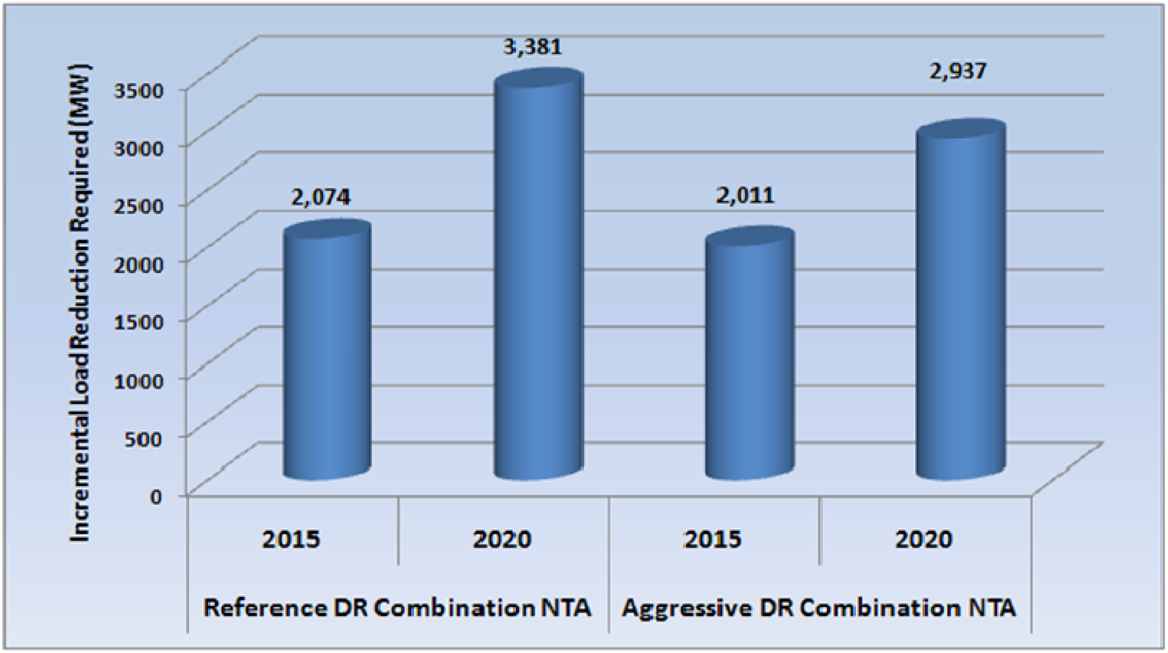
The severity of the thermal overloads is shown in Figure 5-8. The combination NTAs reduced the number of overloads significantly. They were also effective in reducing the severity of overloads. However, many severe thermal overloads still remained. For example, in both of the combination NTAs, some transmission facilities exceeded their Long-Term Emergency rating ("LTE") limits by approximately 30%.

Figure 5-8: Range of Thermal Overloads in Southern New England – Combination NTAs



ICF determined that a combination of generation assumed to be available by reason of its presence in the Interconnection Queue and potentially available passive demand resources would not provide a sufficient combination NTA. ICF then went on to consider whether the addition of potentially available active demand resources could enable a combination NTA to provide performance equivalent to that of the IRP. As it did in its CLL analysis, ICF determined the additional load reduction required to resolve all the thermal overloads that IRP addresses. ICF then estimated the additional active demand resource capacity that would provide the required load reduction. Figure 5-9 shows the load reduction that would be required from active demand resources to produce a combination NTA solution.

Figure 5-9: Combination Case Incremental Required Load Reduction to Achieve an NTA in Southern New England – 2015 and 2020



Estimating the level of active demand resources required to achieve this load reduction was challenging, because active demand resources, unlike traditional generators and energy efficiency measures, do not have a long track record from which future performance may be projected. ICF used the performance factors developed by ISO-NE for use in its 2011 FCA-5 to calculate the required amount of active demand resources in each sub-region, and then aggregated the sub-regional values to determine the values for Southern New England. Table 5-8 illustrates the level of active demand resources that would need to be available, in combination with the Aggressive Combination NTA, to produce an NTA solution. Higher levels of active demands resources would be required for the Reference Combination NTA.

Table 5-8: Active DR Required for the Aggressive Combination NTA

Parameter	Combination NTA 2015		Combination NTA 2020	
	No Derate	FCA-5 Derate	No Derate	FCA-5 Derate
FCA-5 (2014/15) Qualified Active Demand Response Resources (MW)[1]	1,102			
Incremental Active DR Required to Eliminate Thermal Overloads in the Combination Case (MW)	2,011	3.381	2,937	4,871
Total (cumulative) DR Required (MW)	3,113	4,483	4,039	5,973
Average Annual Percentage Growth	182%	207%	24%	33%

[1] The qualified resources from FCA-5 are used as a proxy for the total available demand response resources available for the summer of 2014 as of today. Total is shown for only the Massachusetts, Rhode Island, and Connecticut load zones, as the areas of concern. The total qualified Real Time Demand Response Resource for all of New England is 1,667 MW. Within Rhode Island, Connecticut, and Massachusetts load zones, 1,207 MW of capacity qualified; of this total, 105 MW were accepted for delist, resulting in qualified Real Time Demand Response Resources of 1,102 MW in Southern New England.

The capital costs required to achieve these unprecedented levels of active demand resources over 30 years is estimated to range from $8.5 billion to $37.3 billion, resulting in total capital costs of $15.1 billion to $32.7 billion for the Aggressive Combination NTA, and $18.7 billion to $43.5 billion for the Reference Combination NTA. Furthermore, in order to achieve these levels of active DR, the compound annual average growth rate in active DR would have to be between 24% and 33% until 2020. ICF did not view this as a realistic target. Accordingly, ICF concluded that potentially available active demand resources could not fill the gap, so that potentially available generation resources and active and passive demand resources are not sufficient to develop a feasible combination NTA solution.

5.4.6 Sensitivity Analyses

Following this analysis, ICF modeled two sensitivity scenarios. In one, it assumed the Salem Harbor Generating Station to be retired, in accordance with an announcement made by the owner and a directive from ISO-NE, both of which occurred after ICF began its work. Under this scenario, the performance of the combination NTAs were substantially worse, indicating the potential vulnerability of the NTA to the retirement of existing plants. In the other sensitivity scenario, ICF assumed the addition of a generic 1,400 MW incremental supply source in Tewksbury, Massachusetts. Even that very large resource increment, in addition to the Aggressive Combination NTA, did not eliminate all of the thermal overloads.

5.4.7 Conclusion – Non-Transmission Alternatives

Based on the findings of the ICF study, National Grid concluded that: (1) the construction of new ISO-NE queued generation would not meet the identified need; (2) aggressive implementation of demand-side management, including energy efficiency, distributed generation, and demand response programs would not meet the identified need; and (3) a combination of central generation and demand-side management would not meet the identified need. Moreover, even if a combination of

ISO-NE queued generation and demand-side management could be developed that was indeed able to meet the identified need, it would be substantially more costly than the IRP. Furthermore, implementation of an NTA, were one to exist, would be challenging, compared to implementation of IRP, as it would involve many parties, locations, and resources. Thus, any NTA that could be designed by including even more resources than were tested in the ICF studies would not be practical and feasible. Because none of the NTAs would meet the identified need at a reasonable cost, it was not necessary to analyze the environmental impacts associated with the NTAs and the Company did not bring these alternatives forward for further consideration.

5.5 ALTERNATIVE OVERHEAD ROUTES

To verify that no preferable alternative overhead routes exist for the new 345 kV transmission lines between the Rhode Island/Massachusetts border and the Rhode Island/Connecticut border, with an interconnection with the West Farnum Substation, National Grid examined the general vicinity and the orientation of east-to-west options for possible alternatives to the proposed route using the existing developed ROWs (Refer to Figure 5-10).

5.5.1 Public Streets and Highways

National Grid examined the use of public streets and highways for the proposed 345 kV transmission lines. The majority of the available road layouts would not be wide enough to accommodate an overhead 345 kV line while complying with applicable code clearances to adjoining property lines. As a result, this alternative would require the acquisition of new ROW along the edge of the existing roadways. This would add significantly to the cost and would delay the schedule of the Project. It would also cause impacts to and possible displacement of homes, businesses and other adjoining development and land uses. In addition, this alternative would render the new transmission line very visible along the commonly traveled roadways. Since there is a viable alternative using an existing, dedicated utility corridor that could be delivered in a timelier manner with lower impacts and costs, this option was rejected.

5.5.2 Use of Existing Pipeline Rights-of-Way

Existing pipeline ROWs were examined for co-location opportunities with the proposed transmission lines in Rhode Island. Three interstate pipelines were identified within the project area, including facilities operated by Algonquin Gas Transmission (“AGT”), Tennessee Gas Pipeline (“TGP”), and ExxonMobil Pipeline Company (“ExxonMobil”).

AGT’s facilities in the vicinity of the project deliver natural gas from the Cromwell and Chaplin Compressor Stations in Connecticut east to the Burrillville Compressor Station in Burrillville, Rhode Island. From the Burrillville Compressor Station, natural gas is delivered east to the Ocean State Power Generating Plant, and northeast to the AGT Bellingham Meter and Regulator Station. From this point natural gas is transported to the Boston and southeast Massachusetts service areas. AGT has a 75-foot ROW that contains two natural gas pipelines. There is an existing AGT pipeline crossing of the National Grid ROW located west of Wilson Trail in Burrillville, Rhode Island, and an approximate 1-mile longitudinal occupation with National Grid's ROW, in the vicinity of the Sherman Road Switching Station. Refer to Figure 2-2 map sheet 4, and map sheets 16-17 for these pipeline locations.

Co-location of a portion of the 341 Line along the AGT ROW was evaluated. An overhead route variation would start at the Sherman Road Switching Station and follow the AGT ROW west across Burrillville and into Connecticut, ending at the approximate location of the Chaplin Compressor Station in Chaplin, Connecticut. This route alternative would require National Grid to acquire additional new ROW (approximately 125 feet in width). This new ROW would require tree clearing and vegetation removal, and the construction of a new access road, as the access road along the AGT line would not support the equipment and vehicles needed to construct a new 345 kV transmission line. Since this overhead route alternative would require additional land acquisition, would result in additional impacts to the natural and social environments, and would increase project costs, it was removed from further consideration.

TGP's facilities in the project area deliver natural gas east to their Hopkinton Compressor Station in Hopkinton, Massachusetts. Pipeline systems from the Hopkinton Compressor Station transport natural gas to the Mendon Compressor Station in Mendon, Massachusetts, and then into Rhode Island, including one pipeline that runs south to the Cranston Sales Station in Cranston, Rhode Island, and a second pipeline that transports natural gas to the Ocean State Power Generating Plant in Burrillville, Rhode Island, and then loops back into the TGP main line. One of the TGP pipelines has an approximate 7-mile longitudinal occupation with National Grid's 341/328 transmission line ROW in the towns of North Smithfield and Burrillville (refer to Figure 2-2 map sheets 16A-28). TGP's permanent ROW varies in width and is typically 20 feet wide. The co-location of the TGP and National Grid facilities begins in the vicinity of the TGP pipeline crossing of the National Grid ROW at Matitty Road in North Smithfield and ends in the vicinity of the Sherman Road Switching Station in Burrillville, Rhode Island.

ExxonMobil operates a petroleum pipeline that delivers batched petroleum products from its facility distribution terminal in East Providence, Rhode Island, northwest to its distribution terminal in Springfield, Massachusetts. ExxonMobil's ROW varies in width from 16 feet to 33 feet and contains a single pipeline. ExxonMobil's pipeline occupies approximately 2.5 miles of shared longitudinal occupation with the 366 Line ROW, in the town of North Smithfield, north of the West Farnum Substation (refer to Figure 2-2 map sheets 33-39).

After consideration of the various pipeline ROW alternatives, National Grid determined that constructing the new 345 kV transmission lines parallel to existing TGP or ExxonMobil pipeline ROWs did not offer a distinct geographical route. In addition, use of any of the pipeline ROWs would require land acquisition, and would result in increased environmental impact and cost. Therefore these alternatives were not escalated for further study.

5.5.3 Massachusetts "Noticed Alternative" Route

The IRP, which includes facilities in Rhode Island, Massachusetts and Connecticut, requires approval from the EFSB, the MA EFSB, and the CSC. The MA EFSB process requires a utility to identify and compare two possible routes for the Project, including a Proposed Route and a Noticed Alternative Route. The MA EFSB regulations require that the alternative route must be both practical to build and geographically distinct from the proposed route.

National Grid has identified and developed a Noticed Alternative Route that extends from the Millbury No. 3 Switching Station in Millbury, Massachusetts, to the West Farnum Substation in North Smithfield, Rhode Island, along existing transmission ROWs that are distinct from the Proposed Route. The total length of this alternative route is approximately 37 miles, of which approximately eight miles would be in Rhode Island. As illustrated in Figure 5-10, the Noticed Alternative Route runs through the municipalities of Millbury, Upton, Grafton, Milford, Medway, Bellingham, Franklin and Wrentham, Massachusetts and continues through the communities of Cumberland, Woonsocket and North Smithfield, Rhode Island.

The Proposed Route and the Noticed Alternative Route would provide comparable system reliability and use similar overhead transmission line technologies. However, the Noticed Alternative Route is approximately 17 miles longer than the Preferred Route and would require reconstruction of existing 345 kV and 115 kV transmission lines in order to provide space for the new 345 kV transmission line within the corridor. As such, the cost of the Noticed Alternative Route from the Millbury No. 3 Switching Station to the West Farnum Substation is approximately three times the cost of the Proposed Route between the same substations. In addition, after a review of the environmental impacts along the Notice Alternative Route, National Grid determined that the impacts from the Noticed Alternative Route would be greater than the Proposed Route. Based on these analyses, National Grid concluded that the Proposed Route will meet the project need and reliability criteria at a lower cost to customers with less impact to the environment.[26]

5.5.4 Summary of Alternative Overhead Routes

After an evaluation of route alternatives, National Grid determined that the Proposed Route was preferable to use of public streets and highways, use of the pipeline ROWs, and the use of the Massachusetts Noticed Alternative Route.

5.6 OVERHEAD ALTERNATIVES USING THE EXISTING ROW

Several alternative configurations for constructing the Project within the existing National Grid ROWs were considered. Several different types of structures could be used to support the transmission line conductors. National Grid examined these possible alternatives in detail to

[26] If the MA EFSB were to order construction of the Noticed Alternative Route, National Grid would withdraw the portion of its Rhode Island Application covering the 366 Line, prepare a new Application for the 366 Line on the Noticed Alternative Route, and re-file with the EFSB.

determine the advantages and disadvantages of each, as compared to the proposed option of installing the Project on steel H-frame structures. National Grid assessed the impacts of several overhead design alternatives on Project cost, reliability, visibility of the structures, wetlands, and the level of disturbance caused by construction. The following sections describe the alternatives considered and their advantages and disadvantages.

5.6.1 Construct Interstate Using Davit-Arm Structures

As proposed, the Project will use direct buried weathering steel H-frame structures to support the conductors in a horizontal configuration along with two shield wires. As an alternative, National Grid evaluated using davit-arm structures to support the conductors, shield wire and OPGW. Each davit-arm structure would consist of a reinforced concrete caisson foundation mounted single shaft steel pole supporting the conductors in a davit-arm configuration. Two shield wires (one EHS and one OPGW) would be supported from arms extending from the top of the pole.

The davit-arm structure alternative was determined to have the following advantages and disadvantages relative to the proposed H-frame structure:

- Davit-arm structures would be approximately 35 feet taller than H-frame structures on average, and as such would be more visible.
- Davit-arm structures and H-frame structures would be relatively comparable in terms of their allowable span lengths, and as such, both designs would utilize approximately the same number of structures along the transmission line route.
- Davit-arm structures and H-frame structures are comparable in terms of their structural reliability.
- Davit-arm structures and H-frame structures are comparable in terms of their electrical reliability and performance.
- Davit-arm structures would have a narrower configuration than H-frame structures, utilizing less room on the ROWs and necessitating about 25 feet less tree removal than the proposed H-frame structures.
- Because davit-arm structures require large reinforced concrete caisson foundations, they would approximately double the required excavation for installation as compared to the use of direct buried H-frame structures, would significantly increase the level of access road improvements required for the Project, and increase the size and configuration of construction work pads required for installation of the caisson foundations and structures. The estimated footprint of the davit-arm structure is approximately 79 square feet per structure, whereas the direct embedded H-Frame structure has a footprint of approximately 48 square feet per structure.
- Davit-arm structures would be more expensive than the proposed H-frame configuration.

After considering the relative advantages and disadvantages of utilizing davit-arm structures, National Grid concluded that use of H-frame structures for the Project offered more advantages, created fewer impacts, and was a more cost-effective solution.

5.6.2 Construct Interstate Using Double-Circuit Davit Arm Structures

As an alternative to constructing the Project using H-frame structures, National Grid also evaluated use of a double-circuit structure to carry the new and existing transmission lines that also occupy the ROWs in Rhode Island. With this configuration, the two circuits would be constructed on a common structure. To achieve this configuration, the new line and an existing circuit would be constructed on a common single-shaft steel structure and the existing parallel transmission line would be removed from its present location. National Grid determined that the double-circuit structure alternative had the following advantages and disadvantages relative to the proposed H-frame structure:

- The use of double-circuit structures to combine two 345 kV circuits, such as those that occupy the 341 Line ROW, would not comply with transmission planning criteria and this would not meet the identified Project need.
- Double-circuit structures would be inferior to single-circuit H-frame structures in terms of their electrical reliability and performance. Common mode failure of double-circuit structures could result in loss of both lines. Double-circuit structures would increase the risk of a lightning strike or single transmission line fault causing both transmission lines to be interrupted simultaneously.
- Use of a double-circuit structure could reduce tree removal requirements in portions of the ROW.
- Double-circuit structures and H-frame structures would be relatively comparable in terms of their allowable span lengths, and as such, both designs would utilize approximately the same number of structures along the transmission line route.
- Double-circuit structures and single-circuit H-frame structures would be comparable in terms of their structural reliability.
- Each double-circuit structure would require a reinforced concrete caisson foundation, as opposed to the H-frame structures which would only require concrete foundations at points of line angle and dead-end locations. The additional foundations required for the double-circuit alternative would significantly increase the excavation and soil disturbance required for installation, and would increase the potential for impacts (access roads, construction pads, support work pads) to environmental resources.
- Double-circuit structures would typically be approximately 50 feet taller than single-circuit H-frame structures, and as such would be more visible.
- The larger and heavier steel structures required for a double-circuit transmission line, together with the need to get concrete trucks to each foundation location along the

transmission line route would significantly increase the level of access road improvements required for the Project, and the impacts associated with those improvements.

- The use of double-circuit structures would significantly increase the installed cost of the Project.
- Constructing a double-circuit transmission line would unnecessarily remove, retire and replace existing transmission line segments which are functioning adequately.

After considering the relative advantages and disadvantages of utilizing double-circuit structures, National Grid concluded that utilizing single-circuit H-frame structures for the Project offered more advantages, created fewer impacts, and was a much more cost-effective solution.

5.7 UNDERGROUND TRANSMISSION ALTERNATIVE

Because there are existing overhead transmission corridors between the Project endpoints, the Company focused primarily on overhead transmission alternatives that would meet the identified Project need, and that would utilize existing overhead transmission line corridors. Nevertheless, National Grid developed an underground alternative to compare with the potential overhead transmission line configurations for the IRP. Underground transmission lines typically have much higher installation costs than overhead transmission lines. Underground transmission cables, particularly long underground cables, have very different electrical characteristics than overhead transmission lines. This can lead to operational issues, and can require additional system reinforcements to address these issues. Construction techniques for underground transmission lines create different environmental impacts than overhead transmission line construction. Reliability issues associated with underground transmission lines are different than those associated with overhead transmission lines. In developing the underground alternative, the Company attempted to address these differences between overhead and underground transmission lines.

5.7.1 Selection of Potential Underground Routes

Within Rhode Island, there are portions of two 345 kV transmission lines associated with the Project. These lines are:

- The 366 Line from the West Farnum Substation to the Millbury No. 3 Switching Station; and
- The 341 Line from the West Farnum Substation to the Lake Road Switching Station.

National Grid developed underground alternatives for each of these transmission lines. The route development process for each line segment is discussed separately in the following sections.

5.7.2 West Farnum Substation to the Millbury No. 3 Switching Station

National Grid considered three potential underground routes for the 366 Line between the Millbury No. 3 Switching Station and the West Farnum Substation:

- The existing overhead transmission ROW between the Millbury No. 3 Switching Station and the West Farnum Substation;
- The Route 146 limited access highway corridor; and
- The existing public roadway network.

5.7.2.1 Existing Overhead ROW - Millbury No. 3 Switching Station to the West Farnum Substation

At a screening level, the Company considered both the advantages and disadvantages of utilizing the overhead ROWs for underground transmission line installation. The advantages of installing an underground transmission line along the existing overhead ROW corridor include use of an existing utility corridor, fewer traffic impacts during construction than if a roadway route were used, and a somewhat shorter route in this particular case. These factors might lead to slightly lower costs and lower human environment impacts than a roadway underground route.

However, the existing overhead ROWs between the Millbury No. 3 Switching Station and the West Farnum Substation is ill-suited for an underground transmission line for a number of reasons. The ROWs traverse multiple wetlands and wetland buffer zones, and crosses multiple waterbodies. With overhead construction, it is frequently possible to span wetlands and other sensitive resource areas. This has been demonstrated on these ROWs with the existing transmission lines, and is proposed for the new overhead transmission line. With underground construction, it is necessary to either trench the entire route, or to use trenchless techniques such as horizontal directional drilling (“HDD”). Trenchless installation techniques create additional design, construction, and economic issues, and have their own associated environmental issues. Underground transmission construction techniques have the potential to cause an increase in short and long term impacts to wetlands and other environmental resources along the overhead ROWs.

In addition to environmental resource issues, there is significant visible rock along portions of the ROWs, which would make constructing an underground transmission line difficult and costly. There are also areas of steep grade changes and rock cliffs that would make it difficult to install underground lines.

A substantial permanent access road would need to be constructed along the ROWs for purposes of construction and maintenance of an underground line, causing permanent impacts to the ROWs, and potentially affecting wetlands, stream crossings, rare species habitat, and other environmental resources.

Finally, National Grid does not own the majority of the overhead ROWs in fee, but rather holds easements. These easements generally do not include the right to install underground lines. Acquisition of the underground rights from numerous parties would significantly increase the timeframe for this alternative, and has the potential to increase cost of this routing alternative as well.

These constraints and considerations led National Grid to dismiss the existing overhead ROWs as a potential route for an underground transmission line.

5.7.2.2 Route 146 Limited Access Highway Corridor - Millbury No. 3 Switching Station to the West Farnum Substation

The Route 146 limited access highway alignment passes relatively close to the Millbury No. 3 Switching Station and the West Farnum Substation. As such, it represents a potential routing opportunity for an underground transmission line. On a screening level, National Grid examined use of this alignment. There would be several challenging issues with using this route for an underground transmission line:

- The RIDOT *Rules and Regulations for Accommodating Utility Facilities Within Public Freeway Rights-of-Way (2002)*, Rule 3.3, indicates the following restrictions on longitudinal co-locations: "Longitudinal installation of utility facilities within a Freeway right-of-way are permitted only when there is no feasible or prudent alternative to the installation of said facility." The proponent of the utility must demonstrate "That alternative locations are not available or cannot be implemented at reasonable cost, from the standpoint of providing efficient utility services in a manner conducive to safety, durability, and economy of maintenance and operations; that the accommodation will not adversely affect the design, construction, operation, maintenance or stability of the freeway; and that it will not interfere with or impair the present use or future expansion of the freeway."
- The Massachusetts Department of Transportation ("MassDOT") has similar restrictions for longitudinal utility installation along limited access highways.
- There are a number of areas where the Route 146 alignment passes through large rock-cut areas. Installing underground transmission through these areas would be difficult.
- There are a number of bridges in this alignment where Route 146 passes over local roads or streams/rivers. Such bridges are typically not designed to accommodate utility lines, so alternate means would be needed to traverse these areas.

Use of the Route 146 corridor as an underground transmission route was dismissed for these reasons.

5.7.2.3 Public Roadways – Millbury No. 3 Switching Station to the West Farnum Substation

There can be several advantages to installing an underground transmission line along the public roadway network, as compared to using the overhead ROWs or the Route 146 highway corridor for an underground transmission line. These relative advantages could include:

- Reduced impacts on the natural environment. By using the established roadway network, most construction would not directly impact wetlands or environmentally sensitive areas. Some construction could fall in areas where the roadway is within wetland buffer zones. In these cases, suitable environmental controls and BMPs would be employed to control sedimentation.

- There would likely be less rock removal with a roadway network route, since original road construction would have graded and removed a portion of the rock along the route. Roadway geometry generally is more suitable for underground transmission installation, since there would not be rock cliffs or other extreme grade changes to contend with.
- Access for ongoing maintenance is generally simpler within the roadway network.
- In general, rights for installation of underground facilities within the roadway network are obtained via a utility permit from a limited number of agencies (municipal Departments of Public Works, RIDOT, MassDOT, etc.)

There are some potential disadvantages to using the roadway network for an underground transmission line:

- During installation of the conduit and manhole system, there would be construction related impacts on vehicular traffic. There would also be some traffic impacts during cable installation and splicing, but these would be confined to manhole locations.
- In this case, the roadway route is somewhat longer than the overhead ROW route.

Overall, National Grid concluded that the roadway network provided fewer environmental and property acquisition issues, and had significant operational benefits as compared to installing an underground transmission line on the overhead ROW or along the Route 146 alignment. For these reasons, an underground route was developed using the existing public roadway network.

The underground route was developed as a reasonably direct connection between the West Farnum Substation and the Millbury No. 3 Switching Station, and should be considered as generally representative of a roadway underground route. Other roadway routes would be approximately the same length or longer, and would be expected to have similar costs, electrical issues, and environmental issues. In the event that an underground transmission solution became preferred, a more detailed routing analysis would be performed.

Starting at the West Farnum Substation, the representative underground route follows the overhead transmission ROW west for a short distance to the intersection with Route 5, proceeds north on Route 5 to Route 146A in Slatersville, and continues on Route 146A to the Massachusetts border (North Smithfield, Rhode Island and Uxbridge, Massachusetts). From there, the representative underground alternative route continues in Massachusetts along Route 146A in Uxbridge, Route 122 from Uxbridge to Millbury, and Route 122A in Millbury. In Millbury, the representative route would cross the Blackstone River and traverse a short section of the overhead ROW, ending at the Millbury No. 3 Switching Station. This route is shown in Figure 5-11. The total underground distance in Rhode Island would be 4.7 miles and within Massachusetts would be approximately 17.1 miles, for a total underground length of approximately 21.8 miles.

5.7.3 West Farnum Substation to the Lake Road Switching Station (Killingly, CT)

As with the Millbury to West Farnum transmission line, National Grid examined routing opportunities for an underground transmission line between the West Farnum Substation and the Rhode Island/Connecticut border (continuing in Connecticut to the Lake Road Switching Station). National Grid identified two potential routing opportunities for an underground transmission line:

- The existing overhead transmission ROW between the West Farnum Substation and the Rhode Island/Connecticut border; and
- The existing public roadway network.

5.7.3.1 Existing Overhead ROW - West Farnum Substation to the Lake Road Switching Station

As with the Millbury to West Farnum transmission line, the Company considered both the advantages and disadvantages of utilizing the overhead ROW for underground transmission line installation. The advantages of installing an underground transmission line along the existing overhead ROW corridor include use of an existing utility corridor, fewer traffic impacts during construction than if a roadway were used, and a somewhat shorter route in this particular case. These factors might lead to somewhat lower costs and lower impacts on the human environment than a roadway underground route.

However, the existing overhead ROW between the West Farnum Substation and the Rhode Island/Connecticut border is ill-suited for an underground transmission line for reasons similar to those discussed in Section 5.7.2.1. In particular the existing overhead ROW crosses multiple wetlands, wetland buffer zones, and water bodies; in addition there is significant visible rock along portions of the ROW, as well as steep grade changes and rock cliffs.

Moreover, as with the Millbury to West Farnum ROW, a substantial permanent access road would be required for construction and maintenance of an underground line potentially causing permanent impacts to wetlands, rare species and other environmental resources, as discussed in Section 5.7.2.1.

Finally, National Grid would have to acquire additional underground rights which would significantly increase the timeframe for this alternative, and has the potential to increase cost of this routing alternative as well. These constraints and considerations led National Grid to dismiss the existing overhead ROW as a potential route for an underground transmission line.

5.7.3.2 Public Roadways - West Farnum Substation to the Lake Road Switching Station

There are several potential advantages to installing an underground transmission line along the public roadway network, as compared to using the overhead ROW corridor. These relative advantages, which are discussed in greater detail in Section 5.7.2.3 above, include:

- Reduced impacts on the natural environment;
- Less rock removal;
- Easier access for ongoing maintenance; and
- Fewer property rights acquisition issues.

There are some disadvantages to using the roadway network for an underground transmission line, also discussed in Section 5.7.2.3:

- Construction related impacts during installation of the conduit and manhole system, on vehicular traffic; and
- In this case, the roadway route is longer than the overhead ROW route.

Overall, National Grid concluded that the roadway network provided fewer environmental and property acquisition issues, and had significant operational benefits as compared to installing an underground transmission line on the overhead ROW. For these reasons, an underground route was developed using the existing public roadway network.

The underground route was developed as a reasonably direct connection between the West Farnum Substation and the Rhode Island/Connecticut border, and should be considered as generally representative of a roadway underground route. Other roadway routes would be approximately the same length or longer, and would be expected to have similar costs, electrical issues, and environmental issues. In the event that an underground transmission solution became preferred, a more detailed routing analysis would be performed.

There were two major constraints in developing the roadway network route between the West Farnum Substation and the Rhode Island border.

- The overhead ROW corridor passes directly by the Sherman Road Switching Station in Burrillville. Although the proposed 341 Line will not initially connect to the Sherman Road Switching Station, there may be a future need to do this. The underground route was developed so that it would pass close to the Sherman Road Switching Station to provide the equivalent future capability.
- The route would enter NU service territory at the RI/CT border, continuing to NU's Lake Road Switching Station. National Grid and NU determined that the Route 44 crossing of the Rhode Island/Connecticut border (Glocester, Rhode Island to Putnam, Connecticut) was a suitable "meeting point" for the representative underground route.

With these constraints, a representative underground roadway route was developed. Starting at the West Farnum Substation in North Smithfield, the representative underground route follows Route 104 west to Route 7, follows Route 7 north, crossing into Burrillville, to West Ironstone Road. The route follows West Ironstone Road to Route 98 (Sherman Farm Road). At the West Ironstone Road and Route 98 intersection, the underground route is close to the Sherman Road Switching Station, satisfying one of the routing constraints.

The route then proceeds south on Route 98, entering Glocester, to Route 100. The route continues south on Route 100 to Route 44 in Chepachet, and continues on Route 44 to the Rhode Island/Connecticut border. From that point, NU developed a representative underground route in Connecticut, utilizing Route 44, a short section of an NU overhead transmission ROW, Route 21, Route 12, Attawaugan Crossing Road, and Old Trolley Road, ending at the Lake Road Switching Station. The total underground construction distance in Rhode Island would be 24.1 miles and within Connecticut would be approximately 9.0 miles, for a total underground length of approximately 33.1 miles. This route is shown on Figure 5-11.

5.7.4 Underground Cable Design

Two underground cable technologies were considered for an underground alternative to the overhead 345 kV transmission line: high pressure fluid filled ("HPFF") pipe type cable and solid dielectric cable.

HPFF pipe type cable consists of three single core paper-insulated fluid-impregnated cables. Metallic tapes and "skid wires" are added to the insulated cables for shielding and mechanical protection. The cables are installed in a coated steel pipe. The steel pipe is filled with a synthetic dielectric fluid, which is pressurized to approximately 200 pounds per square inch ("psi"). Pressurizing equipment, consisting of pumps, reservoirs, and associated controls, are required at one or both terminal ends of the cable.

Solid dielectric cable consists of a conductor insulated with an extruded solid material. At 345 kV, the insulation would be cross-linked polyethylene ("XLPE"). Additional layers are added to the insulated cables for shielding and mechanical protection. Solid dielectric cables are typically installed in a duct line consisting of several polyvinyl chloride ("PVC") conduits encased in concrete. Manholes are required at approximately 1,500 to 2,000 foot intervals to allow for splicing of the cables.

Underground alternating current ("AC") transmission cables have an electrical characteristic referred to as capacitance. The capacitance of transmission cables results in a "charging current", which means that it takes electrical current to "charge up" the cable before the cable can transmit useful power. For long AC underground transmission cables, the charging current reduces usable cable rating, and the capacitance can have significant effects on voltage control and system stability of the transmission system. Additional equipment is needed to address cable capacitance issues for the underground transmission alternative. This equipment includes shunt reactors and associated switches and circuit breakers installed at the terminal ends of the lines.

For the length of cable required for an underground alternative for the Project, the charging current would make pipe type cables impractical. With HPFF pipe type cable, almost all the cable rating would be used up in charging the cables, leaving little capacity for real power transfer. Solid dielectric cables have somewhat lower charging currents than pipe type cable, resulting in more useful capacity for real power transfer. The large quantity of dielectric fluid needed for pipe type cables and the operational and environmental issues associated with dielectric fluid maintenance were also considered to be significant disadvantages to a pipe type installation. For these reasons, the Company developed a solid dielectric system as the underground alternative to the Project.

5.7.5 Underground Alternative Design Requirements

Having selected a solid dielectric cable system for the underground alternative, National Grid then determined the required cable ratings through loadflow analysis. In order to satisfy the required ratings, it was determined that two sets of 3,500 kcmil copper 345 kV XLPE insulated cables would be needed, for both the 366 Line between the Millbury No. 3 Switching Station to the West Farnum Substation, and for the 341 Line from the West Farnum Substation to the Lake Road Switching Station. Underground transmission cables take much longer to repair than overhead transmission lines. A typical repair time for an overhead transmission line is measured in the one to two day timeframe. At 345 kV, underground transmission line repair times are measured in the one month or more timeframe. The Company determined that the reliability of the transmission system would be unacceptably compromised if either of the new transmission links were to be out of service for a month or more. In order to address the long repair times, a “3 cable per phase” system was developed using three sets of 3,500 kcmil copper XLPE insulated cables. Two sets of cables would be operated normally; a third set would be available to switch in for loss of one of the active cables.

Preliminary ratings for the “two active cables, one spare cable” system are shown in Table 5-9.

Table 5-9: Provisional Ampacity 2 sets 3,500 kcmil Copper XLPE 345 kV Cable

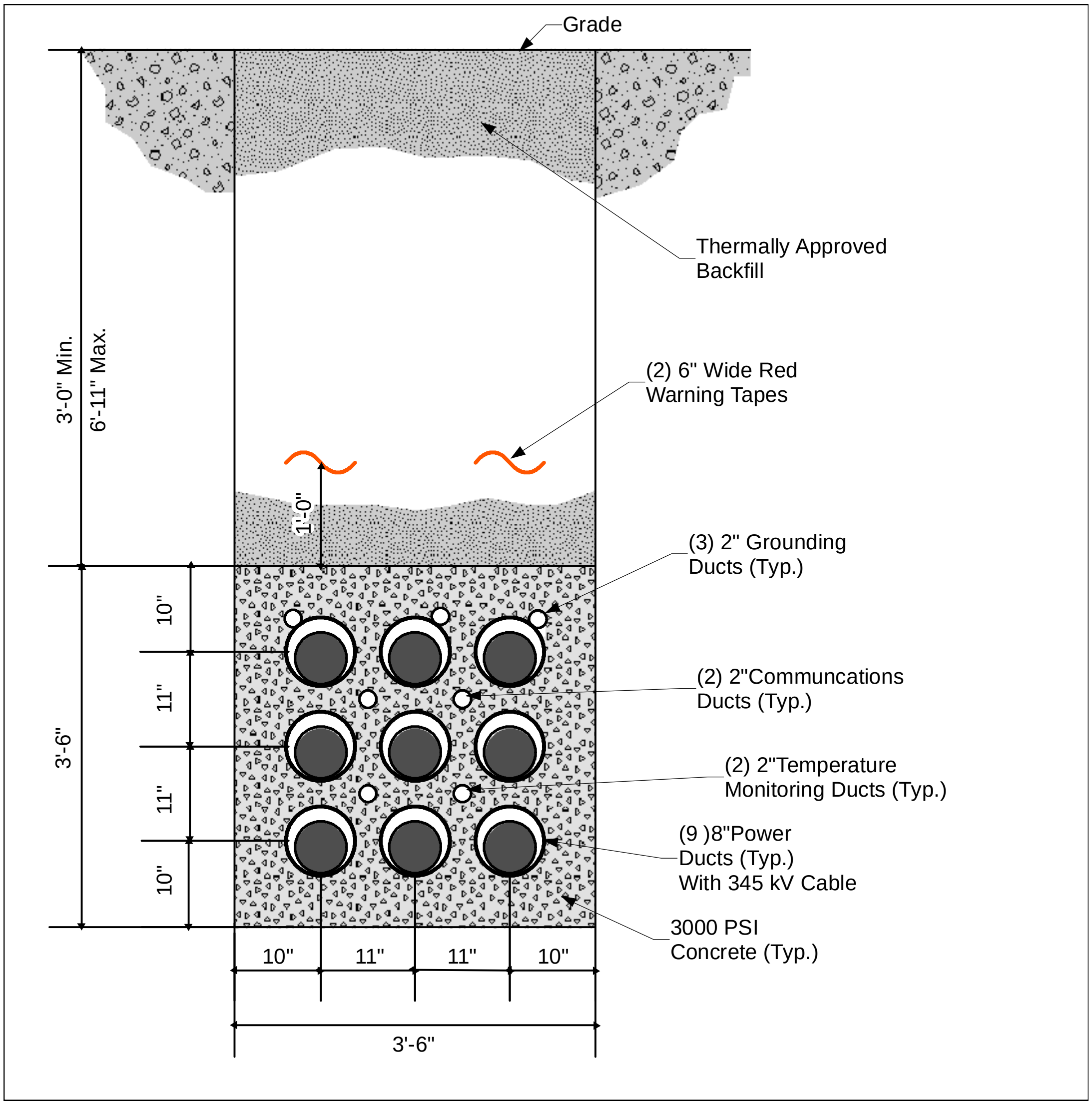
Rating	MVA	Amps
Normal Operating Condition @ 90˚ C Conductor Temperature	860	1450
12 Hour Emergency Condition @ 105˚ C Conductor Temperature	1200	2000

5.7.6 Description of Underground Construction

The solid dielectric underground transmission line alternative would consist of 9 insulated conductors installed in a duct and manhole system. The duct line would consist of nine eight-inch PVC conduits encased in concrete. Some smaller conduits would be installed for relaying, communication, and ground continuity cables. Cables would be installed one cable per duct, between manholes spaced at approximately 1,500 to 2,000 foot intervals.

A typical trench design would be 3.5 feet wide and 6.5 feet deep. The design depth would be 3.0 feet to the top of the duct line concrete encasement, but existing utilities could cause burial depth to vary along the route. In addition to the power conductors, the duct line would contain a ground continuity cable for shield grounding, and fiber optic cables which would be used for the communication and relaying requirements of the transmission system. A typical trench cross-section is shown in Figure 5-12.

Figure 5-12: 345 kV Underground Ductline Cross-Section



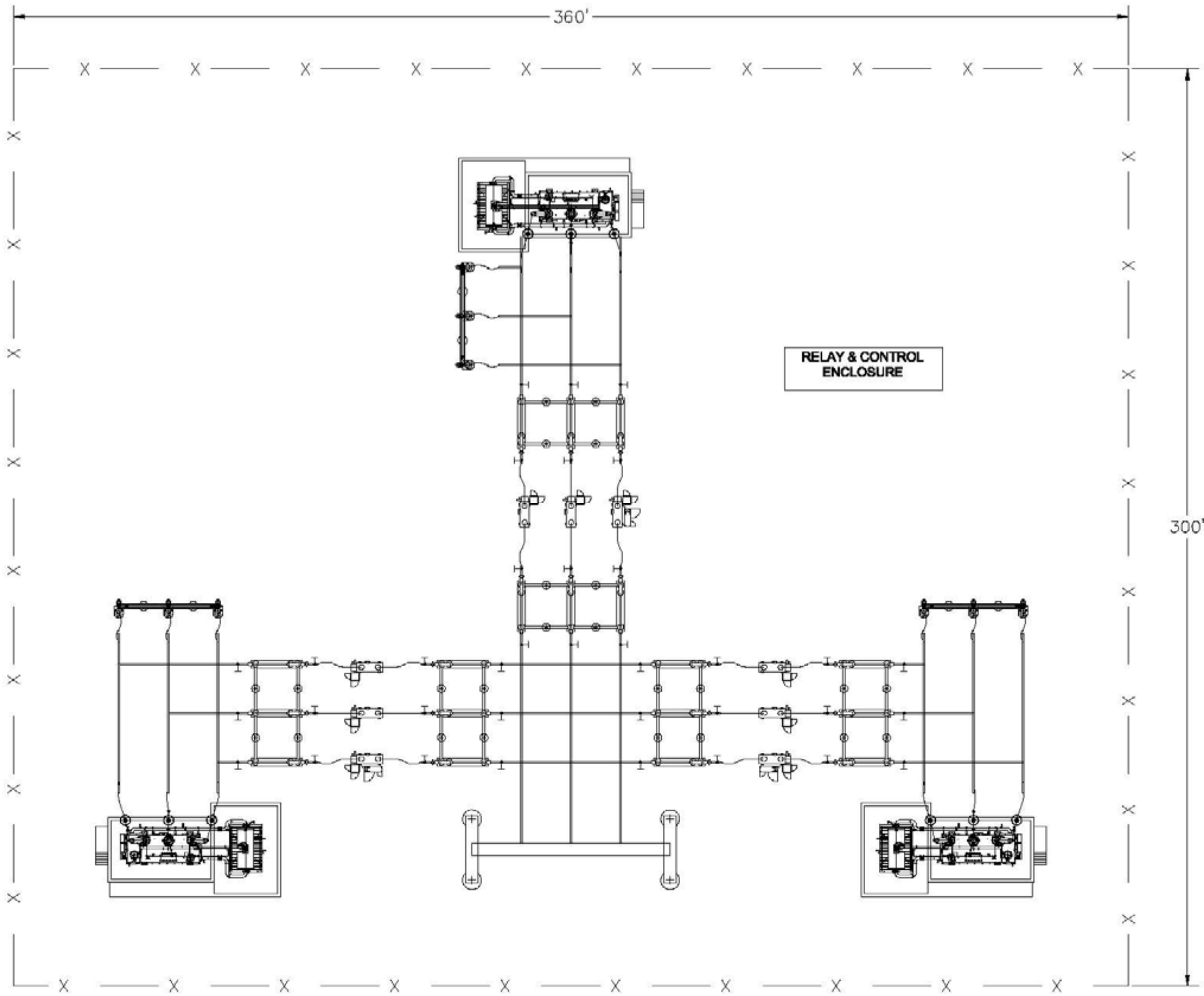
The typical construction progression for an underground installation would begin with the installation of precast concrete manholes. Excavation of the required trench would then commence. The PVC conduit would arrive in ten or twenty foot lengths and would be installed in the trench to form the duct bank. The assembled duct bank would be encased with concrete. The remaining backfill would be native soil or clean gravel. Roadways would be temporarily repaved as the construction progressed. Barriers and steel plates would be used along the trench route to provide protection and access ways for vehicles and pedestrians as necessary.

Once the manholes and duct lines were installed, the remaining construction activities would be confined to the terminals and manhole locations. These activities would consist of installing the cables in the conduits, splicing the cables at each manhole location and final testing. The ROW and streets would be restored following completion of construction.

At the terminal ends, the cables would rise above ground through riser structures. Because of cable charging issues and switching requirements, there would be significantly more equipment needed at the Millbury No. 3 Switching Station, at the West Farnum Substation, and at the Lake Road Switching Station for the underground alternative than there would be for the proposed Project. For the 366 Line between Millbury and West Farnum, this would include three additional circuit breakers and three 150 megavolt ampere reactive ("MVAR") shunt reactors, with associated buswork and protective equipment, at each end. For the 341 Line between West Farnum and Lake Road, this would include three additional circuit breakers and three 225 MVAR shunt reactors, with associated buswork and protective equipment, at each end. This additional equipment cannot fit in the existing yards at any of these substations. The Company developed a "Transition Station" design for the additional equipment needed for the underground alternative for use at the Millbury No. 3 Switching Station and at the West Farnum Substation. NU developed a similar transition station for use at the Lake Road Switching Station.

Each transition station would be approximately 300 feet by 360 feet. Transitions stations could be constructed as expansions of the existing substations, or as separate facilities near to the existing substations, connected by short overhead 345 kV transmission line segments. Figure 5-13 shows the 345 kV transition stations needed for the underground alternative. If the 366 and 341 Lines were both to be constructed underground, there would be a need for two of these transition stations at or near the West Farnum Substation.

Figure 5-13: 345 kV Overhead to Underground Transition Station



5.7.7 Underground Alternative Costs

National Grid prepared conceptual cost estimates for the 366 Line underground alternative between the Millbury No. 3 Switching Station and the West Farnum Substation and for the 341 Line between the West Farnum Substation and the Lake Road Switching Station. A comparison of overhead and underground facility construction costs is shown in Table 5.10. The underground estimates do not include land acquisition costs. There are other common Project costs that are not detailed in Table 5-10, but which are included in cost tables for the Project, as detailed in Section 4.8.

Table 5-10: Cost Comparison of Overhead and Underground Transmission Alternatives

Project Components	Proposed Project ($ Million)[1]	345 kV Underground Alternative ($ Million)[1]
366 345 kV Transmission Line, Millbury No. 3 Switching Station to the MA/RI Border	$67.4	$332.3
366 345 kV Transmission Line, MA/RI Border to the West Farnum Substation	$26.8	$109.3
Overhead to Underground Transition – 366 Line at the Millbury No. 3 Switching Station	$0.0	$15.3
Overhead to Underground Transition – 366 Line at the West Farnum Substation	$0.0	$15.8
Remove K11/L12 Towers in Massachusetts	$2.1	$0.0
Remove K11/L12 Towers in Rhode Island	$0.9	$0.0
Subtotal 366 Line Estimated Cost	**$97.2**	**$472.7**
341 345 kV Transmission Line, West Farnum Substation to RI/CT Border	$74.9	$498.0
Overhead to Underground Transition – 341 Line at the West Farnum Substation	$0.0	$15.8
341 345 kV Transmission Line, RI/CT border to Lake Road Switching Station (NU)	$41.9	$263.0
Overhead to Underground Transition – 341 Line at the Lake Road Switching Station (NU)	$0.0	$15.0
Subtotal 341 Line Estimated Cost	**$116.8**	**$791.8**
Total Project (RI, MA, and CT) Estimated Cost – Transmission Lines	**$214.0**	**$1,264.5**

[1] National Grid cost estimates in 2011 dollars. Connecticut (NU) estimates in 2010 dollars.

The total cost of the IRP from the Millbury No. 3 Substation to the West Farnum Substation, and from West Farnum to the Lake Road Switching Station is $214.0 million compared to $1,264.5 million for the underground alternative. The underground alternative represents a substantial increase in overall line cost over the Preferred Project Alternative.

5.7.8 Comparison of Underground and Overhead Alternatives

Underground and overhead transmission alternatives were compared on the basis of meeting the identified need, reliability, estimated costs, and environmental considerations.

5.7.8.1 Meeting the Identified Need

Both the underground and overhead transmission alternatives would meet the identified need of providing a new 345 kV connection between the Millbury No. 3 Switching Station and the West Farnum Substation and between the West Farnum and the Lake Road Switching Station. Both alternatives could be built with adequate capacity to meet present and future projected loads.

5.7.8.2 Reliability

Underground and overhead transmission technologies are both inherently reliable. However, the operational characteristics of underground transmission lines differ from those of overhead lines in several ways. These are discussed below.

Lengthy Outage Repair Times:

When an overhead transmission line experiences an outage, it can typically be repaired within 24 to 48 hours. In contrast, the failure of a 345 kV underground transmission cable can take a month or more to repair. During this time, the transmission system is exposed both to emergency loadings and to the loss of another transmission element, with possible loss of load. The spare cable included in the underground alternative design presented above would allow for rapid restoration of the cable system for the most common cable system failures (cable, splice, or termination failure). However, it might not address common mode failures such as a significant dig-in of the ductline. Thus, even with the spare cable circuit, there is still the possibility of extended outages with the underground alternative.

Effect on Reclosing:

Many faults on overhead transmission lines are temporary in nature. Often it is possible to "reclose" (re-energize) an overhead transmission line after a temporary fault, and return the transmission 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.

Cable Capacitance:

Underground cables have significantly higher capacitance than overhead transmission lines, meaning that it takes reactive power (MVARs) to "charge up" the cable before the cable can transmit real power (MWs). This has several ramifications:

- Part of the cable's capacity is used up by the charging current, so larger conductors are needed to transmit an equivalent amount of power. These have been included in the system design described above.
- Capacitance can create voltage control problems, meaning that the voltage can get too high when the transmission system is at light load. If the 366 Line were constructed underground, it would require approximately 300 MVAR of cable charging per cable, or 600 MVAR for the two active cables of the three cable installation. In order to compensate for this cable capacitance, three 150 MVAR shunt reactors are needed at both the Millbury No. 3 Switching Station, and the West Farnum Substation. If the 341 Line were constructed underground, it would require approximately 450 MVAR of cable charging per cable, or 900 MVAR for the two active cables of the three cable installation. In order to compensate for this cable capacitance, three 225 MVAR shunt reactors are needed at both the West Farnum Substation and the Lake Road Switching Station. These have been included in the system design described above. Further reinforcements (such as breaker upgrades and protective relaying changes) may also be necessary, and would likely increase the cost of the underground alternative beyond the costs presented in Section 5.7.6.
- Cable capacitance causes higher switching transient voltages on the system (voltage "spikes" during switching). This can damage other system components, may trigger the need to replace surge arresters throughout the area, and complicates future system expansions.

Cable Reactance:

The underground cable would have a significantly lower series reactance than the overhead transmission lines that would operate in parallel with the cable. Consequently, there would be an unequal split of the power flow between the existing overhead transmission lines and the underground cables, with the underground cables "hogging" the load. Under future loading conditions, the underground cables could be operating at their thermal limit, while the overhead transmission lines would be operating well below their limits. This phenomenon limits operating flexibility on the transmission system and might trigger an earlier need for additional system reinforcements.

Ratings:

It is often difficult to match overhead transmission line ratings with underground cables. It is also much more difficult to upgrade ratings on underground lines should that become necessary in the future.

Overall, in this case, the underground alternative would be technically inferior due to the operational challenges associated with cable charging issues and longer repair times.

5.7.8.3 Environmental Considerations

The potential environmental impacts associated with the overhead and underground alternatives were compared. A complete discussion of the potential impacts associated with the proposed overhead alternative can be found in Section 8 of this Report.

The overhead transmission line will be constructed in an existing overhead ROW. Construction techniques would be used that would minimize impacts on the natural environment. Disturbed areas would be allowed to re-vegetate with low growing plant species, similar to existing vegetation within the cleared portions of the ROW.

In the case of the underground alternative, the majority of the construction would occur within existing roadways. Assuming an on-road route, most of the environmental impacts would be to the manmade environment, and would primarily occur during the construction of the lines. These would include significant temporary impacts on traffic during conduit and cable installation. The majority of the installation of an underground transmission system would be performed utilizing cut and cover techniques, where the roadway is excavated, the conduit and manhole system is installed, the trench is backfilled, and the roadway is repaved. For much of the route, the roadway is only two lanes wide. Lane closures with alternating traffic patterns would be required during construction. There would also be temporary noise impacts to the homes and businesses located along the roadway route from construction equipment and vehicles.

The underground route would cross a number of waterways and railroad tracks, including the Blackstone River and several small streams. Railroad tracks and limited access highways would be crossed by means of a pipe-jacking or jack and bore. With this technique, a steel or concrete sleeve (typically 2 to 5 feet in diameter) is hydraulically pushed under the roadway from a pit at one side of the roadway or railroad. The conduits for the electrical cables would then be installed in this larger sleeve.

Where the underground route would pass through buffer areas adjacent to wetlands, proper construction techniques and BMPs such as use of hay bales or other sedimentation barriers would be employed to protect those areas.

Wetlands and waterways would be crossed by installing the cables on bridges (if available and suitable) or by horizontal directional drilling. Horizontal directional drilling involves utilizing a steerable drill rig to create an underground pathway for the electrical conduits. However, this technique may result in frac-outs, which are unplanned releases of the bentonite clay drilling mud into the water body.

Substation expansions would be necessary in order to connect the 345 kV underground cables to the existing terminal substations. These expansions are needed to accommodate the additional facilities associated with the underground cables, primarily shunt reactors, circuit breakers, and the cable terminations. As shown in Figure 5-13, the additional equipment would require a fenced area approximately 300 by 360 feet. With setbacks and other clearance requirements, a 3 to 4 acre area would be needed. The transition from underground line to the substations could be done as an expansion of the existing substation yards, or as a separate transition station near the existing Millbury No. 3 Switching Station and the West Farnum Substation. The development of the substation expansion or a new transition station would, in most instances, require additional tree removal and grading to support the installation of the station, construction of a permanent access road, and construction of underground and overhead transmission line interconnections and facilities. Construction of new transition stations would impact vegetation, wetlands, wildlife habitats, and viewsheds surrounding the existing substation and switching station.

With the exception of the transition stations, there would be no visual impact associated with an underground line.

5.7.8.4 Electric and Magnetic Fields

Underground cables are equipped with metallic shielding, and have essentially no external electric fields. Underground cables do produce magnetic fields. Magnetic fields were calculated for the underground alternative. For an underground cable installed in public roads, the "edge of ROW" is not clearly defined, since the cable could be installed anywhere within the roadway alignment, and since road widths vary. Consequently, magnetic field calculations were made one meter above grade directly over the cable trench.

Anticipated Annual Average Load and Annual Peak Load in 2015 and 2020 were used in calculations. Magnetic field calculations were performed for both the 366 Line and the 341 Line, and are shown in Table 5-11. The magnetic fields drop off rapidly as distance from the cables increases.

Table 5-11: Magnetic Fields (mG) from Underground Alternative

Segment	2015	2020
366 345 kV Cable West Farnum Substation to Millbury No 3, Annual Average Loading	24	26
366 345 kV Cable, West Farnum Substation to Millbury No 3, Annual Peak Loading	36	33
341 345 kV Cable, West Farnum Substation to the Lake Road Switching Station, Annual Average Loading	15	18
341 345 kV Cable, West Farnum Substation to the Lake Road Switching Station, Annual Peak Loading	34	35

Source: Exponent (2012)

These magnetic field levels are roughly comparable to the edge of ROW magnetic fields associated with the proposed Project, as shown in Section 8.16 of this Report.

5.7.9 Underground Alternative Conclusions

Both the overhead and underground alternatives would meet the identified needs of the Project and would be expected to have high levels of reliability. The underground alternative has significant operational issues, longer restoration times, and voltage control issues that make it technically inferior to the proposed Project. Generally, the underground alternative on the public roadway network would have fewer environmental impacts than the preferred overhead alternative. There would, however, be greater temporary impacts to the public during construction. The significantly higher cost and the operational issues make the underground alternative much less preferred than the overhead alternative.

5.7.10 Underground Dips

During siting of overhead transmission lines, questions are often raised regarding the possibility of installing short segments of underground transmission line at discrete locations along the route. This type of short underground segment is often referred to as a "dip". The Company developed an estimated cost for a "generic" one mile underground dip. This underground dip would utilize 3 sets of 3,500 kcmil cu 345 kV XLPE cable in a concrete encased ductline. See Figure 5-12 (trench cross section).

At each end of the dip, there would be a transition station. This would be a fenced switching station, 300 feet by 360 feet (approximately 2.5 acres), and similar in appearance to an electrical substation. The transition station would terminate the overhead line, and would contain cable terminations, circuit breakers, shunt reactors, a control house, and accessory equipment. With buffers and setbacks, a 3 to 4 acre site would be needed at each end of the dip.

The cost of a one mile generic underground dip, utilizing similar assumptions as the underground alternative, is as follows:

Underground Cable:	$21.9 Million
Transition Stations (2)	$26.1 Million
Total:	$48.0 Million

The average overhead transmission line cost along the route is approximately $4.5 million per mile. For a 1 mile dip, the underground line represents more than a ten-fold increase in costs over the overhead line. An underground dip would expose the entire line segment to the underground transmission operational issues as discussed above. These include:

- Lengthy outage repair times for underground transmission cables;
- Effect on reclosing for temporary faults;
- Cable capacitance effects (less for dips);

- Cable reactance effects (less for dips); and
- Ratings – potential for future bottlenecks.

Underground dips represent a large cost increase and introduce operational disadvantages when compared to the proposed overhead line.

5.8 SHERMAN ROAD SWITCHING STATION ALTERNATIVES

As part of the Project, National Grid is proposing to reconstruct the Sherman Road Switching Station. The Sherman Road Switching Station interconnects four 345 kV transmission lines. This station, which has experienced a number of updates through the years, originated as an AIS in a straight bus configuration back in 1968, and was later updated to a ring bus configuration. A section of gas insulated station ("GIS") was installed to interconnect the Ocean State Generating Plant in 1989.

As identified in the 2012 Solution Report (Appendix E) the rebuild of the Sherman Road Switching Station is required in order to address thermal capacity issues, short-circuit duty related issues, asset conditions in the station, and to meet NPCC requirements.

Given the extent of changes required at the switching station, alternatives were developed and evaluated to determine the best solution that would meet the reliability needs identified. The alternatives were grouped based on the number of new elements being added into Sherman Road. Other factors included in the evaluation were construction time, outage requirements, construction sequencing, expansion capabilities, and environmental factors.

Examination of the existing Sherman Road property identified several factors that limit the extent to which the existing switching station could be expanded, including:

- The presence of two high pressure gas mains directly south of the existing station.
- Significant wetland areas to the north, west and east of the existing station.

After evaluating these existing constraints, it was determined that the existing station yard could be expanded to the northwest by an area of approximately 180 feet in width and 540 feet in length without causing significant environmental impacts. Expanding the existing station yard by any greater amount would cause more significant impacts to wetlands and potential cultural resource areas. A 180-foot by 540-foot expansion area is sufficient space to construct up to 2 new bays of 345 kV breaker-and-a-half AIS equipment, or up to 4 new bays of 345 kV breaker-and-a-half GIS equipment.

The 2012 Solutions Report examined numerous options for the Sherman Road Switching Station. Summarized below are the alternatives that are relevant for transmission Option A-1, the Proposed Project.

Alternative 1: Rebuild the existing station in place with air-insulated switchgear ("AIS")

This work would entail systematic equipment upgrades in each 345 kV ring position including circuit breakers, disconnect switches, structures, insulators and bus. All trenches and raceways would be replaced and a new control building will be installed to comply with NPCC requirements. In order to execute the various construction phases, a significant number of equipment outages would be required, and significant temporary arrangement measures would need to be taken in order to maintain the switching station operation. The outages may restrict operation of, or potentially remove from service, a number of generators in the area. The alternative of rebuilding the existing station in place has significant disadvantages:

- Increased exposures to reliability risks due to ring bus being opened during construction;
- Numerous and extended equipment outages would be required;
- Potential generation restrictions or forced generation outages;
- Extended construction durations; and
- Increased construction costs.

This alternative would also severely limit the potential for future switching station expansion. The future addition of a fifth transmission element would require the station to be changed from a ring bus configuration to a breaker-and-a-half configuration to meet the ISO Planning Procedure guidelines, which would again involve significant station changes and investment. The conceptual grade estimate for rebuilding the existing switching station in place is $38.0 million.

Alternative 2: Build a new gas-insulated station ("GIS")

The electrical configuration would be arranged as a modified breaker-and-a-half scheme using 345 kV GIS equipment including 345 kV breakers, disconnect switches, instrument transformers, structures, bus and other required accessories. The electrical work would entail adding a new GIS/Control building, associated yard equipment and transmission line termination structures to complete the new GIS station. A two-bay switchyard would be required and could be built in the expansion area to the northwest of the existing yard. All the work could be performed unimpeded until the element cutovers were made. Alternative 2 was estimated to cost $44.9 million.

Alternative 3: Build a new station with air-insulated switchgear ("AIS")

The work would entail building a completely new 345 kV AIS station in a breaker-and-a-half configuration consisting of 345 kV breakers, disconnect switches, instrument transformers, structures, bus and other required accessories. A new control building would also be installed. A two-bay switchyard would be built in the expansion area to the northwest of the existing yard. All the work could be performed unimpeded until the final element cutovers were made. Upon completion of all the cutovers, the existing yard equipment would be removed and the ground restored to the final elevation. Alternative 3 was estimated to cost $36.6 million including realignment of 347, 333, and 3361 transmission lines.

Table 5-12 summarizes the evaluation of the three alternatives.

Table 5-12: Sherman Road Alternatives

Comparison Factor	Alternative 1 Rebuild Existing Station in Place	Alternative 2 New GIS Station	Alternative 3 New AIS Station
Cost (Conceptual Grade[1] Estimate)	Medium Ring Bus- $38.0M	High 2-Bays - $44.9M	Low 2-Bays - $36.6M
Construction Time	Long – 24-36 Months	Standard – 18-24 Months	Standard – 18-24 Months
Outage Requirements	Very High Requirements High Risk Outages Long Duration Outages	Low Requirements Low Risk Outages Short Duration Outages	Low Requirements Low Risk Outages Short Duration Outages
Construction Sequencing	Construction will conflict with other components at West Farnum and Millbury	Minimal Conflicts	Minimal Conflicts
Expansion Capabilities	Difficult to Expand: Expansion requires reconfiguring from ring bus to breaker –and-a-half	Easy to expand: Up to 4 bays	Easy to expand: Up to 4 bays (after initial 2-bay build-out and removal of existing station)
Environmental Factors	Low Impact	GIS may not be considered carbon neutral	Medium Impact

Source: 2012 Solutions Report, Table 5-4, page 80.

[1] Estimates have a -25% / +50% degree of accuracy

Alternative 3, constructing a new 2-bay AIS Station, was determined to be the best solution for the Sherman Road Switching Station, based on lowest cost, low equipment outage requirements, minimal construction sequencing and outage difficulties, opportunity for future expansion, and minimizing environmental impacts given the constraints of the existing site conditions.

5.9 SUMMARY OF ALTERNATIVES AND CONCLUSIONS

In the development of the Project and selection of the preferred alternative, National Grid evaluated a variety of alternatives to the proposed action. Alternatives to the construction of the 345 kV transmission lines included a No Action alternative, electrical alternatives, non-transmission alternatives, alternative overhead routes, overhead alternatives using the existing ROW with different design configurations, an underground transmission line alternative, and alternatives for the modifications to the Sherman Road Switching Station.

The No Action alternative was rejected because it would not resolve the regional electric reliability problems identified by the ISO-NE and the transmission system owners, and therefore, the No Action alternative was not considered to be acceptable.

The Working Group identified five alternative transmission line solutions that could resolve the reliability issues identified in the 2011 Needs Assessment. These electrical transmission alternatives included Options A-1, A-2, A-3, A-4, and C-2.1. Option A-1 (the proposed Project) was identified by the Working Group as the preferred IRP option. Option A-1 was determined to perform well electrically, would result in overall reduced potential environmental impacts, was the most cost effective solution, and offered future system expandability and flexibility.

The findings of the ICF study concluded that none of the non-transmission alternatives analyzed, including demand-side resources, generation, and a combination of generation and demand-side resources, would meet the identified project need at a reasonable cost.

National Grid also examined alternative routes for the overhead 345 kV transmission lines utilizing public streets and highways. In order to provide proper electrical safety clearances, additional ROW would have to be acquired along most public streets, potentially displacing homes, businesses, and adjoining land uses, and adding significant cost and time to develop the alternative. The visibility of this type of installation would be much greater than for the proposed project. This option was dismissed for these reasons.

National Grid considered siting the new 345 kV transmission lines parallel to one of the existing pipeline system ROWs. After careful consideration of these alternatives, National Grid determined that constructing the new 345 kV transmission lines parallel to existing pipeline ROWs did not offer advantages from land acquisition, environmental impact, or cost perspectives, over the preferred alternative.

National Grid evaluated the use of different design configurations within the existing ROW, including davit-arm and double-circuit structures for the new 345 kV transmission lines. National Grid concluded that utilizing single-circuit H-frame structures offered more advantages from an engineering design perspective, created fewer natural and social environmental impacts, and was a more cost-effective solution.

National Grid assessed the feasibility of underground lines as an alternative to an overhead route. National Grid concluded that the operational issues, longer restoration times, and voltage control issues, combined with the significantly higher cost of the underground alternative make it less preferred than the overhead route alternative.

Following an evaluation of the relative merits and disadvantages of the various transmission and non-transmission alternatives, the proposed action of constructing the new 366 and 341 345 kV transmission lines, reconstructing and reconductoring the existing 328 345 kV transmission line within the existing ROWs, and rebuilding the existing Sherman Road Switching Station, was determined to be preferable to the other alternatives.

The proposed overhead route alternative is superior to other routing alternatives because it:

- Utilizes existing ROWs dedicated to existing overhead transmission lines, thus avoiding acquisition of new ROW and reducing new environmental impacts;
- Minimizes tree clearing by making use of an existing cleared ROW currently occupied by decommissioned 69 kV structures for a portion of the 366 Line; and

- Is substantially less expensive than any of the routing alternatives considered.

An alternatives analysis was also performed to determine the best design solution for the proposed modifications to the existing Sherman Road Switching Station. Evaluation of the design alternatives showed that a new AIS would:

- Minimize construction time and outage difficulties for an existing switching station that serves as a "hub" for area transmission lines;
- Address the system reliability needs identified by the Working Group;
- Provide a cost effective solution; and
- Could be expanded to meet future needs of the transmission grid.

National Grid concluded that the construction of a new AIS switching station to the northwest of the existing yard and removal of the existing switching station is the preferred option.

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6 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 existing transmission line ROW and substation sites. As required by the Rules and Regulations of the EFSB, a detailed description of all environmental characteristics within and immediately surrounding the Project has been prepared. This section describes the specific natural features that have been evaluated for impacts. Information pertaining to existing site conditions has been obtained through available published resource information, the Rhode Island Geographic Information System ("RIGIS") database, various state and local agencies, and field investigations of the Project site.

6.1 PROJECT STUDY AREA

A Project Study Area was established to assess the existing environment within and immediately surrounding the transmission line ROW. This Study Area consists of a 5,000-foot-wide corridor centered on the existing transmission line ROW. The boundaries of this corridor were determined to allow for a detailed desktop analysis of existing conditions within and adjacent to the ROW (Figure 6-1).

6.2 GEOLOGY

6.2.1 Bedrock Geology

The Study Area is located within the Seaboard Lowland section of the New England physiographic province. The Study Area consists of two geologic areas: The Hope Valley Subterranne and the West Bay Area of the Esmond-Dedham Subterranne. The bedrock geology of the northern and eastern part of the Study Area (Massachusetts/Rhode Island border to Route 100) is epidote and buitite schist, undifferentiated rock, Woonasquatucket formation, metaclastic rock (undivided), and granite from the Blackstone and Harmony period laid during the late Proterozoic period or older group. West of Route 100 to the Connecticut border, the Project area is Plainfield formation, granite gneiss, and metaclastic rock (undivided) (Hermes et al., 1994).

6.2.2 Surficial Geology

The present landscape of the Study Area, as with much of the Northeastern United States, was formed during the Wisconsin glacial age approximately 10,000 years ago. The dynamic land forming processes that occurred during this geologic event produced the landforms and surficial geologic deposits within the Study Area (Figure 6-2).

The Study Area is comprised of predominantly glacial till, with pockets of glaciofluvial deposits known as outwash deposits and ice contact deposits interspersed throughout. Glacial till is material carried and directly deposited by glacial ice with little or no reworking by running water. Therefore, this material is not well sorted and the stones are not well rounded. Glacial till is non-stratified glacial drift consisting of clay, silt, sand, stones, and boulders transported and deposited by glacial ice. There are two forms of glacial till: lodgement till, which was deposited directly under the glacier as it moved or melted, and ablation till, which lay on top of the ice or was incorporated into the ice, and then deposited on the ground when the ice melted. Lodgement till tends to be more compact. In contrast, glaciofluvial deposits, often referred to as glacial outwash, were deposited by the abundant meltwater which flowed from the shrinking glacier. Glaciofluvial deposits are typically composed of well rounded stones and sorted silt, sand and gravel deposited in recognizable layers by glacial meltwater.

Glaciofluvial deposits are common in low areas of the landscape, such as broad, level plains and valleys. Landforms associated with glaciofluvial deposits include outwash terraces, outwash fans or deltas, valley trains, eskers, kames, and kame terraces. Significant areas of glacial outwash are located in almost every town and city in the State. Some of these areas are capped with windblown deposits of silt, known as loess. The boundary between areas of till and outwash deposits is often characterized by an abrupt change in slope.

6.2.3 Geological Hazards

Geological hazards, such as earthquakes or fault zones, could have negative impacts on transmission line or substation facilities. Normal possible fault zones are evident to the east and south of the Study Area. Historically, seismic activity in the northeastern United States is the result of rebound in the earth's crust depressed by ice loading during the Pleistocene glacial event. These events are non-tectonic and do not usually result in vertical movement along fault lines. This rebound may cause moderate to very strong ground shaking locally and some horizontal movement, but this potential can be regarded as minimal for the design life of the Project.

6.2.4 Sand and Gravel Mining

Areas of sand and gravel operations are located within the Study Area. One sand and gravel pit is located southwest of the West Farnum Substation to the west of Todd's Pond in North Smithfield. In addition, a series of sand and gravel pits are located between Providence Pike (Route 5) and Black Plain Road, along Trout Brook in North Smithfield. The presence of these sand and gravel operations is not expected to have any material impact on the Project.

6.3 SOILS

Detailed information concerning the physical properties, classification, agricultural suitability, and erodibility of soils in the vicinity of the Study Area are presented in this section. Descriptions of soil types identified within the Study Area were obtained from the *Soil Survey of Rhode Island* (Rector, 1981), and from on site investigations conducted by AECOM. The Soil Survey delineated map units that may consist of one or more soil series and/or miscellaneous non-soil areas that are closely and continuously associated on the landscape. 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. A total of 23 named soil series have been mapped within the Study Area. Table 6-1 lists the characteristics of the 55 soil phases (lower taxonomic units than series) found within the Study Area. Study Area hydric soil status is depicted on Figure 6-3.

Table 6-1: Characteristics of Soil Phases within the Study Area

Soil Map Unit Symbol	Soil Phase	Drainage Class	Percent Slope	Depth to Bedrock
Aa	Adrian Muck	vpd	0	>60
AfA	Agawam fine sandy loam	wd	0-3	>60
AfB	Agawam fine sandy loam	wd	3-8	>60
CaC	Canton-Charlton-Rock outcrop complex	wd	3-15	>60
CaD	Canton & Charlton rock outcrop complex	wd	15-35	>60
CB	Canton – Urban complex	wd	0-15	>60
CC	Canton – Urban Complex, very rocky	wd	0-15	>60
CdA	Canton & Charlton fine sandy loams	wd	0-3	>60
CdB	Canton & Charlton fine sandy loam	wd	3-8	>60
CdC	Canton & Charlton fine sandy loam	wd	8-15	>60
CeC	Canton & Charlton fine sandy loam, very rocky	wd	3-15	>60
ChB	Canton & Charlton v. fine sandy loam	wd	3-8	>60
ChC	Canton & Charlton v. stony fine sandy loam	wd	8-15	>60
ChD	Canton & Charlton v. stony fine sandy loam	wd	15-25	>60
CkC	Canton & Charlton ex. Stony f.s. loam	wd	3-15	>60
Co	Carlisle Muck	vpd	0	>60
Du	Dumps	NL	0-25	>60
GhC	Gloucester- Hinckley v. stony sandy loam	ed	3-15	>60
GhD	Gloucester- Hinckley v. stony sandy loam	ed	15-25	>60
HkA	Hinckley gravelly sandy loam	ed	0-3	>60
HkC	Hinckley gravelly sandy loam	ed	rolling	>60
HkD	Hinckley gravelly sandy loam	ed	hilly	>60
HnC	Hinckley-Enfield complex, rolling	ed	3-15	>60
MmA	Merrimac sandy loam	Swed	0-3	>60
MmB	Merrimac sandy loam	Swed	3-8	>60
MU	Merrimac- Urban Complex	wd	0-15	>60
Nt	Ninigret fine sandy loam	mwd	0-3	>60
PaA	Paxton fine sandy loam	wd	0-3	>60
PaB	Paxton fine sandy loam	wd	3-8	>60
PbB	Paxton v. stony fine sandy loam	wd	0-8	>60
PbC	Paxton v. stony fine sandy loam	wd	8-15	>60
PD	Paxton-Urban land complex	wd	0-15	>60
Pg	Pits, gravel	ed-swed	var.	>60
Pp	Podunk fine sandy loam	mwd	0-3	>60
Re	Ridgebury fine sandy loam	pd	0-3	>60
Rf	Ridgebury, Whitman & Leicester ex. stony fine sandy loam	pd-vpd	NL	>60
Ru	Rumney fine sandy loam	pd	NL	>60
Sb	Scarboro mucky sandy loam	vpd	0-3	>60
Ss	Sudbury sandy loam	mwd	NL	>60
StA	Sutton fine sandy loam	mwd	0-3	>60
StB	Sutton fine sandy loam	mwd	3-8	>60
SuB	Sutton v. stony fine sandy loam	mwd	0-8	>60
SvB	Sutton extremely stony fine sandy loam	mwd	0-8	>60
Tb	Tisbury silt loam	mwd	0-3	>60
UD	Udorthents- urban land complex	mwd-ed	var.	NL

Soil Map Unit Symbol	Soil Phase	Drainage Class	Percent Slope	Depth to Bedrock
Ur	Urban Land	NL	0-10	NL
W	Water	NL	NL	NL
Wa	Walpole sandy loam	pd	NL	>60
WcB	Wapping v. stony silt loam	mwd	0-8	>60
WgA	Windsor loamy sand	ed	0-3	>60
WgB	Windsor loamy sand	ed	3-8	>60
WhA	Woodbridge fine sandy loam	mwd	0-3	>60
WhB	Woodbridge fine sandy loam	mwd	3-8	>60
WoB	Woodbridge v. stony fine sandy loam	mwd	0-8	>60
WrB	Woodbridge extremely stony fine sandy loam	mwd	0-8	>60

Notes: ed – excessively drained
wd – well drained
mwd – moderately well drained
swed – somewhat excessively drained
pd – poorly drained
vpd – very poorly drained
8-15 percent slope – highly erodible
NL – Not Listed

Source: Soil Survey of Rhode Island (Rector, 1981) and USDA/NRCS SSURGO soils (2010).

6.3.1 Soil Series

The soil series detailed in the following subsections have been identified within the Study Area. The classification follows that published in the *Soil Survey of Rhode Island* (Rector, 1981).

Adrian Series

The Adrian series is classified as sand or sandy-skeletal mixed, euic, mesic, Terric Medisaprists. These very poorly drained soils formed in organic material derived from herbaceous plants and are underlain by sand and gravel. The soils are in depressions and small drainageways of glacial till uplands and outwash plains.

Agawam Series

The Agawam series is classified as coarse-loamy over sandy-skeletal, mixed, mesic Typic Dystrochrepts. These well drained soils formed in glaciofluvial deposits derived mainly from schist, gneiss, and phyllite. The soils are on terraces and outwash plains.

Canton & Charlton Series

The Canton series is classified as coarse-loamy over sandy skeletal, mixed, mesic Typic Dystrochrepts. These well drained soils formed in glacial till derived mainly from schist and gneiss. The similar Charlton series is classified as coarse-loamy, mixed, mesic Typic Dystrochrepts. These soils were also formed in glacial till derived mainly from schist and gneiss. Charlton soils have a finer textured substratum than Canton soils. Because these series are similar, they are grouped and mapped together as an association.

Carlisle Series

The Carlisle series is classified as euic, mesic Typic Medisaprists. These very poorly drained soils are formed in deep organic deposits in depressions in outwash plains, till plains and moraines.

Enfield Series

The Enfield series is classified as coarse-silty over sandy or sandy-skeletal, mixed, mesic Typic Dystrochrepts. These well drained soils formed in silt mantled outwash deposits derived mainly from schists, gneiss, and phyllite. The soils are on terraces and outwash plains.

Gloucester and Hinckley Series

The Gloucester series is classified as sandy-skeletal, mixed, mesic Typic Dystrochrepts. These somewhat excessively drained soils are formed in sandy till. They are nearly level to very steep soils on ground moraine uplands and moraines. The Hinckley series is classified as sandy-skeletal, mixed, mesic Typic Udorthents. These excessively drained soils are formed in glaciofluvial deposits derived mainly from schist and gneiss. These soils are grouped and mapped together as an association.

Merrimac Series

The Merrimac series is classified as sandy, mixed mesic Typic Dystrochrepts. These somewhat excessively drained soils are formed in outwash deposits derived from schist, gneiss, and phyllite. The soils are on outwash plains and terraces.

Ninigret Series

The Ninigret series is classified as coarse-loamy over sandy or sandy-skeletal, mixed, active, mesic Aquic Dystrudepts. These very deep moderately well drained soils are 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.

Paxton Series

The Paxton series is classified as coarse-loamy, mixed, mesic Typic Fragiochrepts. These well drained soils are formed in compact glacial till derived mainly from gneiss and schist. They are on side slopes and crests of glacial till upland hills and drumlins. The soil surface ranges from non-stony to extremely stony.

Pits, gravel (sand and gravel operations)

This unit consists of areas that have been excavated for sand or gravel. The areas are mostly on broad outwash plains and terraces of stream valleys and generally range from 3 to 30 acres. These areas have sparse vegetation consisting of drought-resistant plants. Slopes range mostly from 0 to 25 percent and these are steep escarpments along the edges of the pits. Included with this unit in mapping are small, intermingled areas of Udorthents, excessively drained Hinckley and Windsor soils, and somewhat excessively drained Lippitt and Merrimac soils. A few areas have bedrock outcrops and small bodies of water, and a few are used for parking lots and buildings.

Podunk Series

The Podunk series is classified as coarse-loamy, mixed, active, frigid fluvaquentic Dystrudepts. These very deep moderately well drained soils are formed principally from gneiss, schist, granite, and quartzite recent alluvium on floodplains.

Ridgebury, Whitman and Leicester Series

The Ridgebury, Whitman and Leicester series are commonly grouped together as one soil complex due to their similar properties. However, they are distinct series with individual classifications. The Ridgebury series is classified as coarse-loamy, mixed, mesic Aeric Fragiaquepts, the Whitman series is classified as coarse-loamy, mixed, mesic Humic Fragiaquepts and the Leicester series is classified as coarse-loamy, mixed, acid, mesic Aeric Haplaquepts. Ridgebury and Leicester soils are poorly drained and Whitman soils are very poorly drained. Whitman and Ridgebury soils have a dense till layer within one meter of the soil surface. These soils are formed in loamy glacial till derived mainly from schist, gneiss and granite. These soils are in depressions, drainage ways in glacial till uplands, and nearly level areas of glacial upland hills and drumlins.

Rumney Series

The Rumney series is classified as coarse-loamy, mixed, nonacid mesic Aeric Fluvaquents. These poorly drained soils are formed in recent alluvium derived mainly from granite, gneiss, and schist. The soils are on flood plains.

The Scarboro Series

The Scarboro series is classified as sandy, mixed, mesic Histic Humaquepts. These very poorly drained soils have thin organic surfaces over sand deposits derived mainly from schist, gneiss, and shale. The soils are in depressions and drainage ways in outwash plains and terraces.

Sudbury Series

The Sudbury series is classified as sandy, mixed, mesic Aquic Dystrochrepts. These moderately well drained soils are formed in glaciofluvial deposits derived mainly from schist and gneiss. These soils are on terraces and outwash plains.

Sutton Series

The Sutton series is classified as coarse-loamy, mixed, mesic Aquic Dystrochrepts. These moderately well drained soils are formed in glacial till derived mainly from schist, gneiss and granite.

The soils are on side slopes and in depressions of upland hills. The soil surface ranges from non-stony to extremely stony.

Tisbury Series

The Tisbury series is classified as coarse-silty over sandy or sandy-skeletal, mixed, mesic Aquic Dystrochrepts. These moderately well drained soils formed in glaciofluvial deposits derived mainly from schist, gneiss, and granite. These soils are on outwash terraces.

Udorthents Series

Udorthents are moderately well drained to excessively drained soils that have been cut, filled, or eroded. The areas have had more than two feet of the upper part of the original soil removed or have more than two feet of fill on top of the original soil. Udorthents are extremely variable in texture. They are on glacial till plains and gravelly outwash terraces.

Urban Land

These areas consist mostly of sites for buildings, paved roads, and parking lots. There are limited areas of urban land along the Project route; most areas are in intensely built-up portions of Providence County. The areas range from 5 to 100 acres. Slopes range from 0 to 10 percent but are dominantly 0 to 5 percent. Included with this unit in mapping are small, intermingled areas of Udorthents; somewhat excessively drained Merrimac soils; well drained Canton, Charlton, and Newport soils; and moderately well drained Pittstown, Sudbury, and Sutton soils.

Walpole Series

The Walpole series is classified as sandy, mixed, mesic Aeric Haplaquepts. These poorly drained soils are formed in glaciofluvial deposits derived mainly from schist, gneiss, and granite. The soils are in depressions and drainage ways.

Wapping Series

The Wapping series is classified as coarse-loamy, mixed, mesic Aquic Dystrochrepts. These moderately well drained soils formed in silt mantled glacial till. The soils are on side slopes or in depressions of glaciated uplands.

Windsor Series

The Windsor series is classified as mixed, mesic Typic Udipsamments. These excessively drained soils are formed in glaciofluvial deposits and Pleistocene dunes derived mainly from schist, gneiss, and phyllite. The soils are on terraces, outwash plains, kames, and eskers.

Woodbridge Series

The Woodbridge series is classified as coarse-loamy, mixed, mesic Typic Fragiochrepts. These moderately well drained soils are formed in glacial till derived mainly from schist, gneiss, and phyllite. The soils are on lower slopes and crests of upland hills and drumlins.

6.3.2 Prime Farmland Soils

Prime farmland, as defined by the United States Department of Agriculture ("USDA"), 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 high yield of crops when it is treated and managed using acceptable farming methods. Rhode Island recognizes 35 prime farmland soils. The Study Area crosses 16 prime farmland soil units as listed in Table 6-2.

Table 6-2: USDA Prime Farmland Soils within Study Area

Soil Map Unit Symbol	Name	Percent Slope
Afa	Agawam fine sandy loam	0-3
AfB	Agawam fine sandy loam	3-8
CdA	Canton & Charlton fine sandy loams	0-3
CdB	Canton & Charlton fine sandy loam	3-8
MmA	Merrimac sandy loam	0-3
MmB	Merrimac sandy loam	3-8
Nt	Ninigret fine sandy loam	0-1
PaA	Paxton fine sandy loam	0-3
PaB	Paxton fine sandy loam	3-8
Pp*	Podunk fine sandy loam	0-1
Ss	Sudbury fine sandy loam	NL
StA	Sutton fine sandy loam	0-3
StB	Sutton fine sandy loam	3-8
Tb	Tisbury silt loam	0-1
WhA	Woodbridge fine sandy loam	0-3
WhB	Woodbridge fine sandy loam	3-8

* This mapping unit is prime farmland if protected from flooding or not frequently flooded during the growing season.
NL – Not Listed
Source: Rhode Island Prime Farmlands at URL: http://www.ri.nrcs.usda.gov/technical/primefarmlands.html (accessed on January 3, 2012).

Prime farmland soils could be used as cropland, pastureland, rangeland, forestland, or other land. Urbanized land and water are exempt from consideration as prime farmland. Within the Study Area, prime farmland soils exist on land occupied by residential, agricultural, commercial, and industrial land uses as well as forestland and roads.

6.3.3 Farmland of Statewide Importance

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, forage, 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.

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

Table 6-3 lists soil units designed as farmland soils of statewide importance that are found within the Study Area.

Table 6-3: Farmland Soils of Statewide Importance within the Study Area

Soil Map Unit Symbol	Name	Percent Slope
Afa	Agawam fine sandy loam	0-3
AfB	Agawam fine sandy loam	3-8
CdA	Canton & Charlton fine sandy loams	0-3
CdB	Canton & Charlton fine sandy loam	3-8
CdC	Canton and Charlton fine sandy loams	8-15
HkA	Hinckley gravelly sandy loam	0-3
HkC	Hinckley gravelly sandy loam, rolling	0-1
HnC	Hinckley-Enfield complex, rolling	0-1
MmA	Merrimac sandy loam	0-3
MmB	Merrimac sandy loam	3-8
Nt	Ninigret fine sandy loam	0-1
PaA	Paxton fine sandy loam	0-3
PaB	Paxton fine sandy loam	3-8
Pp*	Podunk fine sandy loam	0-1
Re	Ridgebury fine sandy loam	0-1
Ru	Rumney fine sandy loam	0-1
Ss	Sudbury fine sandy loam	NL
StA	Sutton fine sandy loam	0-3
StB	Sutton fine sandy loam	3-8

Soil Map Unit Symbol	Name	Percent Slope
Tb	Tisbury silt loam	0-1
Wa	Walpole sandy loam	0-1
WgA	Windsor loamy sand	0-3
WgB	Windsor loamy sand	3-8
WhA	Woodbridge fine sandy loam	0-3
WhB	Woodbridge fine sandy loam	3-8

NL – Not Listed
Source: Rhode Island Prime Farmlands at URL: http://www.ri.nrcs.usda.gov/technical/primefarmlands.html (accessed on January 3, 2012).
Special note: In Rhode Island, all soils that meet the "Prime Farmland" criteria are also included in the "Additional Farmland of Statewide Importance" category. The inclusion of these soils in the list of Additional Farmland of Statewide Importance" by the U.S. Dept. of Agriculture resulted from a May 1985 request by the RI Department of Administration's Division of Planning seeking to have the Prime Farmlands afforded the additional protection given to Farmlands of Statewide Importance.

6.3.4 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. 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 and soil map units with moderate erosion hazard are listed in Table 6-4.

Table 6-4: Study Area Soil Mapping Units with Potential Steep Slopes

Soil Map Unit Symbol	Soil Phase	Percent Slope	Surface K Values
AfB	Agawam fine sandy loam	3-8	0.28
CaC	Canton-Chartlon-Rock outcrop complex	3-15	0.24
CaD	Canton & Charlton Rock Outcrop	15-35	0.20
CB	Canton-Urban land Complex	0-15	0.24
CC	Canton-Urban land complex, very rocky	0-15	0.24
CdB	Canton & Charlton fine sandy loams	3-8	0.20
CdC	Canton & Charlton fine sandy loams	8-15	0.20/0.24
CeC	Canton & Charlton fine sandy loams v. rocky	3-8	0.20
ChB	Canton & Charlton v. stony fine sandy loams	3-8	0.20
ChC	Canton & Charlton v. stony fine sandy loams	3-8	0.20
ChD	Canton & Charlton v. stony fine sandy loams	8-15	0.20
CkC	Canton and Charlton extremely stony fine sandy loam	3-15	0.24
GhC	Gloucester-Hinckley v. stony sandy loams	rolling	0.20/0.24

Soil Map Unit Symbol	Soil Phase	Percent Slope	Surface K Values
GhD	Gloucester-Hinckley v. stony sandy loams	hilly	0.17
HkC	Hinckley gravelly sandy loam	rolling	0.17
HkD	Hinckley gravelly sandy loam	hilly	0.17
HnC	Hinckley-Enfield complex, rolling	3-15	0.28
MmB	Merrimac sandy loam	3-8	0.24
MU	Merrimac-Urban land complex	0-15	0.28
PaB	Paxton fine sandy loam	3-8	0.24
PbB	Paxton v. stony fine sandy loam	0-8	0.20
PbC	Paxton v. stony fine sandy loam	3-15	0.20
PD	Paxton-Urban land complex	0-15	0.28
StB	Sutton fine sandy loam	3-8	0.24
SuB	Sutton v. stony fine sandy loam	0-8	0.20
SvB	Sutton ex. Stony fine sandy loam	0-8	0.20
UD	Udorthents-Urban land complex	0-15	0.24
WcB	Wapping very stony silt loam	0-8	0.43
WgB	Windsor loamy sand	3-8	0.17
WhB	Woodbridge fine sandy loam	3-8	0.24
WoB	Woodbridge v. stony fine sandy loam	0-8	0.20
WrB	Woodbridge extremely stony fine sandy loam	0-8	0.24

Source: Soil Survey of Rhode Island (Rector, 1981) and United States Department of Agriculture, Natural Resources Conservation Service, Highly Erodible Soil Map Units of Rhode Island, Revised January 1993.

6.4 SURFACE WATER

The majority of the Study Area is drained by waterways in the Blackstone River drainage basin. A small portion of the Study Area located west of the West Farnum Substation is contained in the Woonasquatucket River drainage basin. Both the Blackstone and Woonasquatucket River drainage basins are drained by waterways that generally flow to the east and southeast into Narragansett Bay. The Bay, in turn, ultimately empties into the Atlantic Ocean. The extreme western portion of the Study Area is drained by waterways in the Thames River drainage basin that generally flow southward and eventually discharge into the Long Island Sound. A drainage basin is the area that drains water, sediment, and dissolved materials to a common outlet at some point along a stream channel (Dunne and Leopold, 1978), and is synonymous with watershed.

The Blackstone River drainage basin is made up of the following sub-drainage basins; the Blackstone River, the Peters River, the Branch River, and the Clear River. Portions of the Study Area fall within the Woonasquatucket watershed (North Smithfield) and the Thames River watershed (Rhode Island and Connecticut border). The Woonasquatucket River drainage basin includes the Woonasquatucket River sub-drainage basin. The Thames River drainage basin is made up of the following sub-drainage basins: the Fivemile River, the French River, the Moosup River, the Pachaug River, the

Quinebaug River, the Shetucket River, the Natchaug River, the Willimantic River, the Yantic River, and the Thames River Main Stem.

The major surface water resources and classifications within the Study Area and water resources crossed by the Project are listed in Table 6-5. The waters of the State of Rhode Island (meaning all surface water and groundwater of the State) are assigned a Use Class 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 water quality classification of the major surface waters within the Study Area are identified in the descriptions of the water courses that follow.

Table 6-5: Major Surface Water Resources within the Study Area

Water Body Name	Town	Classification and Partial Use	Fishery Designation	Water Body Crossed by the Project
Pratt Pond	North Smithfield	NA	NA	Yes
Dawley Brook	North Smithfield	B	NA	No
Branch River and tributaries	North Smithfield	B	Warm	Yes
Cherry Brook and tributaries	North Smithfield	B	Warm	Yes
Forestdale Pond	North Smithfield	NA	NA	No
Todd's Pond	North Smithfield	A	NA	No
Tarkiln Pond	North Smithfield	B	Warm	No
Trout Brook	North Smithfield	B	Warm	No
Trout Brook Pond	North Smithfield	B	Warm	No
Unnamed tributary to Blackstone River #7	North Smithfield	B	NA	No
Slatersville Reservoir	North Smithfield/ Burrillville	B	Warm	Yes
Tributaries to Slatersville Reservoir	Burrillville	B	NA	Yes
Branch River and tributaries	Burrillville	B	Warm	No
Tucker Brook and tributaries	Burrillville	B	Cold	Yes
Unnamed tributaries to Branch River in Black Hut State Management Area	Burrillville	B	Cold	No
Chockalog River and tributaries	Burrillville	A	Cold	Yes
Round Top Brook and tributaries	Burrillville	A	Warm	Yes
Big Round Top Pond	Burrillville	A	NA	No
Little Round Top Pond	Burrillville	A	NA	No
Unnamed tributaries to Wakefield Pond	Burrillville	B	NA	No
Tributaries to Wilson Reservoir	Burrillville	B	NA	Yes
Card Machine Brook	Burrillville	A	NA	No
Mowry Brook and tributaries	Burrillville	B	Cold	Yes
Clear River and tributaries	Burrillville	B1	Cold	Yes
Dry Arm Brook and tributaries	Burrillville	B	Warm	Yes
Round Pond	Burrillville	B	NA	No

Water Body Name	Town	Classification and Partial Use	Fishery Designation	Water Body Crossed by the Project
Cedar Swamp Pond	Burrillville	B	NA	No
Keach Brook	Burrillville	NA	NA	No

Classification	Use
A	Primary and secondary contact recreational activities and for fish and wildlife habitat. Suitable for compatible industrial processes and cooling, hydropower, aquaculture uses, navigation, and irrigation and other agricultural uses. These waters shall have excellent aesthetic value.
B	Fish and wildlife habitat and primary and secondary contact recreational activities. Suitable for compatible industrial processes and cooling, hydropower, aquaculture uses, navigation, and irrigation and other agricultural uses. These waters shall have good aesthetic value.
B1	Primary and secondary contact recreational activities and fish and wildlife habitat. Suitable for compatible industrial processes and cooling, hydropower, aquaculture uses, navigation, and irrigation and other agricultural uses. These waters shall have good aesthetic value. Primary contact recreational activities may be impacted due to pathogens from approved wastewater discharges. However, all Class B criteria must be met.
NA	no data found

Source: R.I. Department of Environmental Management. State of Rhode Island Water Quality Regulations, Amended December 2010.

Pursuant to the requirements of Section 305(b) of the Federal Clean Water Act, water bodies that are determined to be not supporting their designated uses in whole or in part are considered impaired, and placed on the Clean Water Act, Section 303(d) List of Impaired Waters where they are prioritized 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. Three impaired waters are within the Study Area: Branch River, Cherry Brook, and Slatersville Reservoir (Table 6-6).

Table 6-6: Impaired Surface Water Resources within the Study Area

Water Body	Impairment
Branch River	Aquatic Macroinvertebrate Bioassessments, Copper (Cu), Lead (Pb), Non-Native Aquatic Plants, Enterococcus
Cherry Brook	Copper (Cu), Enterococcus, Fecal Coliform
Slatersville Reservoir	Copper (Cu), Lead (Pb), Non-Native Aquatic Plants

Source: R.I. Department of Environmental Management. State of Rhode Island 2010 303(d) List of Impaired Waters, Final July 2011.

6.4.1 Branch River

The Branch River originates in Burrillville at the confluence of the Clear and Chepachet Rivers. It flows for approximately 16 miles, heading north to North Smithfield, past Slatersville and Forestdale and eventually to the Blackstone River. There are six dams along this river.

6.4.2 Cherry Brook

Cherry Brook is located in the Study Area northwest of the West Farnum Substation in North Smithfield. The headwaters to the brook are in a large wetland system known as Cedar Swamp. The brook flows northwest, crossing the Project ROW, before turning northeast to flow into the City of Woonsocket, where it discharges into the Blackstone River.

6.4.3 Slatersville Reservoirs

The Branch River is impounded to form the Slatersville Reservoirs. The Slatersville Reservoirs include the Upper, Middle and Lower Reservoirs. The Upper Reservoir is located in Burrillville and North Smithfield and is approximately 144 acres. The Middle Reservoir is approximately 102 acres and the Lower Reservoir is approximately 40 acres. Both are located in North Smithfield. The Branch River flows over the Upper, Middle and Lower Dams and continues northeast to its confluence with two tributaries, and then travels along the eastern edge of the Blackstone Gorge area and empties into the Blackstone River. The Slatersville Reservoirs have been designated as Class B waters. The project ROW crosses the confluence of the Upper and Middle Reservoirs over property owned and operated by Holliston Sand and Gravel.

6.5 GROUNDWATER RESOURCES

The RIDEM classifies the state's groundwater resources into four classes and establishes groundwater quality standards for each class. The presence and availability of groundwater resources is a direct function of the geologic deposits in the Project area.

Groundwater resources within the Study Area are depicted on Figure 6-4. The majority of the groundwater resources in the Study Area, approximately 66%, are classified by the RIDEM as GA, a designation that RIDEM gives to groundwater resources that are known or presumed to be suitable for drinking water use without treatment but which do not meet any of the priority areas for designation as GAA (RIDEM designates approximately 70% of groundwater in RI as GA). Approximately 32% of the groundwater resources in the Study Area, are classified as GAA, or known or presumed to be suitable for drinking water use without treatment and are either a part of the state's major stratified drift aquifers that are capable of serving as a significant public supply source, or are a RIDEM delineated wellhead protection area. Three small isolated pockets of groundwater, approximately 1% of the Study Area, are classified as GB, or groundwater that may not be suitable for drinking water use without treatment (RIDEM, 2010). There are no sole source aquifers designated within the Project Study Area (USEPA, 2008).

6.6 VEGETATION

The Study Area contains a variety of vegetative cover typical of Southern New England. These include oak/pine forest, old field, and managed lawn. This section of the report focuses on upland communities. Wetland communities are discussed in Section 6.7 of this report.

6.6.1 Oak/Pine Forest Community

Forested cover types within the Study Area are typically dominated by oaks (*Quercus* spp.) with or without a white pine (*Pinus strobus*) component. Although these woodlands may appear similar throughout the Study Area, differences in the structure and composition of species in these forests may occur between sites. Soil moisture holding capacity and slope aspect are important factors in determining the plant associations present at a particular site. Plant associations growing on hilltops and south facing slopes are likely to face moisture deficits during the summer. Sandy soils associated with glacial outwash deposits have lower moisture holding capacity in comparison with soils formed over deposits of glacial till. Forests established in these drier sites are often characterized by smaller and more widely spaced trees in comparison with more mesic sites.

Common associates of the hilltop oak/pine forests in the vicinity of the Project ROW include black (*Quercus velutina*), scarlet (*Q. coccinea*), and white oaks (*Q. alba*) as well as aspen (*Populus sp*.) and gray birch (*Betula populifolia*). The shrub/sapling understory includes such species as black cherry (*Prunus serotina*), lowbush blueberry (*Vaccinium angustifolium*) and greenbrier (*Smilax rotundifolia*). Sheep laurel (*Kalmia angustifolia*) and sweet fern (*Comptonia peregrina*) occasionally occur in openings between oak stands with canopy openings and on rocky slopes. Herbaceous species include bracken fern (*Pteridium aquilinum*), tree clubmoss (*Lycopodium obscurum*) and hayscented fern (*Dennstaedtia punctilobula*). These hilltop communities occur where excessively drained soils predominate, and on hilltops throughout the Study Area.

There is an increase in the diversity within plant communities on midslopes compared with dry hilltops. The increase in soil moisture produces this greater diversity in trees, shrubs and herbs. Midslope tree species in addition to oaks include black birch (*Betula lenta*), white ash (*Fraxinus americana*), American beech (*Fagus grandifolia*) and several species of hickory (*Carya* spp.). Shrubs include witch hazel (*Hamamelis virginiana*), sassafras (*Sassafras albidum*) and ironwood (*Carpinus caroliniana*). Greenbrier and poison ivy (*Toxicodendron radicans*) are also common in this community. Common groundcover species include tree clubmoss and wintergreen (*Gaultheria procumbens*). Midslope oak/pine communities occur on mesic mid-slope and lower slope positions and adjacent to forested wetlands on the uncleared portion of the ROW.

6.6.2 Old Field Community

Upland vegetation within the cleared portions of the ROW is typically representative of an old field successional community. Old field communities are established through the process of natural succession from cleared land to mature forest. Within the cleared ROW, periodic vegetation management has favored the establishment and persistence of grasses and herbs. Over time, pioneer woody plant species including gray birch, sumac (*Rhus sp.*) and eastern red cedar (*Juniperus virginiana*) have become established.

Within the cleared portions of the ROW, vegetation varies considerably. On dry hilltops, little bluestem (*Schizachyrium scoparium*), bluets (*Houstonia caerulea*), sweet fern *(Comptonia peregrina)* and eastern red cedar are common. On the mid-slope, greenbrier and blackberry (*Rubus* sp.) form dense, impenetrable thickets. Numerous herbs including goldenrod (*Solidago* sp.), sheep sorrel (*Rumex acetosella),* wild indigo (*Baptisia tinctoria*), and mullein (*Verbascum thapsus*) are also common.

6.6.3 Upland Scrub-Shrub Community

The Project ROW has been managed to selectively remove trees so they do not interfere with the operation of the existing transmission lines. Shrubs 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. Mature forest containing northern red oak and red maple (*Acer rubrum*) are also present along the corridor, and saplings of these species are occasionally found in the ROW.

6.6.4 Managed Lawn/Grass

Portions of the cleared ROW contain managed residential lawn. Typically these areas consist of a continuous grass cover which may include Kentucky bluegrass (*Poa pratensis*), red fescue (*Festuca rubra*), clover (*Trifolium* sp.), and plantains (*Plantago* sp.). Ornamental shrubs may also occur within these areas.

6.6.5 Agricultural Areas

Based on the existing land use mapping obtained from the RIGIS and field survey, the ROW crosses agricultural lands in North Smithfield and Burrillville, including pasture land, nurseries and tree farms, and cropland.

6.7 WETLANDS

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

6.7.1 Study Area Wetlands

State-regulated freshwater wetlands and/or streams have been identified and delineated within the ROW. 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 proximate to the proposed Project. Wetlands outside the ROW, within the overall 5,000-foot corridor Study Area, were identified based on a desktop review of RIGIS wetlands data (RIGIS, 1993). Figure 6-5 depicts wetland resources within the Study Area based on the results of this desktop analysis.

In accordance with the provisions of the *Rhode Island Fresh Water Wetlands Act and Rules and Regulations Governing the Administration and Enforcement of the Freshwater Wetlands Act* (RIDEM, 2010) (the "Rules"), State-regulated freshwater wetlands include swamps, marshes, bogs, forested or shrub wetlands, emergent plant communities and other areas dominated by wetland vegetation and showing wetland hydrology. Swamps are defined as wetlands dominated by woody species and are three acres in size, or greater. Marshes are wetlands dominated by "bog" species and generally support sphagnum moss. Bogs have no minimum size criteria. Emergent wetland communities are areas similar to marshes in vegetation composition; however, they are less than one acre in size. Forested and shrub wetlands are similar to swamps, but do not meet the three-acre size criteria. The upland area within 50 feet of the edge of a swamp, marsh, or bog is regulated as the 50-foot Perimeter Wetland under the Rules. Emergent wetland communities, forested wetlands, and shrub wetlands do not merit a 50-foot Perimeter Wetland.

The Act also regulates activities in and around streams and open water bodies which include rivers, streams, ponds, ASSF, areas subject to flooding ("ASF") and floodplains. A river is any perennial stream indicated by a blue line on a USGS topographic map. If a stream or river is less than 10 feet wide, the area within 100 feet of each bank is regulated as a 100-foot riverbank wetland. If the stream or river is greater than 10 feet wide, the area within 200 feet of each bank is regulated as a 200-foot riverbank wetland. A pond is an area of open standing or slow moving water present for six or more months during the year and at least one quarter of an acre in size. Ponds have a 50-foot perimeter wetland associated with their boundary. An ASSF is defined as any body of flowing water as identified by a scoured channel or change in vegetative composition or density that conveys storm runoff into or out of a wetland. ASSFs include drainage swales and channels that lead into, out of, pass through, or connect other freshwater wetlands or coastal wetlands, and that carry flows resulting from storm events, but may remain relatively dry at other times. ASFs include, but are not limited to, floodplains, depressions or low lying areas flooded by rivers, streams, intermittent streams, or areas subject to storm flowage which collect, hold, or meter out storm and flood waters. ASSF and ASFs are not assigned perimeter or riverbank wetlands.

6.7.1.1 Pond

The boundary of a pond is determined by the extent of water which is delineated and surveyed. Named ponds located within the Study Area are Pratt Pond, Forestdale Pond, Todd's Pond, Primrose Pond, Tarklin Pond, Trout Brook Pond, Slatersville Reservoir, Big Round Top Pond, Little Round Top Pond, Round Pond, and Cedar Swamp Pond (Refer to Figure 2-2) (RIGIS, 2010). In addition to these ponds, there are 67 unnamed ponds within the Study Area (RIGIS, 1989).

6.7.1.2 Swamp

Swamps are defined as areas at least three acres in size, dominated by woody vegetation, where groundwater is at or near the surface for a significant part of the growing season. A 50-foot Perimeter Wetland is applied to both forested and shrub swamps. Shrub swamps are areas dominated by broad-leaved deciduous shrubs and often have an emergent herbaceous layer. Dominant species in shrub swamps include sweet pepperbush, highbush blueberry, winterberry, swamp azalea, and silky dogwood (*Cornus amomum*). Drier portions of shrub swamps are often densely overgrown with greenbrier and blackberry (*Rubus allegheniensis*). Common species in the herbaceous layer include sensitive fern (*Onoclea sensibilis*), skunk cabbage (*Symplocarpus foetidus*) and cinnamon fern (*Osmunda cinnemomea*). Shrub swamp generally occurs in areas where the wetland crosses the managed portion of the ROW.

Forested swamps mainly occur on the edges of the managed ROW where the shrub swamps are present, but where the tree cover is allowed to dominate. Vegetation in a forested swamp includes red maple, willow (*Salix sp*.), black gum (*Nyssa sylvatica*), alder (*Alnus sp.*), silky dogwood, sweet pepperbush, winterberry, swamp azalea, cinnamon fern, common reed (*Phragmites sp*.), and peat moss (*Sphagnum spp*.).

Two forested wetland areas within the ROWs contain Atlantic white cedar (*Chamaecyparis thyoides*) trees. These cedar swamps are a rare biological and cultural resource in the northeast. In Burrillville, within the proposed 341 Line ROW, Atlantic white cedar trees are present in wetland w03pr165 (southwest of Staghead Drive in Burrillville) within the existing ROW and within the proposed limit of new clearing. Cedar trees are also present in wetland w04pr033 (north of the West Farnum Substation) within the existing ROW and proposed 366 Line ROW limit of clearing. In both locations the cedar trees are 30 to 50 feet tall and no regeneration is present.

There are 140 swamps within the Study Area (RIGIS, 1993).

6.7.1.3 Marsh/ Emergent Wetlands/ Wet Meadows

Marshes are wetlands at least one acre in size where water is generally above the surface of the substrate and where the vegetation is dominated by emergent herbaceous species. Marshes are the dominant cover type in several large wetlands within the ROW. Marsh vegetation is typically dominated by broad-leaved cattail (*Typha latifolia*), tussock sedge (*Carex stricta*), and reed canary grass (*Phalaris arundinaceae*), with lesser amounts of common reed, sensitive fern, skunk cabbage, steeplebush (*Spiraea tomentosa*), marsh fern (*Thelypteris palustris*), and soft rush (*Juncus effusus*).

Emergent wetlands and wet meadows within the Project ROW are characterized by cattail, bulrush (*Scirpus pungens*), woolgrass (*Scirpus cyperinus*), soft rush, sensitive fern, and reed canary grass. Within the Study Area there are 161 wetlands that are identified as marsh, emergent wetlands or wet meadows (RIGIS, 1993).

6.7.1.4 River / Perennial Stream

A River is typically a named body of water designated as a perennial stream by the U.S. Geological Survey (a blue line stream on a USGS topographic map). A perennial stream maintains flow year-round, and is also designated as a solid blue line on a USGS topographic map. In this Study Area there are 123 rivers and perennial streams (NHD, 1993).

6.7.1.5 Stream / Intermittent Stream

A stream is any flowing body of water or watercourse other than a river which flows during sufficient periods of the year to develop and maintain defined channels. Such watercourses carry groundwater discharge and/or surface water runoff. Such watercourses may not have flowing water during extended dry periods but may contain isolated pools or standing water. Smaller unnamed streams may also be encompassed within a particular wetland. There are 37 mapped intermittent streams within the Study Area (NHD, 1993).

6.7.1.6 Shrub / Forested Wetland

Shrub wetlands in the transmission line ROW are dominated by highbush blueberry, sweet pepperbush, arrowwood, maleberry, meadowsweet, steeplebush, and greenbrier with minor amounts of emergent plant community species such as skunk cabbage and cinnamon fern. There are 487 shrub/forested wetlands (less than 3 acres in size) present within the Study Area (RIGIS, 1993).

6.7.1.7 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, 2011). These areas within the Study Area include lands surrounding Forestdale Pond and the Branch River (North Smithfield), land area between west of Greenville Road (Route 104) and surrounding the West Farnum Substation (North Smithfield), lands surrounding Cherry Brook (North Smithfield), lands surrounding Todd's Pond (North Smithfield), lands to the east of Tarkiln Pond (North Smithfield), lands surrounding Trout Brook Pond (North Smithfield), lands surrounding Slatersville Reservoir and associated streams (North Smithfield), lands surrounding Tucker Brook (Burrillville), lands surrounding the Chockalog River (Burrillville), lands surrounding Big Round and Little Round Top Ponds and Round Top Brook (Burrillville), and lands surrounding the Clear River and the Dry Arm Brook (Burrillville). Other unnamed watercourses may also contain 100-year floodplain though they are not mapped.

In addition, the Project Study Area includes the FEMA mapped floodway surrounding Cherry Brook in North Smithfield. According to FEMA, a "Regulatory Floodway" means the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.

6.7.1.8 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 a marked change in vegetative density and/or composition.

6.7.1.9 Special Aquatic Site – Vernal Pools

A vernal pool is a type of special aquatic site that is generally defined as a contained basin that 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, 2011). 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 or 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."

Field investigations for potential vernal pools and amphibian breeding habitats were initially performed in conjunction with the identification and evaluation of wetlands located along the Project ROW during the 2008 field surveys. All wetlands along the ROW with potentially suitable vernal pool/amphibian breeding habitat were again investigated during the spring of 2011 (coinciding with the amphibian breeding season) to confirm the presence/absence of such amphibian breeding activity. A total of 34 vernal pools were identified supporting obligate vernal pool species, including spotted salamanders (*Ambystoma maculatum*), wood frogs (*Rana sylvatica*), and fairy shrimp (*Eubranchipus* spp.). In addition, 22 wetlands along the ROW were observed to provide amphibian breeding habitat, due to evidence of breeding by facultative vernal pool species such as the spring peeper (*Pseudacris crucifer*) or gray treefrog (*Hyla versicolor*), or by obligate vernal pool species occurring together with fish populations.

6.8 WILDLIFE

As previously described, the Project passes through a variety of aquatic and terrestrial habitats. The wildlife assemblages present within the Study Area vary according to habitat characteristics. An overall list of wildlife species expected to occur within the transmission line Study Area was compiled. In addition, a breeding bird survey was conducted along the ROW during the spring of 2008, and is discussed further in Section 6.8.1. This list encompasses the expected and observed (observed birds indicated with an *) birds within the Study Area. It should be noted that individual species may not occur in one particular area as opposed to another, but may be found in the general area of the transmission line. A list of amphibians, reptiles, birds, and mammals expected to occur within a given habitat are provided in Table 6-7. 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).

6.8.1 Breeding Birds

An inventory of potential breeding birds in the Study Area was compiled based on a review of published data concerning breeding birds in Rhode Island, field reconnaissance of the subject ROW (Spring 2008), and agency consultation. *The Atlas of Breeding Birds of Rhode Island* (Enser, 1992) was the primary source consulted to determine which bird species are likely to breed in the Study Area. Bird species observed or expected to inhabit areas along the ROW are listed in Table 6-7 below.

6.8.2 Fisheries

There are six Designated Trout Waters, which are waters annually stocked with trout (*Oncorhynchus* spp.) by the RIDEM, located within the Study Area: Branch River, Clear River, Round Top Brook, Round Top Ponds (2), and Tarkiln Pond. In addition to trout, other common gamefish species expected to exist in the vicinity of the Project include largemouth bass (*Micropterus salmoides*), northern pike (*Esox lucius*), calico bass (*Pomoxis* sp.), and yellow perch (*Perca flavescens*). Other fish species expected to exist in the Project vicinity include bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*), white perch (*Morone americana*), chain pickerel (*Esox niger*), carp (*Cyprinus carpio*), brown bullhead (*Ameiurus nebulosus*), and a variety of minnows and other species.

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Table 6-7: Expected and Observed Wildlife Species within the Study Area

	Terrestrial Habitats					Aquatic Habitats						
	Oak/ Pine Forest	**Shrub/ Old Field**	**Cultivated Field**	**Grass Field**	**Managed Lawn**	**Sedge Meadow**	**Shallow Marsh**	**Shrub Swamp**	**Pond**	**Stream**	**River**	**Riparian**
Amphibians and Reptiles												
American Bullfrog							X	X	X	X	X	X
American Toad	X	X	X	X		X	X	X	X			X
Black Rat Snake	X	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	X	X	X
Common Snapping Turtle	X	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								
Eastern Smooth Green Snake	X	X		X		X	X	X				
Eastern Worm Snake	X	X	X									
Four-toed Salamander	X					X	X	X		X		
Fowler's Toad	X	X	X	X		X	X	X	X			X
Green Frog						X	X	X	X	X	X	X
Gray Treefrog	X					X	X	X	X			X
Marbled Salamander	X							X	X			X
Northern Black Racer	X	X		X			X	X				X
Northern Dusky Salamander	X									X		X
Northern Redback Salamander	X						X					
Northern Red-bellied Snake	X	X						X				
Northern Ringneck Snake	X											
Northern Spring Peeper	X					X	X	X	X			X
Northern Two-lined Salamander	X									X		X
Northern Water Snake						X	X	X	X	X	X	X
Pickerel Frog	X			X		X	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			X
Wood Frog	X					X	X	X				X
Wood Turtle	X	X	X	X		X	X	X	X	X	X	X
Birds												
Acadian Flycatcher	X											X

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	Terrestrial Habitats					Aquatic Habitats						
	Oak/ Pine Forest	Shrub/ Old Field	Cultivated Field	Grass Field	Managed Lawn	Sedge Meadow	Shallow Marsh	Shrub Swamp	Pond	Stream	River	Riparian
American Black Duck						X	X	X	X	X	X	X
American Crow *	X	X	X	X								
American Goldfinch *	X	X	X	X		X	X	X				X
American Kestrel	X	X	X	X		X	X					
American Redstart *	X											
American Robin *	X	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
Bank Swallow	X	X	X	X		X	X		X	X	X	
Barn Owl			X	X								
Barn Swallow *	X			X		X	X		X	X	X	X
Barred Owl	X	X		X								X
Belted Kingfisher *									X	X	X	X
Black & White Warbler *	X											X
Black-billed Cuckoo	X	X										
Black-capped Chickadee *	X	X						X				X
Black-throated Green Warbler *	X											
Blue-gray Gnatcatcher	X	X						X				
Blue Jay *	X	X		X								X
Blue-winged Warbler *	X	X		X				X				
Bobolink				X		X	X					
Broad-winged Hawk	X			X								
Brown Creeper	X											X
Brown Thrasher	X	X										X
Brown-headed Cowbird *	X	X	X	X			X					X
Bufflehead										X	X	
Canada Goose *			X	X	X	X	X		X	X	X	X
Canada Warbler	X							X				X
Carolina Wren *	X	X										X
Cedar Waxwing	X	X						X				X
Chestnut-sided Warbler *		X						X				
Chimney Swift *		X	X	X		X						
Chipping Sparrow *	X		X	X								
Common Grackle *	X		X	X		X	X	X				X
Common Merganser	X								X	X	X	X

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	Terrestrial Habitats					Aquatic Habitats						
	Oak/ Pine Forest	**Shrub/ Old Field**	**Cultivated Field**	**Grass Field**	**Managed Lawn**	**Sedge Meadow**	**Shallow Marsh**	**Shrub Swamp**	**Pond**	**Stream**	**River**	**Riparian**
Common Nighthawk	X	X	X	X		X						X
Common Redpoll	X	X	X	X			X	X				
Common Yellowthroat *	X	X				X	X	X	X			X
Cooper's Hawk *	X	X		X								
Dark-eyed Junco	X			X								
Downy Woodpecker *	X	X										X
Eastern Bluebird *	X	X		X				X				X
Eastern Kingbird *	X	X		X		X	X	X			X	X
Eastern Meadowlark			X	X					X			
Eastern Phoebe *	X	X		X				X				
Eastern Screech Owl	X	X		X		X	X					X
Eastern Towhee *	X	X										
Eastern Wood-Pewee	X	X						X				X
European Starling	X	X	X	X								X
Evening Grosbeak	X											X
Field Sparrow *		X	X	X								
Fish Crow							X		X	X	X	X
Fox Sparrow	X	X										X
Grasshopper Sparrow			X	X								
Golden-crowned Kinglet	X							X				X
Golden-winged Warbler	X	X										
Gray Catbird *	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										
Great Horned Owl	X	X	X	X		X	X	X				X
Green Heron *	X					X	X	X	X	X	X	X
Hairy Woodpecker *	X											X
Hermit Thrush	X	X						X				
Herring Gull											X	
Hoary Redpoll		X	X	X			X	X				
Hooded Merganser	X								X	X	X	
Hooded Warbler	X	X						X				
Horned Lark			X	X								
House Finch	X											
House Sparrow *			X	X								

	Terrestrial Habitats					Aquatic Habitats						
	Oak/ Pine Forest	Shrub/ Old Field	Cultivated Field	Grass Field	Managed Lawn	Sedge Meadow	Shallow Marsh	Shrub Swamp	Pond	Stream	River	Riparian
House Wren *	X	X		X				X				X
Indigo Bunting	X	X		X								X
Killdeer			X			X						X
Lapland Longspur			X	X								
Least Bittern							X					
Least Flycatcher	X											X
Louisiana Waterthrush	X									X		X
Mallard			X	X		X	X	X	X	X	X	X
Mourning Dove *	X	X	X	X								
Mute Swan			X	X		X	X	X	X	X	X	
Nashville Warbler *	X							X				X
Northern Bobwhite	X	X	X	X								
Northern Cardinal *	X	X						X				X
Northern Flicker *	X	X	X	X								
Northern Goshawk	X	X		X								
Northern Mockingbird *	X	X						X				
Northern Rough-winged Swallow *	X	X	X	X		X	X		X	X		X
Northern Saw-whet Owl	X											X
Northern Shrike	X	X		X		X	X					
Northern Waterthrush *	X							X				
Orchard Oriole *	X											X
Ovenbird *	X											
Pine Grosbeak	X		X									
Pine Siskin	X	X		X				X				X
Pine Warbler *	X											
Prairie Warbler *	X	X										X
Purple Finch	X	X										
Purple Martin		X	X	X		X	X		X	X	X	X
Red-bellied Woodpecker *	X											X
Red-breasted Nuthatch	X											X
Red-eyed Vireo *	X											X
Red-shouldered Hawk	X							X				X
Red-tailed Hawk *	X	X	X	X				X				
Red-winged Blackbird *			X	X		X	X	X	X			X
Ring-necked Pheasant		X	X	X								
Rock Dove			X									

	Terrestrial Habitats					Aquatic Habitats						
	Oak/ Pine Forest	**Shrub/ Old Field**	**Cultivated Field**	**Grass Field**	**Managed Lawn**	**Sedge Meadow**	**Shallow Marsh**	**Shrub Swamp**	**Pond**	**Stream**	**River**	**Riparian**
Rose-breasted Grosbeak *	X	X						X				X
Rough-legged Hawk		X	X	X		X	X	X				
Ruby-crowned Kinglet	X											
Ruby-throated hummingbird*	X	X										
Ruffed Grouse	X	X										
Rusty Blackbird												X
Savannah Sparrow			X	X		X	X					
Scarlet Tanager *	X											
Sharp-shinned Hawk	X										X	
Snow Bunting			X	X		X	X					
Solitary Sandpiper *							X					
Song Sparrow *	X	X	X	X		X	X	X				X
Sora Rail						X	X	X	X			
Spotted Sandpiper				X					X	X	X	X
Swamp Sparrow *						X	X	X	X			X
Tree Swallow *	X	X	X	X		X	X	X	X	X	X	X
Tufted Titmouse *	X	X						X				X
Turkey Vulture *	X	X	X	X				X	X			
Veery *	X											
Virginia Rail							X					
Warbling Vireo *	X	X										X
Whip-poor-will	X	X		X								
White-breasted Nuthatch *	X	X										
White-eyed Vireo	X	X						X				X
White-throated Sparrow	X	X		X								
Wild Turkey *	X	X	X	X								
Willow Flycatcher	X	X										
Wilson's (Common) Snipe		X				X	X	X				X
Winter Wren	X							X				X
Wood Duck *	X						X	X	X	X	X	X
Wood Thrush *	X											X
Worm-eating Warbler	X											
Yellow-bellied Sapsucker	X											X
Yellow-billed Cuckoo	X	X						X				
Yellow-throated Vireo *	X											X
Yellow Warbler *	X	X						X				

	Terrestrial Habitats					Aquatic Habitats						
	Oak/ Pine Forest	**Shrub/ Old Field**	**Cultivated Field**	**Grass Field**	**Managed Lawn**	**Sedge Meadow**	**Shallow Marsh**	**Shrub Swamp**	**Pond**	**Stream**	**River**	**Riparian**
Mammals												
Beaver	X						X	X	X	X	X	X
Big Brown Bat	X	X	X	X		X	X	X	X	X	X	X
Bobcat	X	X		X		X		X				
Coyote	X	X		X		X	X	X				X
Deer Mouse	X	X										
Eastern Chipmunk	X	X		X								
Eastern Cottontail	X	X		X		X	X	X				X
Eastern Mole	X	X	X	X								
Eastern Pipistrelle	X	X	X	X		X	X	X	X	X	X	X
Ermine	X	X	X	X			X	X				X
Fisher	X	X										
Gray Fox	X	X				X	X	X				X
Gray Squirrel	X											X
Hoary Bat	X	X	X	X		X	X	X	X	X	X	X
House Mouse		X	X	X								
Little Brown Myotis	X	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
Meadow Vole	X	X		X		X	X	X				X
Masked Shrew	X	X		X		X	X	X				X
Mink	X					X	X	X	X	X	X	X
Muskrat						X	X	X	X	X	X	X
New England Cottontail	X	X		X		X	X	X				X
Northern Flying Squirrel	X											
Northern Myotis	X	X	X	X		X	X	X	X	X	X	X
Northern Short-tailed Shrew	X	X		X		X	X	X				X
Norway Rat		X	X	X								
Raccoon	X	X	X	X		X	X	X				X
Red Bat	X	X	X	X		X	X	X	X	X	X	X
Red Fox	X	X	X	X		X	X	X				X
Red Squirrel	X											
River Otter	X						X	X	X	X	X	X
Silver-haired Bat	X	X	X	X		X	X	X	X	X	X	X
Snowshoe Hare	X	X					X					
Southern Bog Lemming	X	X		X		X	X					X

	Terrestrial Habitats					Aquatic Habitats						
	Oak/ Pine Forest	**Shrub/ Old Field**	**Cultivated Field**	**Grass Field**	**Managed Lawn**	**Sedge Meadow**	**Shallow Marsh**	**Shrub Swamp**	**Pond**	**Stream**	**River**	**Riparian**
Southern Flying Squirrel	X											
Southern Red-backed Vole	X	X	X	X								X
Star-nosed Mole						X	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
White-tailed Deer	X	X	X	X		X	X	X				X
Woodchuck	X	X	X	X								
Woodland Vole	X	X		X				X				

Legend:
X = Expected
Source: DeGraaf and Yamasaki, 2001
* = Observed during 2008 avian field surveys

6.8.3 Rare and Endangered Species

Project correspondence regarding federal and state listed species is included in Appendix L, Agency Consultation Letters.

6.8.3.1 Federal-listed Species

Correspondence (refer to Appendix L) from the United States Fish and Wildlife Service ("USFWS") (September 4, 2007, May 13, 2009, January 3, 2011, and January 17, 2012), including review of the USFWS Endangered Species Consultation Procedure, available on their website, indicates that no Federal-listed and/or proposed, endangered, or threatened species or critical habitat are known to occur in the Project area. As such, preparation of a Biological Assessment and further Endangered Species Act consultation or coordination is not required for this Project.

6.8.3.2 State-listed Species

AECOM, on behalf of National Grid, consulted with the Rhode Island Natural History Survey ("RINHS") regarding state-listed species in the Project area. Correspondence (refer to Appendix L) from the RINHS (E. Endrulat, June 11, 2007 and D. Gregg, March 25, 2011) indicated the presence of several state-listed plant species within a 5,000-foot buffer around the ROW, including slender gerardia (*Agalinis tenuifolia*), pale corydalis (*Capnoides sempervirens = Corydalis sempervirens*), grass-leaf arrowhead (*Sagittaria graminea*), zigzag bladderwort (*Utricularia subulata*), woodland horsetail (*Equisetum sylvaticum*), Northern beech fern (*Phegopteris connectilis*), American yew (*Taxus canadensis*), rose twisted-stalk (*Streptopus lanceolatus*), and dewdrop (*Rubus dalibarda = Dalibarda repens*). In addition, one state-listed dragonfly species, the crimson-ringed whiteface (*Leucchorinia glacialis*) has been mapped within the Study Area. Biological surveys have been completed for these state-listed species to document their presence and extent on the Project ROWs.

Additional correspondence from the RIDEM (P. Jordan, March 12, 2012) indicated the addition of a new state-listed species, green adder's mouth (*Malaxis unifolia*), within the Project area. Biological surveys have been completed for this state-listed species. National Grid will be coordinating with the RIDEM and RINHS to report the findings of the biological surveys and to determine appropriate avoidance/protection measures that should be implemented during construction. Three species previously included in the 2011 data were not included in the 2012 correspondence: rose mandarin, American yew and crimson-winged whiteface dragonfly. A summary of the descriptions and habitat requirements for each of the rare species mapped in the vicinity of the Project is provided below.

Information on rare plant species was obtained from *Vascular Flora of Rhode Island: A List of Native and Naturalized Plants* (Gould et al., 1998), *Rare Native Plants of Rhode Island* (Enser, 2007), *Manual of Vascular Plants of Northeastern United States and Adjacent Canada* (Gleason and Cronquist, 1993), *Newcomb's Wildflower Guide* (Newcomb, 1977), and *The Vascular Plants of Massachusetts: A County Checklist (First Revision)* (Cullina et. al., 2011). Information on the USDA Natural Resources Conservation Service ("NRCS") Plants Profile (http://plants.usda.gov) was also reviewed, as was additional supporting information obtained from other online sources. Information on the state-listed dragonfly species reported to occur within the Study area was obtained primarily from the following references: *Dragonflies Through Binoculars* (Dunkle, 2000), *A Field Guide to the Dragonflies and Damselflies of Massachusetts* (Nikula et al., 2007), *The Odonata of Canada and Alaska, Vol. III* (Walker and Corbet, 1975), and online sources.

Field investigations were conducted by AECOM, on behalf of National Grid, initially in the spring and summer of 2008, in the summer of 2011, and again in the spring of 2012. Field surveys of state-listed plant species were performed during the 2011 field season on the following dates: July 6 to 7, 2011; July 21, 2011; August 3, 2011; and September 13 to 14, 2011. During the 2011 field surveys, observations of Eastern box turtles (*Terrapene carolina*) were made in distinct locations within the ROW. Additional field surveys were preformed on June 8, 2012 for green adder's mouth, Northern beech fern, dewdrop, and the crimson-winged whiteface dragonfly. Surveys for the crimson-ringed whiteface dragonfly were performed during the peak flight period, as recommended by the Rhode Island Division of Fish and Wildlife ("RIDFW"). The survey protocol submitted to the RIDFW in the application for a Scientific Collection permit was approved in August 2011.

The field investigations performed during the 2008, 2011, and 2012 field seasons have confirmed the presence of slender gerardia, a young American yew seedling, pale corydalis populations, a population of zigzag bladderwort, and a population of grass-leaved arrowhead within the existing ROW. During the 2012 field survey, a striped maple (*Acer pensylvanicum*) sapling was identified in the vicinity of the Project. The striped maple was not previously identified by the RINHS or RIDEM as occurring in the Project vicinity. The field investigations were conducted within open upland grassy meadows and shrub-dominated habitats in the transmission line ROW and access roads. Adjacent upland and wetland habitats potentially impacted by the Project were also investigated.

Due to the sensitivity of locational information on rare species, information regarding the exact locations of state-listed species documented in the recent surveys is not released in this document. Results of rare species surveys will be provided to the RIDEM.

<u>State-Listed Plant Species Descriptions and Habitat Requirements:</u>

- **Slender Gerardia:** Slender gerardia is an annual, herbaceous wildflower in the Figwort Family (*Scrophulariaceae)* that grows in dry woods and fields, or sometimes in damper situations. Blooming time for this species is summer and fall and the flowers are light purple and broadly funnel-shaped. The leaves of the slender gerardia are opposite, entire and very narrow. This species grows to approximately 6 to 24 inches high. Slender gerardia is a state-listed Species of Concern.
- **Rock Harlequin or Pale Corydalis:** Rock harlequin is an annual or biennial wildflower in the Poppy Family (*Papaveraceae*) that grows in dry woods or rocky places. Blooming time for rock harlequin is spring to fall and its flowers are in short racemes. The flowers are rose to pink-purple in color with a yellow tip. The leaves of this species are alternate and finely

divided. This species grows erect, usually branched and to approximately 6 to 24 inches high. Rock harlequin is a state-listed Species of Concern.

- **Grass-leaf Arrowhead:** Grass-leaved arrowhead is an emergent or submerged perennial flowering plant in the Water Plantain Family (*Alismataceae*) that grows in shallow water, swamps, mud, and marshes. This species blooms in the summer. The flowers have white petals and occur in erect clusters in whorls of three from an unbranched stalk. Grass-leaved arrowhead has basal leaves only which are entire with a narrowly lance-shaped or occasionally arrow-shaped flat blade. Grass-leaved arrowhead is a state-listed Species of Concern.
- **Zigzag Bladderwort:** Zigzag bladderwort is a tiny, obscure aquatic plant in the Bladderwort Family (*Lentibulariaceae*). The finely divided underwater leaves bear tiny bladders that entrap minute water life. The two-lipped flowers grow singly or in small cluster at the top of the emergent stalk. The zigzag bladderwort blooms are small, pale-yellow, closed flowers 1 to 2 millimeters in size, and present in the summer. Zigzag bladderwort is a state-listed Species of Concern.
- **Woodland Horsetail:** Woodland horsetail is a slender perennial in the Horsetail Family (*Equisetaceae*). This species grows from creeping rhizomes. The hollow stems are annual with two markedly different sterile and fertile stem types. The woodland horsetail has compound branches and occurs in moist habitats, including cool moist forest habitats. Woodland horsetail is a state-listed Species of Concern.
- **Northern Beech Fern:** Long beech fern is a perennial species in the Marsh Fern Family (*Thelypteridaceae*). This fern grows in rich, moist woodlands. The fronds of the long beech fern are six to ten inches long and are shaped like arrowheads with the lowest pair of leaflets pointing downward at a diagonal. Long beech fern is a State Threatened species.
- **American Yew:** The American yew is a low, straggling evergreen shrub or ground cover in the Yew Family (*Taxaceae*). This shrub grows to three to six feet tall with a spreading appearance. The flat, narrow needles are dark green above and pale green below. The fruits of the American yew are bright red and berry-like. American yew is a state-listed Species of Concern
- **Rose Twisted-stalk:** Rose-twisted stalk is a perennial wildflower in the Lily Family (*Liliaceae*) that grows in cold woods. The blooming time for this species is April to July and the bell-shaped flowers are rose-purple or pink with twisted stalks. The leaves of this plant are egg-shaped and the fruits are a red berry. Rose Twisted-stalk is a State Threatened species.
- **Dewdrop:** Dewdrop is a perennial wildflower in the Rose Family (*Rosaceae*) that grows in rich, wet, woods. This species blooms in the summer with white, erect five-petaled, flowers that are barely taller than the leaves. The dewdrop has heart-shaped, dark green, basal leaves. Dewdrop is State Endangered.

- **Green Adder's Mouth:** Green adder's mouth is a perennial wildflower in the Orchid Family (*Orchidaceae*). This plant grows in open woods, swamps and bogs, and blooms in the summer. Blooms of the flower are greenish flowers are in a short, thick raceme 1-3 inches long. The plant grows approximately 4-10 inches high. The Green adder's mouth is State Endangered.
- **Striped Maple:** Striped maple, also called moosewood, is a small tree or large shrub identified by its conspicuous vertical white stripes on greenish-brown bark. It grows best on shaded, cool northern slopes of upland valleys where it is common on well drained sandy loams in small forest openings or as an understory tree in mixed hardwoods. This very slow growing maple may live to be 100 and is probably most important as a browse plant for wildlife, although the tree is sometimes planted as an ornamental in heavily shaded areas. The striped maple is a State-listed Species of Concern in Rhode Island.

State-Listed Animal Species Descriptions and Habitat Requirements:

- **Crimson-ringed Whiteface:** The Crimson-winged whiteface is a small, delicate dragonfly in the Skimmer Dragonfly family. Preferred habitat is sparsely to well vegetated boggy lakes, ponds, and marshes in forested areas. The mature male Crimson-ringed whiteface has a mostly black body, with some red on the thorax. The base of the abdomen is ringed with red. The face is white and the eyes are dark. Females and immature males have yellow markings instead of red. Immature males are yellow at the base of the abdomen, but the rest of the abdomen is black. Females are similar, but have yellow spots on the abdomen. On older females the spots may fade or turn red. Larvae feed on a wide variety of aquatic insects, such as mosquito larvae, other aquatic fly larvae, mayfly larvae, and freshwater shrimp. They also prey on very small fish and tadpoles. Adult crimson-winged whiteface dragonflies will eat almost any soft-bodied flying insect including mosquitoes, flies, small moths, mayflies, and flying ants or termites. Crimson-ringed Whiteface dragonfly is a state-listed S1 Critically Imperiled species.
- **Eastern box turtle:** The Eastern box turtle is a small, terrestrial turtle ranging from 11.4–16.5 cm (4.5–6.6 in.) in length. It is so named because a hinge on the lower shell (plastron) allows it to enclose head, legs, and tail completely within the upper (carapace) and lower shells. The adult box turtle has an oval, high-domed shell with variable coloration and markings. The carapace is usually dark brown or black with numerous irregular yellow, orange, or reddish blotches. The plastron typically has a light and dark variable pattern, but some may be completely tan, brown, or black. The head, neck, and legs also vary in color and markings, but are generally dark with orange or yellow mottling. The Eastern box turtle has a short tail and an upper jaw ending in a down-turned beak. The male box turtle almost always has red eyes, and females have yellowish-brown or sometimes dark red eyes. Males have a moderately concave plastron (female's are flat), the claws on the hind legs are longer and the tail is both longer and thicker than the females. Hatchlings have brownish-gray carapace with a yellow spot on each scute (scale or plate), and a distinct light colored mid-dorsal keel

(ridge). The plastron is yellow with a black central blotch, and the hinge is poorly developed. The Eastern box turtle is a State Protected species in Rhode Island.

Summary

The field investigations performed during the 2008, 2011, and 2012 field seasons have confirmed the presence of slender gerardia, a young American yew seedling, pale corydalis populations, a population of zigzag bladderwort, and a population of grass-leaved arrowhead within the existing ROW. The Eastern box turtle, and striped maple, species not previously identified by the RINHS or RIDEM, were also documented during the 2011 and 2012 field surveys, respectively. The field investigations were conducted within open upland grassy meadows and shrub-dominated habitats in the transmission line ROW and access roads. Adjacent upland and wetland habitats potentially impacted by the Project were also investigated.

National Grid will continue to consult with the RIDEM and RINHS to ensure that appropriate survey methods and avoidance/protection measures are implemented during construction to avoid adverse impacts to state-listed species.

Due to the sensitivity of locational information on rare species, information regarding the exact locations of state-listed species documented in the recent surveys is not released in this document. Results of rare species surveys will be provided to the RIDEM.

6.9 AIR QUALITY

The National Ambient Air Quality Standards (“NAAQS”) were established by the Federal Clean Air Act Amendments (“CAAA”), and are designed to protect both public health and welfare. Air quality analyses for projects that may impact motor vehicle traffic are required to evaluate their impact on ozone (“O_3”) and carbon monoxide (“CO”).

Rhode Island developed a State Implementation Plan (“SIP”) in 1982 to comply with the 1977 CAAA requirements for O_3 and CO. While three pollutants, CO, Nitrogen Oxide (“NO_x”), and Volatile Organic Compounds (“VOCs”), play a role in O_3 formation, the USEPA determined in 1980 that SIPs must require the reduction of VOCs as the most effective strategy to achieve the O_3 standard. The 1990 CAAA requires states to update their SIPs to evaluate the impact of reducing all three pollutants.

The State of Rhode Island is required by the CAAA to attain the NAAQS “as expeditiously as practicable.” In March 2003, the RIDEM submitted the “Rhode Island Attainment Plan for the One-Hour National Ambient Air Quality Standard” to the USEPA as a revision to the state’s SIP. The plan demonstrated that Rhode Island will attain the one-hour ozone standard by 2007. As required by the USEPA, Rhode Island agreed to submit to the USEPA by December 31, 2004 a mid-course review demonstrating that Rhode Island remained on track to attain the one-hour standard by 2007. In December 2004 the RIDEM submitted the “Mid-Course Review of the Rhode Island Attainment

Plan for the One-Hour Ozone National Ambient Air Quality Standard" to the USEPA which demonstrated that Rhode Island was still on track to attain the one-hour standard by 2007.

The USEPA revoked the one-hour standard as of June 15, 2005 replacing it with a more stringent 8-hour ozone standard. Subsequently, revised planning and emissions reduction efforts were required to focus on achieving the more stringent 8-hour standard.

In February 2008[27], Rhode Island adopted *Rhode Island Attainment Plan for the 8-Hour Ozone National Ambient Air Quality Standard* and the *Revision of the Rhode Island State Implementation Plan to Address Interstate Transport of Pollutants Affecting Attainment and Maintenance of the 8-Hour Ozone and Fine Particulate Matter ($PM_{2.5}$) National Ambient Air Quality Standards*. These standards were to be met by the end of the 2009 ozone season to fulfill requirements of the CAA. The transport plan demonstrates that Rhode Island emissions do not significantly contribute to elevated levels of ozone and fine particulate matter in areas outside of the state's borders that are not in attainment of the NAAQS for those pollutants.

In April 2008, the RIDEM submitted the *Revision of the Rhode Island State Implementation Plan to Address Interstate Transport of Pollutants Affecting Attainment and Maintenance of the 8-Hour Ozone and Fine Particulate Matter ($PM_{2.5}$) National Ambient Air Quality Standards* to the USEPA as a revision to the state's SIP. The plan also demonstrated that emissions from Rhode Island sources do not contribute significantly to downwind ozone non-attainment and will not prevent downwind areas from attaining the NAAQS by their required attainment dates.

As reported in the most recent available monitoring report from RIDEM, *2009 Air Quality Summary State of Rhode Island*[28], the current 8-hour ozone standard (0.075 ppm) was exceeded on one day in 2009, as compared to six days in 2008. Ambient concentrations of the other criteria pollutants continued to comply with the NAAQS. As noted, the 1990 CAAA required Rhode Island, and other ozone nonattainment areas, to implement a variety of measures to limit emissions of ozone precursors (VOCs and NOx) from mobile sources (motor vehicles) and from industrial and commercial sources such as surface coating facilities, power plants and gasoline stations. Although implementation of these measures has reduced ozone levels in the Rhode Island, levels continue to exceed the NAAQS during the summer months. Since Rhode Island's air quality is substantially affected by transport of pollutants into the State, further reductions in emissions in upwind states will be necessary for Rhode Island to attain and maintain compliance with the ozone standard[2].

[27] http://www.dem.ri.gov/programs/benviron/air/8hroztrn.htm
[28] http://www.dem.ri.gov/programs/benviron/air/pdf/aqds2009.pdf

7 DESCRIPTION OF AFFECTED SOCIAL ENVIRONMENT

The EFSB Rules require a detailed description of all environmental characteristics of the proposed site including the physical and social environment on and off site. The Project is located within an existing ROW, some of which is easement and some of which is fee owned by National Grid.

7.1 POPULATION TRENDS

The populations of Burrillville and North Smithfield, Rhode Island (“the Project Towns”) are shown in Table 7-1.

Table 7-1: Project Towns Population Trends, 1990-2000, 2000-2010

				Change			
				1990-2000		2000-2010	
Area	1990	2000	2010	Absolute	Percent	Absolute	Percent
Burrillville	16,230	15,796	15,955	(434)	(2.7%)	159	1.0%
North Smithfield	10,497	10,618	11,967	121	1.2%	1,349	12.7%
State of Rhode Island	1,003,464	1,048,319	1,052,567	44,855	4.5%	4,248	0.4%
Project Towns*	26,727	26,414	27,922	(313)	(1.2%)	1,508	5.7%
Percent of State	2.7%	2.5%	2.7%				

Notes:
* Towns of Burrillville and North Smithfield
( ) Negative
Source: U.S. Department of Commerce, Rhode Island Census, 1990, 2000 and 2010

According to the Rhode Island Statewide Planning projections, the population of the towns will increase slightly between 2000 and 2030.

Table 7-2: Project Town Population Projections, 2000-2030

				Change in Population			
				2000-2020		2020-2030	
Area	2000	2020	2030	Absolute	Percent	Absolute	Percent
Burrillville	15,796	17,439	18,195	1,643	10.4%	756	4.3%
North Smithfield	10,618	11,021	11,207	403	3.8%	186	1.7%
State of Rhode Island	1,048,319	1,111,464	1,140,543	63,145	6.0%	29,079	2.6%
Project Towns *	26,414	28,460	29,401	2,046	7.7%	941	3.3%
Percent of State Population	2.5%	2.6%	2.6%				

Notes:
1 Population projections based on the Rhode Island Statewide Planning (Source data: U.S. Bureau of the Census, 2000)
( ) Negative
Source: U.S. Bureau of the Census, 2000
Rhode Island Statewide Planning Program, 2004

7.2 EMPLOYMENT OVERVIEW AND LABOR FORCE

According to the Rhode Island Economic Development Corporation ("RIEDC"), Rhode Island's economy centers on a number of large and growing industry sectors: health care, financial services, marine products, defense and manufacturing. Located in the midst of the Northeast "knowledge corridor," Rhode Island is also a center of higher education, with such institutions as Brown University, the University of Rhode Island, Providence College, Johnson & Wales and Bryant University. In addition, the U.S. Navy has long had a significant presence in the Newport area, home to the Naval Undersea Warfare Center and the U.S. Naval War College. Rhode Island's well-developed tourism industry, and its range of scenic and cultural attractions, draw visitors from all over the world.

Table 7-3: Labor Force and Employment Estimates, 1990-2010

	Burrillville	North Smithfield	State of Rhode Island
2011			
Labor Force	9,554	6,727	563,413
Employment	8,512	6,100	500,014
Unemployment	1,042	627	63,399
Unemployment rate	10.9%	9.3%	11.3%
2010			
Labor Force	9,724	6,863	570,301
Employment	8,570	6,142	503,576
Unemployment	1,154	721	66,725
Unemployment rate	11.9%	10.5%	11.7%
2000			
Labor Force	9,161	5,858	543,404
Employment	8,817	5,663	520,758
Unemployment	344	195	22,646
Unemployment rate	3.8%	3.3%	4.2%
1990			
Labor Force	8,456	5,562	525,851
Employment	7,941	5,253	493,674
Unemployment	515	309	32,177
Unemployment rate	6.1%	5.6%	6.1%

Source: RI Department of Labor and Training, Labor Market Information

Rhode Island's workforce is known for its high productivity and diverse set of skills. The state's long tradition in metal, electronics, plastic and other manufacturing is complemented by an expanding workforce in financial and business services, life sciences and information technology.

7.3 LAND USE

This section describes existing and projected future land use within the Study Area. The scope of this discussion will address those features which might be affected by the Project.

7.3.1 Study Area Land Use

As depicted in Figure 7-1, several dominant land uses are evident within the Project Area. These general land uses include forest, residential, recreation, agriculture, commercial and institutional.

Most residential development in the Study Area is low-density and northern Rhode Island remains mostly rural. Commercial development is primarily focused along Routes 146 and 102 in North Smithfield, and is characterized by a mixture of uses including shopping plazas, gas stations and restaurants.

7.3.2 Land Use along the Transmission Line Corridor

From an east-to-west oriented view of the ROW, the Project Area begins on the Massachusetts/Rhode Island border north of the junction of Route 146 and Route 102 in North Smithfield. The transmission line heads southeast through forests, residential and commercial areas of North Smithfield where it generally parallels Route 146 and then Pound Hill Road. This area can be described as a mixture of agricultural, forestland, transportation and residential land uses. The ROW heads southwest, crossing Route 146, to the West Farnum Substation in North Smithfield. The area around the West Farnum Substation is mainly wetland and forestland with some residential land use. From the substation, the ROW heads west across Route 5, through mainly forestland and wetlands with some residential land use, to the Slatersville Reservoir and Route 102, to the Sherman Road Switching Station in Burrillville. From the Sherman Road Switching Station the ROW heads west-southwest through forests and light residential areas of Burrillville, across Route 100 and joins the NU ROW at the Rhode Island/Connecticut line south of Wakefield Pond and north of Peck Pond in Burrillville.

7.3.3 Utility Co-location

Portions of the Project ROW are co-located with other existing utility infrastructure, including 115 kV and 345 kV electric transmission lines, electric distribution lines, natural gas pipelines, a petroleum pipeline, fiber optic lines, and municipal sewer and water lines.

7.3.3.1 Electric Transmission and Distribution Lines

The Project ROW and/or associated facilities are shared with several existing National Grid overhead transmission lines, including the following:

Q-143S and R-144 Lines: 115 kV transmission lines, which are located within the Project ROW from the Massachusetts/Rhode Island border southeast to the junction just west of Greenville Road (Route 104). These two lines are installed on separate H-frame structures.

T-172N and S-171N Lines: 115 kV transmission lines. The lines are sited on separate H-frame structures within the Project ROW from the junction just west of Greenville Road (Route 104) southwest to the West Farnum Substation.

315, 332, and 359 Lines: 345 kV lines. Although not co-located within the Project ROW, these lines enter the West Farnum Substation from the south and east.

H-17 Line: 115 kV transmission line. The line is not located within the Project ROW, but connects to the West Farnum Substation from the east.

B-23 Line: 115 kV transmission line. The line runs west and then north within the Project ROW from the West Farnum Substation to just east of the L&RR Landfill Site off of Old Oxford Road in North Smithfield.

328 Line: 345 kV transmission line. The line is co-located within the Project ROW from the West Farnum Substation to the Sherman Road Switching Station. This line will be reconstructed and reconductored as part of this Project.

333 Line: 345 kV transmission line. This line extends from the Sherman Road Switching Station east and southeast to the Ocean State Power Generating Plant.

3361 Line: 345 kV transmission line that enters the Sherman Road Switching Station from the northeast. Approximately 900 feet of this transmission line is owned by National Grid, from the Sherman Road Switching Station to the Rhode Island/Massachusetts border. The Massachusetts portion of this line is owned by NSTAR.

347 Line: 345 kV transmission line. The line is co-located within the Project ROW from the Sherman Road Switching Station west/southwest to the Connecticut/Rhode Island border.

108W61 Line: a 13.8 kV distribution line owned by National Grid is located within the Project ROW from Pound Hill Road in North Smithfield east to the junction just west of Greenville Road (Route 104). The distribution line is located along the northern edge of the maintained ROW and is installed on wood poles.

7.3.3.2 Tennessee Gas Pipeline Company Natural Gas Pipeline

A 16-inch (outside diameter) high pressure natural gas pipeline constructed in the early 1990's and owned by TGP is co-located within the Project ROW in North Smithfield. The pipeline first bisects the Project ROW between Bear Skin Road and Black Plain Road, travelling north then northwest for a distance of approximately 340 feet. The pipeline then again enters the Project ROW just north of

Bear Skin Road and generally runs along the eastern to northern edge of the Project ROW to West Ironstone Road in Burrillville, a distance of approximately 6 miles. The pipeline is centered within a 20-foot wide easement.

7.3.3.3 Algonquin Gas Transmission Natural Gas Pipeline

Natural gas pipelines owned by AGT cross the Project ROW in two locations in Burrillville. At each location, two pipelines are sited within a 75-foot wide easement. A 24-inch pipeline, which was commissioned in 1952, is located on the north side of the easement. A 30-inch pipeline, commissioned in 1956, occupies the south side of the easement.

At the first crossing location, the pipelines pass approximately 70 feet southeast of the Sherman Road Switching Station, and cross the Project ROW immediately southwest of the Sherman Road Switching Station for a distance of approximately 370 feet. At the second crossing location, the pipelines cross the Project ROW for a distance of approximately 370 feet southwest of Wilson Trail adjacent to George Washington Management Area in Burrillville.

7.3.3.4 ExxonMobil Petroleum Pipeline

A 6-inch steel petroleum pipeline owned by ExxonMobil Pipeline Company occupies portions of the Project ROW in North Smithfield. The ExxonMobil line was commissioned in 1933 and extends from East Providence, Rhode Island to Springfield, Massachusetts. The pipeline carries a combination of liquid petroleum products.

In general, the pipeline is located within the Project ROW between the Rhode Island/Massachusetts border south to Greenville Road (Route 104) in North Smithfield. The pipeline has mainly a longitudinal occupation with the National Grid ROW, but does not continuously follow the overhead ROW. The pipeline diverges from the Project ROW in several locations. The existing easement for the petroleum pipeline varies in width from 16 to 33 feet.

7.3.3.5 Fiber Optic Line

There are four fiber optic line crossings of the National Grid Project ROW. The first crossing location is just northwest of East Harkness Road adjacent to Route 146 northbound, and the second is east of Providence Pike (Route 5) in North Smithfield. Two fiber optic cables are located in the National Grid ROW in each of these locations. The third crossing is located west of Greenville Road (Route 104) in North Smithfield, east of the existing Woonsocket Substation. The fourth crossing is located immediately west of Sherman Farm Road (Route 98) in Burrillville.

7.3.3.6 Wireless Facility

National Grid issued a license agreement to a wireless facility owner to operate on property owned in fee by National Grid located on the easterly side of Providence Pike (Route 5) in North Smithfield.

The wireless facility is affixed to an existing National Grid transmission line structure (structure 328-313).

As part of the reconstruction and reconductoring of the existing 328 Line, the existing 328-313 wood H-frame structure will be removed, and a new steel H-frame structure will be installed to the west of the existing structure location. National Grid will coordinate with wireless facility owner on the construction schedule for the 328 Line.

7.3.3.7 Sewer Line

Existing sewer lines are also co-located adjacent to and within the Project ROW. In the Town of North Smithfield, one sewer line enters the Project ROW at Woonsocket Hill Road and traverses east within the ROW for approximately 1,000 feet.

7.3.4 Open Space and Recreation

Several areas of open space, including recreational areas, are present within the Study Area (Figure 7-2).

7.3.4.1 Local and Non-Government Organization Conservation Lands

The ROW passes through the following local and non-governmental conservation lands in North Smithfield and Burrillville:

Greenville Road/Village Way: This 42-acre parcel, owned and managed by the North Smithfield Land Trust, contains fields, woodlands, bogs and rocky outcroppings serving as a wildlife habitat protection area. This property is open for passive recreation, which is walking and hiking.

Old Oxford Road Subdivision: This 6.3-acre parcel is protected as Town of North Smithfield Open Space and Recreation Land. The property is a wooded lot with wetland resources.

Fort Nature Refuge: This 235-acre woodland, owned by the Audubon Society of Rhode Island, gives rise to the headwaters of the Woonasquatucket River. The property contains three small ponds and a variety of deciduous and coniferous forestland and provides open space and recreation including bird watching, hiking and photography.

Wallum Lake Rod and Gun Club: The Wallum Lake Rod and Gun Club is located off Brook Street in the Town of Burrillville. The property contains indoor and outdoor facilities including: archery, skeet, trap, rifle and pistol ranges, an indoor pistol range, banquet hall and an outdoor pavilion. The Wallum Lake Rod and Gun Club has prepared a Conservation Management Plan for their property that they implement with participation from the NRCS.

National Grid has met with representatives of the rod and gun club to discuss the proposed construction and potential mitigation.

Within the 5,000-foot wide Study Area but not crossed by the ROW, additional local and non-governmental organization conservation lands include:

Mattity Swamp: This 11.5-acre parcel is protected as Town of North Smithfield Open Space and Recreation Land. The property is a conservation easement that does not allow access.

Halliwell School: This 15-acre property is protected as Town of North Smithfield Open Space and Recreation Land. The property functions as wellhead protection.

Blackstone Gorge: This property, owned by the Town of North Smithfield, is part of a 100-acre two-state corridor that runs along the Blackstone River. This property provides a scenic outlook.

Branch Village Park: This 7.5-acre property is protected as Open Space by the Town of North Smithfield. The property is part of the larger Branch River Greenway and is listed as a playground/minor park.

Union Village (Cherry Brook Wetland): These properties, protected by the Town of North Smithfield, are associated with the Cherry Brook Wetland. The Cherry Brook drains some of the most urbanized sections of the Town of North Smithfield.

Northern Green Farm: This property, owned by the Agricultural Land Preservation Commission, is approximately 80 acres and located in the southwestern portion of the Study Area.

Cedar Swamp: This property, owned by the Town of North Smithfield, is part of the Cedar Swamp. This swamp is the largest wetland in the Town of North Smithfield.

Mowry Fire Tower: This 7.0-acre property, owned by the Town of North Smithfield, is protected as Open Space without public access. The property contains a 65-foot fire tower.

Barry Memorial Field: Barry Memorial Field, in the City of Woonsocket, is one of the largest sports/recreational parks in Woonsocket. The park is locally funded by the school system and operates year-round.

R-Goal Park: This 20.1-acre property, owned by the Town of North Smithfield, provides a cross-country trail for recreation.

Fayette E. Bartlett Woodland: This 66-acre property is owned by the Audubon Society of Rhode Island. It is located in the Blackstone River corridor in Burrillville.

Buck Hill Association- Lizotte: This 3.8-acre property is associated with the Buck Hill Association/ Round Pond/ Staghead Drive and is privately-owned.

7.3.4.2 Government Conservation Lands

The ROW crosses the following federal and state conservation lands:

Blackstone River Valley National Heritage Corridor: The Blackstone River Valley National Heritage Corridor is a National Heritage Corridor dedicated to the history of the early American Industrial Revolution, including mill towns stretching across 24 cities and towns (400,000 acres in total) near the river's course in Worcester County, Massachusetts and Providence County, Rhode Island. The Towns of North Smithfield and Burrillville are included in this National Corridor. The National Corridor was designated by an Act of Congress on November 10, 1986 to preserve and interpret for present and future generations the unique and significant value of the Blackstone Valley.

Slatersville Reservoirs (Slatersville Pond): The Slatersville Reservoir has three impoundments created by the upper, middle, and lower dams. The impoundment created by the upper dam contains a RIDEM managed cement plank boat ramp and associated parking lot located off of Route 102.

Black Hut Management Area: The Black Hut Management Area is a 1,548-acre property managed by RIDEM and comprised mainly of forestland, wetlands and agricultural land. The management area provides the public with hiking, open space, bird watching and hunting.

Round Top Fishing Area and Wildlife Management Area: The Round Top Fishing Area and Wildlife Management Area is managed by RIDEM and consists of the land surrounding Big Round Top Pond and Little Round Top Pond. This property provides hunting, fishing and boating access to the public.

George Washington Management Area: This 3,489-acre management area on the shores of the Bowdish Reservoir provides hiking, camping, picnicking, fishing, bird watching, and swimming to the public. The management area is comprised on mostly forestland and wetlands.

Within the Study Area but not crossed by the ROW, the Rhode Island state conservation lands are:

Casimir Pulaski Memorial Forest: This 100-acre property is a day-use facility that provides fishing, swimming, hiking, cross-country skiing, and picnicking to the public.

Buck Hill Management Area: This 2,049-acre management area is comprised of mostly forestland, wetlands and agricultural lands protecting an approximately 31-acre wildlife marsh. The property provides open space, hunting, bird watching, wildlife viewing and hiking to the public.

Other areas of open space include lands associated with farmlands, wetlands, streams, and rivers, and educational facilities within the Study Area.

7.3.5 L&RR Superfund Site

The Project ROW crosses the L&RR site, a USEPA-designated National Priorities Listing Superfund Site located on Old Oxford Road in North Smithfield, Rhode Island. The L&RR site is a 28-acre landfill on a 36-acre parcel of land, which extends onto and beyond the National Grid ROW. The L&RR site was originally a sand and gravel pit and was used for small-scale refuse disposal from 1927 to 1974. In 1974, the site was sold and developed into a large-scale disposal facility accepting commercial, municipal, and industrial wastes. The types of hazardous wastes accepted at this site included bulk and drummed organic and inorganic materials in liquid, sludge, and solid forms. In 1979 a polyvinyl chloride cover was placed over the area containing hazardous waste. The site was closed in 1985, and an additional synthetic cover, soil, and vegetation were placed over most of the landfill.

Groundwater at the landfill is contaminated with arsenic, lead and VOCs, and the surface water is contaminated with lead. The USEPA prepared a Record of Decision (“ROD”) dated September 29, 1988 and modified further by an Explanation of Significant Difference (“ESD”) executed March 8, 1991 and again September 16, 1996. The ROD required an upgrade of the existing landfill closure to protect groundwater, to protect wetlands and to meet applicable or relevant and appropriate requirements, treatment of the landfill gas by thermal destruction to reduce the potential risk to public health from inhalation of the landfill vent emissions, and long-term monitoring of the groundwater and air to ensure that the remedy remains protective.

Although the majority of the L&RR site is owned by others, some portions of the site are held in fee by National Grid or subject to National Grid easement. A series of Environmental Land Use Restrictions (“ELURs”) are being negotiated by the property owners and the USEPA and RIDEM. The ELURs are being developed to protect the engineering controls that are in place now, and to protect construction personnel that may work on the site or on adjacent utility infrastructure. Soil Management Plans (“SMP”) will be part of the ELURs and will prescribe how soils are handled on the site. These ELURs will restrict the use of the site, but will allow National Grid to continue to construct, operate and maintain transmission lines through the property, subject to protective measures that will be outlined in the SMP.

7.3.6 Future Land Use

In order to assess future land use, an analysis of current zoning was undertaken. Typically, towns and cities manage future growth through zoning regulations which provide a degree of control over a community. The majority of the Study Area is zoned agricultural or residential in varying densities, with industrial and commercial pockets in North Smithfield. Specifically, the route crosses medium to low density rural residential land within the Study Area in the Towns of North Smithfield and Burrillville. The ROW also crosses an area zoned as a Mill Rehabilitation Zone in the Union Valley section of North Smithfield. The purpose of the Mill Rehabilitation Zone is to maintain the historic mill buildings by converting their use from industrial to mixed use residential.

Currently, forested land that is residentially zoned within the Study Area in the Towns of North Smithfield and Burrillville can be used for future residential development in accordance with the town zoning ordinances. The town ordinances include restrictions and/or prohibitions on development within zoned conservation areas. The Project involves replacement and/or expansion of electric transmission facilities on either existing easements held by National Grid or fee property owned by National Grid. There are areas of agricultural and open pasture land throughout the Study Area (Figure 7-1).

The Town of North Smithfield's Comprehensive Community Plan Five-Year Update, approved September 2005 and updated in August 2007, states that proposals for power line extensions or major improvements to high voltage lines should consider burying lines underground. The Plan suggests that utility ROW should be used to provide pedestrian links between open space and conservation areas. The Plan also recommends the further study of whether or not high tension line maintenance is a threat to the prehistoric archaeological resource known as the "Vegetable Garden Site" located off of Woonsocket Hill Road in the Union Village section of North Smithfield. This site is addressed in a PAL technical report.

The Town of Burrillville Comprehensive Plan, approved June 2004 (revised June 2005), notes that utilities should make every effort to minimize adverse impacts of power transmission facilities to the environment as well as allow for a minimum vegetated buffer between transmission facilities and adjacent properties with special concern given to high energy electromagnetic fields.

7.4 VISUAL RESOURCES

The visual quality of a landscape is defined by the perceived value of its existing pattern of landform (topography), vegetation, land use, and water features.

The Project ROW extends approximately 22.5 miles in Rhode Island through the Towns of North Smithfield and Burrillville. The study area for the visual assessment for this Project was defined as the area within a one mile radius of the ROW. The topography in the study area varies from level plains to gently rolling hills and valleys with elevations ranging from 154 to 782 feet above mean sea level. Land use is a mix of undeveloped forestland (the predominating land cover type), occasional agricultural fields, as well as suburban residential areas. A relatively small area of commercial and industrial development exists in the central to eastern portion of the study area along major transportation routes.

Forest vegetation is primarily an oak-hickory community, intermixed with beech-maple-red oak forest and white pine/oak forest. Mature forest vegetation typically occurs in large intact blocks that provide a strong sense of enclosure and screening along roadways and around residential and commercial areas. There are several lakes, ponds, rivers, and small streams within the study area, but they are typically obscured from direct view by dense forest vegetation.

The study area includes a number of resources/sites that could be considered visually sensitive from a statewide, regional or local perspective. Visually sensitive resources within the study area include 23 sites that are listed on or candidates for listing on the National Register of Historic Places, numerous public recreational sites and several areas designated as scenic by RIDEM. Designated scenic areas within the study area include the Round Pond, Wallum Lake, Wilson Reservoir, and the Wakefield Road/Croft Farm in Burrillville; and the Colwell Road, East Ironside Road, and Grange Road areas in North Smithfield.

Areas of intensive land use in the study area are also considered visually sensitive due to the number of potential viewers. These areas include residential neighborhoods, commercial districts and transportation corridors in North Smithfield and Burrillville. Specific viewer groups within the study area include local residents, recreational users, commuters and through-travelers and business employees.

7.5 NOISE

Environmental sound levels are quantified by 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 dB change in a constant broadband noise "imperceptible" and a 3 dB change "just barely perceptible". Similarly, a 5 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 hertz ("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 decibels, dBA. For reference, the A-weighted sound pressure levels associated with some common noise sources are shown in Table 7-4.

Table 7-4: 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 ft	
130	Threshold of pain	Jet aircraft takeoff at 300 ft	
120	Threshold of feeling	Elevated train	Rock band concert
110	Extremely loud	Jet flyover at 1,000 ft	Inside propeller plane
100	Very loud	Motorcycle at 25 ft, auto horn at 10 ft, crowd noise at football game	
90	Very loud	Propeller plane flyover at 1,000 ft, noisy urban street	Full symphony or band, food blender, noisy factory
80	Moderately loud	Diesel truck (40 mph) at 50 ft	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 ft, 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.

For the most part, the Study Area is characterized by rural and suburban environments, with some commercial land uses, where 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. Receptors to noise include residences, schools, daycare facilities and designated recreational areas.

7.6 CULTURAL AND HISTORIC RESOURCES

In consultation with the RIHPHC, PAL conducted an identification survey consisting of a Phase I(a/b) reconnaissance and a Phase I(c) archaeological testing in 2009. The Phase I (a/b) reconnaissance archaeological survey included archival research and a project site walkover to assess the potential for pre-contact, contact, and post-contact period cultural resources to be present within the existing ROWs. As a result of the reconnaissance, the ROWs were stratified into zones of high, moderate, and low archaeological sensitivity, relative to the probability that potentially significant cultural resources could be expected to be located within those zones.

Zones of high and moderate archaeological sensitivity were identified in sections of the ROWs that have not been substantially disturbed and are situated in attractive environmental settings (elevated terrain, well-drained soils, within 500 meters of a source of water) and/or are within or proximate to identified cultural resources. Poorly drained areas (wetlands) and sections of the existing ROWs substantially disturbed due to land use activities such as sand and gravel mining were identified as zones of low sensitivity. The Phase I(c) archaeological survey consisted of testing the areas of high and moderate sensitivity.

As a permitted undertaking under ACOE review, the cultural resource surveys also included consultation with the Narragansett NITHPO and the Wampanoag Tribe of Gay Head (Aquinnah) WTHPO. PAL was accompanied during field work by these Native American representatives who identified landscape features and locations as “Areas of Interest” or “Areas of Concern.”

PAL completed an identification survey of the Project ROWs in November 2009. The Phase I(c) survey of the 341 Line and 9.2 mile segment of the 328 Line ROWs resulted in the identification or verification of 61 newly identified and previously recorded archaeological sites and historic features. Of these, 39 were pre-contact archaeological sites and find spots, 21 consisted of post-contact sites and/or structural features, and one deposit could be pre- or post-contact in nature. The 341 Line and 328 Line ROWs survey also resulted in the identification of 77 features or groupings of features designated Native American areas of concern and/or interest, and 113 stone walls. Along the 366 Line ROW within Rhode Island, three pre-contact archaeological sites or find spots, four post-contact sites, one Native American area of interest, and 17 stone walls were identified during the survey.

Following the identification surveys of the 341, 328 and 366 Line ROWs in November 2009, PAL conducted archaeological site evaluations (Phase II) in May and June 2010.

Archaeological site evaluations were conducted on six archaeological sites that were considered potentially significant. PAL also conducted an identification survey consisting of a Phase I(a/b) reconnaissance and a Phase I(c) archaeological testing at the Sherman Road Switching Station expansion area in March and April of 2012.

National Grid requested the ACOE to initiate Section 106 Consultation for the Rhode Island portion of the IRP on April 13, 2012.

7.7 TRANSPORTATION

The Study Area is served by a network of interstate, state and local roads and highways. The urban artery in the Study Area running north/south is Route 146, with on/off ramps that cross the ROW at School Street in North Smithfield. Other major north/south routes in the area include Route 102, Route 100 and Route 5.

In addition to multiple local roadway crossings, the Project ROW crosses the following state highways: Route 146 (North Smithfield Expressway); Route 5 (Providence Pike); Route 102

(Broncos Highway); Route 7 (Douglas Turnpike); Route 98 (Sherman Farm Road); Route 96 (Round Top Road); and Route 100 (Wallum Lake Road). Construction access to the ROW may be from any of the local or state roadways described above. National Grid will coordinate with applicable entities for permission to use these public ways for construction access. Access permits for use of state highways will be obtained from the RIDOT prior to construction.

7.8 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. National Grid, like all North American electric utilities, supplies electricity at 60 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 an electromagnetic model.

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 dependent on the magnitude of current flow. The magnitude of the electric field 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 conducting surface, such as trees, fences, walls, buildings, and most types of 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 V.

Magnetic fields are present whenever current flows in a conductor, and are not dependent on the voltage present on the conductor. The magnetic field strength 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. Unlike electric fields, however, most common materials have little shielding effect on magnetic fields.

Magnetic fields are measured in units called Gauss. For the low levels normally encountered during daily activities, however, the field strength is expressed in a much smaller unit, the mG, which is one thousandth of a Gauss.

Electric and magnetic fields from the existing transmission lines were calculated at the edges of the ROW for each of eight segments of the ROW (four segments on the 366 Line ROW and four on the 341 Line ROW) using projected annual average load and annual peak load levels for the year 2015. Table 7-5 shows calculated electric field levels at the edge of the ROW for the eight transmission line segments. Tables 7-6 and 7-7 show the magnetic field levels produced by the existing transmission line(s) on the ROWs under average and peak loads, respectively. The magnetic field at peak loading level is not a good predictor of potential exposure because peak loading on the proposed and existing lines would be expected to occur at most during a few hours on a few days of the year.

Table 7-5: Calculated Pre-IRP Electric Fields (2015) (kV/m) for Segments RI-1 through RI-8

Segment	Cross- Section Number / Figure 2-2 Map Sheet Number	Description	Calculated Electric Fields (kV/m)	
			−ROW edge[1]	+ROW edge[1]
RI-1	RI-366-1 of 6 33-36 of 41	MA/RI border to southeast of Old Great Road	0.02	0.24
RI-2	RI-366-2 of 6 36-37 of 41	southeast of Old Great Road to south of School St.(N)/Main Street	0.01	0.30
RI-3	RI-366-4 of 6 38-39 of 41	Pound Hill Road to northwest of Greenville Road	0.03	0.18
RI-4	RI-366-5 of 6 39-41 of 41	southwest from Greenville Road parallel to Greenville Road	0.56	0.03
RI-5	RI-341-5 of 5 26-32 of 41	West Farnum Substation to the L&RR Superfund Site	0.06	1.21
RI-6	RI-341-3 of 5 16-25 of 41	west of L&RR Superfund Site to Sherman Road Switching Station	0.09	1.19
RI-7	RI-341-2 of 5 9-16 of 41	Sherman Road Switching Station to west of Clear River	0.04	0.09
RI-8	RI-341-1 of 5 1-8 of 41	west of Clear River to RI/CT border	1.19	0.09

[1] -ROW edge is the east edge in ROW segments RI-1-3, the southeast edge in ROW segment RI- 4, and the south edge in ROW segments RI-5-8.

+ROW edge is the west edge in ROW segments RI-1-3, the northwest edge in ROW segment RI-4, and the north edge in ROW segments RI-5-8.

Table 7-6: Calculated Pre-IRP Magnetic Fields (2015) (mG) for Segments RI-1 through RI-8, (Annual Average Load)

Segment	Cross- Section Number / Figure 2-2 Map Sheet Number	Description	Calculated Magnetic Fields (mG)	
			−ROW edge[1]	+ROW edge[1]
RI-1	RI-366-1 of 6 33-36 of 41	MA/RI border to southeast of Old Great Road	1.0	0.7
RI-2	RI-366-2 of 6 36-37 of 41	southeast of Old Great Road to south of School St.(N)/Main Street	0.8	1.2
RI-3	RI-366-4 of 6 38-39 of 41	Pound Hill Road to northwest of Greenville Road	1.0	0.8
RI-4	RI-366-5 of 6 39-41 of 41	southwest from Greenville Road parallel to Greenville Road	22.7	3.7
RI-5	RI-341-5 of 5 26-32 of 41	West Farnum Substation to the L&RR Superfund Site	5.7	35.3
RI-6	RI-341-3 of 5 16-25 of 41	west of L&RR Superfund Site to Sherman Road Switching Station	5.8	35.5
RI-7	RI-341-2 of 5 9-16 of 41	Sherman Road Switching Station to west of Clear River	0.6	1.1
RI-8	RI-341-1 of 5 1-8 of 41	west of Clear River to RI/CT border	6.6	1.1

[1] -ROW edge is the east edge in ROW segments RI-1-3, the southeast edge in ROW segment RI-4, and the south edge in ROW segments RI-5-8.

+ROW edge is the west edge in ROW segments RI-1-3, the northwest edge in ROW segment RI-4, and the north edge in ROW segments RI-5-8.

Table 7-7: Calculated Pre-IRP Magnetic Fields (2015) (mG) for Segments RI-1 through RI-8, (Annual Peak Load)

Segment	Cross- Section Number / Figure 2-2 Map Sheet Number	Description	Calculated Magnetic Fields (mG)	
			−ROW edge[1]	+ROW edge[1]
RI-1	RI-366-1 of 6 33-36 of 41	MA/RI border to southeast of Old Great Road	3.0	11.9
RI-2	RI-366-2 of 6 36-37 of 41	southeast of Old Great Road to south of School St.(N)/Main Street	2.3	15.5
RI-3	RI-366-4 of 6 38-39 of 41	Pound Hill Road to northwest of Greenville Road	3.1	9.8
RI-4	RI-366-5 of 6 39-41 of 41	southwest from Greenville Road parallel to Greenville Road	57.9	9.3
RI-5	RI-341-5 of 5 26-32 of 41	West Farnum Substation to the L&RR Superfund Site	4.9	31.1
RI-6	RI-341-3 of 5 16-25 of 41	west of L&RR Superfund Site to Sherman Road Switching Station	5.2	31.5
RI-7	RI-341-2 of 5 9-16 of 41	Sherman Road Switching Station to west of Clear River	2.4	4.2
RI-8	RI-341-1 of 5 1-8 of 41	west of Clear River to RI/CT border	25.5	4.2

[1] -ROW edge is the east edge in ROW segments RI-1-3, the southeast edge in ROW segment RI-4, and the south edge in ROW segments RI-5-8.

+ROW edge is the west edge in ROW segments RI-1-3, the northwest edge in ROW segment 4, and the north edge in ROW segments RI-5-8.

A discussion of the current status of the health research relevant to exposure to electric and magnetic fields is included in Appendix J. This report was prepared by Exponent, Inc.

8 IMPACT ANALYSIS

This chapter 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 have been minimized by the careful location of structures, facilities, and access roads, and by the adoption of numerous mitigation practices.

Potential impacts to the natural and social environments associated with the Project can be categorized based on construction-related (temporary) impacts and siting 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 (such as swamp mats), and short-term construction noise associated with the operation of heavy equipment. Examples of permanent impacts include fill, new structures, vegetation removal, on-going vegetation management, and facility maintenance.

The Project will be constructed in a manner that minimizes the potential for adverse environmental impacts. A monitoring program will be conducted by National Grid to ensure 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 ensure that construction-related environmental impacts are minimized.

8.1 GEOLOGY

The Project will have negligible impact on the bedrock and surficial geologic resources of the Project ROW. The Project ROW consists of ablation till with pockets of lodgment till and organic deposits associated with wetland areas. Glacial outwash deposits make up the majority of the soils in the vicinity of the watercourses and open water bodies along the ROW. Organic deposits and sections of urban land are scattered throughout the Project ROW.

The development of the Project within the existing National Grid ROW will have negligible impact on topography and geology. Soil resources may be affected by the creation or expansion of access roads, and construction work pads, along the ROW, as well as by the earth-disturbing activities required to install the transmission line structures. Impacts on soil resources will be short-term, lasting only for the duration of the construction period, until re-vegetation or other forms of site stabilization are achieved.

In general, the construction of the Project will result in minor changes in topography, localized at structure locations or along access roads. For example, grading, which would change elevations, would only be performed to create level areas for the installation of structures, and to improve existing access roads or to create new access roads along the ROW in order to provide safe passage for construction equipment. Changes in the grades adjacent to proposed structure locations will be required for the construction of work pads, where fill may be imported to provide a safe and level work area around each structure location or where earth grading may be required. Work pads may be removed in some locations after construction. Grading would not be required along the ROW where the terrain is flat and open, or where no access road improvements are needed.

Where grading and earth disturbing activities are required, temporary soil erosion and sediment control measures will be installed to minimize the potential for soil erosion and sedimentation off the ROW or into watercourses or wetlands. Temporary soil erosion controls (e.g., silt fence, straw bales, filter socks, mulching, and temporary reseeding) will be deployed as necessary after vegetation removal or grading, or at other times during construction, in areas of land disturbance. The need for and extent of temporary and permanent soil erosion and sediment controls such as water bars, diversion channels, etc., will be a function of considerations such as slope/steepness, degree of vegetation removal, soil erodibility factor, soil moisture regime, proximity of cleared areas to natural resources, time of year, extreme weather conditions, and schedule of future construction activities.

Excess rock (if any) generated from excavation/construction activities may be stockpiled at approved locations along the ROW, with the landowner's permission, to create structure as wildlife habitat, or placed across or along the ROW to provide barriers to unauthorized vehicular traffic (ATV usage) along the ROW. The rock also may be used to re-construct stone walls, if any such walls are affected by the construction activities. Excess rock generated from upland areas will not be deposited in wetlands or watercourses.

Bedrock may be encountered along sections of the Project ROW during drilling activities and excavation for structure foundations. If bedrock is encountered at or below the surface and it is sufficiently stable and unfractured, the pole structures may be anchored directly to the bedrock which will serve as the footing for the structures. If the bedrock is inadequate as a pole footing, it will be drilled or blasted to the required depth and a concrete footing will be prepared, or the pole set and backfilled with clean granular material.

The majority of the transmission line structures will be direct embedded steel pole H-frames structures. All angle and dead-end structures will require concrete foundations with anchor bolts. If rock is encountered during excavation, rock removal can generally be accomplished by means of rock drilling. In some cases, rock blasting could be necessary along segments of the ROW and at the Sherman Road Switching Station expansion area. If blasting is required, it will be undertaken in a controlled manner to break up the rock but maintain a socket in the rock for pole placement. Heavy mats will be used to contain the blast materials. Blasting activities will be performed in adherence to relevant local, state and federal regulations. Potential effects from rock removal may include dust and vibration/noise from rock drilling, blasting (if required), and removal.

8.2 SOILS

Construction activities which expose unprotected soils have the potential to increase natural 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 reestablishment of vegetation and dust control measures. These devices will be inspected by National Grid's environmental monitor frequently during construction and repaired or replaced if necessary. National Grid will develop and implement a Stormwater Pollution Prevention Plan ("SWPPP"), which will detail BMPs and inspection protocols.

Excess soil from excavation at pole structures in uplands will be spread around the poles and stabilized to prevent migration to wetland areas. Excess material and rocks excavated from pole structure locations in wetlands will be disposed of at upland sites. Any excess rock not otherwise used along the ROW would be disposed of off-site at an appropriate location, pursuant to regulatory requirements. Topsoil will then be spread over the excess excavated subsoil material to promote rapid revegetation.

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 soils are impacted. National Grid will adhere to its *Right-of-Way Access, Maintenance, and Construction Best Management Practices (EG-303)*, and will prepare a project-specific Stormwater/Erosion and Sediment Control Plan, in compliance with the *Rhode Island Soil Erosion and Sediment Control Handbook*, the *Rhode Island Stormwater Design and Installation Standards Manual*, and the *Wetland BMP Manual: Techniques for Avoidance and Mitigation*.

Typically, temporary soil erosion controls will be installed based on the specifications in the Stormwater/Erosion and Sediment Control Plan. Temporary soil erosion controls 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, amount of vegetative cover remaining, and down-slope environmental resources;
- Across or along access ways within the transmission line ROW;
- Across areas of impacted soils on slopes leading to streams and wetlands; and
- 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 stormwater 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.

During the course of periodic post-construction inspections, National Grid 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.

8.3 SURFACE WATER RESOURCES

Any impact of the Project upon surface waters will be minor and temporary. 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 rivers and streams along the construction corridor without the use of temporary mat bridges or other crossing structures. Emphasis has been placed on using existing gravel roadways within the ROW and seeking access points that avoid crossing wetlands and surface waters.

There are a number of 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 ROW or by spanning the areas using temporary wooden 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 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.

All of the watercourses located along the Study Area are presently spanned by existing transmission lines, and certain of the smaller stream crossings along these existing ROW also are traversed by existing utility access roads. Because the development of the proposed transmission lines would not create an entirely new corridor across these watercourses and, for the most part, would not involve in-stream activities, the Project would have limited and short-term impacts on streams and water quality.

National Grid proposes to avoid direct construction work in watercourses to the extent feasible and to limit the potential for impacts associated with soil erosion, sedimentation, or spills into streams and rivers from nearby upland construction activities. In general, the proposed transmission lines will span watercourses, although temporary and possibly permanent access will be required (i.e., use of existing access roads or creation of new access roads) across the smaller stream crossings along the ROW subject to RIDEM Freshwater Wetlands permitting.

Vegetation removal will be minimized along streams. Only the minimum amount of vegetation necessary for the construction and safe operation of the transmission facilities (including the provision of access) will be removed. Vegetation removal near streams will be performed selectively, to preserve desirable streamside vegetation for habitat enhancement, shading, bank stabilization, and soil erosion and sediment control.

Potential impacts on watercourses may occur from vegetation removal within riparian zones/buffers (as necessary to allow safe construction or to maintain appropriate clearance from conductors) and the movement of construction equipment across watercourses involving the use of temporary equipment bridges or permanent access roads. Access across wetland areas and streams, where upland access is not available, will be accomplished by the temporary placement of swamp mats. Temporary timber mats, or other similar bridging techniques, will be installed to cross streams so not to impede or interrupt natural flow. Such temporary swamp mat access roads will be removed following completion of construction and, if necessary, areas will be restored to re-establish pre-existing topography and hydrology.

Crossings of smaller streams by construction equipment will be minimized to the extent possible. Existing access roads, which already cross these watercourses along the ROW, will be utilized whenever possible. In general, culverted access roads have historically been installed across the smaller existing watercourses along the ROW. Prior to construction, integrity inspections of the culverts will be conducted, and culvert structures deemed to either be in disrepair or unable to support the weights of the anticipated construction vehicles will be replaced at the same location and designed to maintain the stream flows. New culverts may be required where no culvert currently exists. These new culverted crossings will be designed and installed in accordance with the ACOE and RIDEM guidelines.

8.3.1 Water Quality

The primary potential impact to water quality from any major 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 through the use of existing roadways. Overhead transmission line construction requires only a minimal disturbance of soil for pole or foundation excavation. Further, equipment (with exceptions for equipment that is not readily mobile) will not be refueled or maintained near wetland or surface water resources. Therefore, it is anticipated that any adverse impacts to water resources resulting from construction of the proposed transmission lines will be negligible.

The removal of vegetation prior to construction may result in increased soil erosion potential so that slightly higher than normal sediment yields may be delivered to areas streams and wetlands during a heavy rainfall. However, these short-term impacts should be minor as a result of the relatively small area to be impacted, the use of selective vegetation removal within 25 feet of the streams, the implementation of soil erosion control measures and the short duration of construction activities. In addition, a detailed Stormwater/Erosion and Sediment Control Plan will be designed and implemented which will confine sediment within the immediate construction area and minimize impacts to downstream areas.

A Spill Prevention and Response Plan will be implemented to provide contractors with an action plan for responding to an inadvertent release or spill of oil or other hazardous materials.

8.3.2 Hydrology

Some minor, temporary impacts to surface drainage can be expected during construction and maintenance of the transmission lines. These impacts will be associated with access road improvements and installation of the pole structures. Following construction, temporarily disturbed areas will restored to pre-construction conditions, to the extent practicable. Features that are to permanently remain on the ROW (i.e., construction work pads and 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 some stream channels to allow for the passage of construction equipment without disturbing the stream or its channel substrate. These bridges will be removed following construction. A slightly higher rate of stormwater runoff may result from the removal of vegetation which would otherwise slow down the runoff and increase infiltration. These impacts will be short-term because vegetative cover will quickly reestablish in the area following construction.

8.3.3 Floodplain

Table 8-1 below summarizes the Project impacts to the 100-year floodplain, which represents the extent of flooding that would result during a storm event having a one percent chance of occurring per year. It is recognized that by definitions provided in the Rhode Island Freshwater Wetland Regulations, all rivers, streams and intermittent streams have 100-year floodplain, although they may not be mapped by FEMA.

In Rhode Island, approximately 24 new structures will be located within the FEMA-designated floodplains of five watercourses. The locations of these proposed structures, based on current Project plans. Due to the lateral extent of the floodplain boundaries associated with these waterbody crossings, spanning the entire floodplain(s) is not feasible; therefore, the installation of new 345kV transmission line structures within the limits of the FEMA-designated floodplains is not feasible. In some cases, installation of transmission line structures within floodplains, where no detailed FEMA study has been performed, is anticipated to have *de minimus* impact on flood storage capacity and not result in an increase in flood storage in a meaningful way. The removal of existing structures and replacement with new structures is not expected to result in any significant displacement of flood waters in these instances.

A detailed FEMA Flood Insurance Study was completed for the 100 year floodplain and floodway associated with Cherry Brook in North Smithfield. Therefore a hydrologic and hydraulic study was prepared by National Grid to satisfy requirements for floodplain management.

As part of the Project, National Grid will be installing multiple pole structures in the floodplain to support the new 345 kV 366 Line. Additionally, National Grid is proposing to replace the existing timber crib bridge/culvert access road crossing at Cherry Brook. The hydrologic and hydraulic modeling for the proposed conditions resulted in no rise in the stream base flood elevation. To offset the displacement of flood storage capacity within the regulated floodway, compensatory flood storage volume will be provided within the same watershed and reach of Cherry Brook to mitigate impacts on the floodway of Cherry Brook.

Any temporary fill placed within documented floodplains for temporary access roads or work pads would be removed following the completion of construction.

8.4 GROUNDWATER RESOURCES

Potential impacts to groundwater resources from the proposed construction include issues associated with storage of hazardous materials, reduction in groundwater recharges or degradation of groundwater resources due to discharges of regulated materials. Normal operation of the substation facilities includes proper storage and handling of hazardous and regulated materials, and development of contingency plans in the event of a spill of such materials. Normal facility operation does not include discharges of any substances to groundwater.

Potential impacts to groundwater resources within the transmission ROW as a result of construction activity on the transmission line facilities will be negligible. Equipment used for the construction of the transmission lines will be properly inspected, maintained and operated to reduce the chances of spill occurrences of petroleum products. Pumps used for dewatering activities would be placed and operated within secondary containment devices. Refueling equipment will be required to carry spill containment and prevention devices (i.e., absorbent pads, clean up rags, five gallon containers, absorbent material, etc.) and fueling of equipment will only occur in upland areas. In addition, maintenance equipment and replacement parts for construction equipment will be on hand to repair failures and stop a spill 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.

8.5 VEGETATION

The objective of National Grid's well-established vegetation management program is to maintain safe access to its transmission facilities and to promote the growth of vegetative communities along its ROW that are compatible with transmission line operation and in accordance with federal and state standards. National Grid has conducted Integrated Vegetation Management ("IVM") within ROWs as a matter of good utility practice since the late 1980s. National Grid's vegetation management program is designed to allow the safe operation of transmission lines by preventing the growth of incompatible vegetation that would interfere with the transmission facilities or access along the ROW. As a result, the vegetation within the maintained portions of National Grid's ROW typically consists of shrubs, herbaceous species, and other low-growing species. Portions of National Grid's ROW that are not proximate to an existing line may support taller vegetation, as long as it will not conflict with the construction or operation of the lines.

To stabilize impacted sites after the installation of the transmission facilities, National Grid would restore the contours, 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, over time. National Grid 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.

During and following the new transmission line construction, danger trees that have been determined to present a potential hazard to the integrity of the lines, will be identified and pruned or removed. A danger tree is a tree, located either on or off the ROW, that would contact electric lines if it were cut or failed. Hazard trees will also be pruned or removed at this time. Hazard trees are danger trees that are structurally weak, broken, damaged, decaying or infested trees that could contact the structures or conductors, or violate the conductor clearance zones, if they were to fail and fall towards the ROW.

8.6 WETLANDS

Construction of the Project will result in temporary, permanent, and secondary impacts to wetland resources. The following section describes the impacts associated with construction of the Project including vegetation removal, excavation for pole structures and access road construction.

Table 8-1 summarizes the potential impacts of the Project on wetlands based on preliminary design data. As summarized below, forested wetland vegetation and upland "buffer" vegetation would have to be removed to clear an additional 75 to 115 feet along the 341 Line ROW; and vegetation removal along the 366 Line ROW will be 75 to 85 feet on average, including some vegetation maintenance work. Such forested wetlands will be converted to and maintained as scrub-shrub and emergent wetland cover types.

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Table 8-1: Summary of Potential Impacts on Wetlands, Watercourses and Floodplains in Acres (and Square Feet) Along the Rhode Island Portion of the Project, By Town[1]

Impact Type	Palustrine Emergent Wetland	Forested Wetland	Palustrine Scrub-Shrub Wetland	Open Water	State-Regulated 50' Perimeter Wetland	Non-Wetland Floodplain	State Regulated 100' Riverbank	State Regulated 200' Riverbank	Area Subject to Storm Flowage[4]	Stream	Total
Town of North Smithfield											
Temporary Pulling Pads	0.31 (13,360)	0.40 (17,541)	0.07 (3,126)	--	0.29 (12,731)	--	--	0.18 (8,039)	--	--	1.26 (54,797)
Permanent Access Roads	<0.01 (31)	0.07 (3,008)	0.08 (3,675)	--	2.25 (97,893)	0.05 (2,333)	0.12 (5,140)	--	<0.01 (95)	<0.01 (215)	2.58 (112,390)
Temporary Access Roads	0.56 (24,226)	0.30 (13,108)	1.65 (72,052)	0.03 (1,497)	0.69 (30,135)	0.08 (3,700)	0.01 (308)	--	<0.01 (60)	0.03 (1,232)	3.36 (146,318)
Temporary Work Pads	1.85 (80,580)	3.13 (136,272)	9.15 (398,454)	0.01 (232)	0.20 (8,623)	0.67 (29,087)	<0.01 (9)	--	0.02 (798)	0.10 (4,416)	15.12 (658,471)
Permanent Work Pads	--	--	--	--	5.48 (238,583)	--	0.37 (16,090)	0.18 (8,005)	--	--	6.03 (262,678)
Permanent New Structures	<0.01 (144)	0.02 (790)	0.02 (884)	--	0.02 (743)	<0.01 (87)	<0.01 (48)	<0.01 (24)	--	--	0.06 (2,720)
Temporary Guy Anchors	<0.01 (100)	0.01 (339)	0.05 (2,373)	--	0.02 (710)	0.01 (242)	--	--	--	--	0.09 (3,764)
Total Tree Removal Within ROW[2]	--	17.98 (783,179)	0.77 (33,679)	--	7.39 (321,738)	1.48 (64,285)	0.77 (33,679)	0.03 (1,388)	0.03 (1,457)	0.22 (9,454)	28.67 (1,248,859)
Tree Removal Within ROW Minus Construction Features[3]	<0.01 (1)	14.27 (621,813)	--	--	6.05 (263,365)	1.03 (44,945)	0.65 (28,353)	0.03 (1,376)	0.02 (835)	0.20 (8,564)	22.25 (969,252)
Access Routes for Vegetation Removal[5]	0.04 (1,648)	2.01 (87,747)	0.20 (8,852)	<0.01 (20)	1.10 (47,770)	0.29 (12,625)	0.14 (6,036)	0.01 (398)	<0.01 (198)	0.02 (775)	3.81 (166,069)
Total[6]	2.76 (120,091)	20.22 (880,618)	11.24 (489,415)	0.04 (1,749)	16.08 (700,553)	2.14 (93,019)	1.29 (55,984)	0.41 (17,842)	0.05 (1,986)	0.35 (15,202)	54.56 (2,376,459)
Town of Burrillville											
Temporary Pulling Pads	0.04 (1,937)	--	0.13 (5,869)	0.15 (6,361)	0.68 (29,422)	--	0.03 (1,420)	--	<0.01 (20)	--	1.04 (45,029)
Permanent Access Roads	<0.01 (65)	0.06 (2,593)	0.80 (34,634)	--	4.45 (193,786)	0.01 (650)	0.36 (15,794)	0.15 (6,667)	0.04 (1,831)	0.03 (1,502)	5.91 (257,522)

Impact Type	Palustrine Emergent Wetland	Forested Wetland	Palustrine Scrub-Shrub Wetland	Open Water	State-Regulated 50' Perimeter Wetland	Non-Wetland Floodplain	State Regulated 100' Riverbank	State Regulated 200' Riverbank	Area Subject to Storm Flowage[4]	Stream	Total
Temporary Access Roads	0.16 (6,970)	0.30 (12,915)	1.33 (57,907)	--	0.59 (25,532)	0.02 (1,012)	--	--	<0.01 (85)	0.01 (627)	2.41 (105,048)
Temporary Work Pads	0.97 (42,435)	1.84 (80,315)	2.48 (107,853)	<0.01 (95)	0.15 (6,683)	0.16 (6,929)	0.02 (848)	--	0.04 (1,585)	0.18 (7,934)	5.85 (254,677)
Permanent Work Pads	--	--	--	--	9.41 (409,770)	--	0.63 (27,272)	1.04 (45,246)	--	--	11.07 (482,288)
Permanent New Structures	<0.01 (149)	0.01 (299)	<0.01 (188)	--	0.05 (1,990)	--	<0.01 (145)	<0.01 (7)	<0.01 (4)	<0.01 (61)	0.07 (2,843)
Switching Station Expansion (Temporary)	0.08 (3,438)	0.02 (743)	--	--	0.17 (7,239)	--	--	0.21 (9,241)	<0.01 (149)	--	0.48 (20,810)
Switching Station Expansion (Permanent)	0.06 (2,658)	0.14 (6,159)	--	--	0.08 (3,417)	--	--	0.20 (8,704)	0.04 (1,885)	--	0.52 (22,823)
Temporary Guy Anchors	--	--	<0.01 (58)	--	<0.01 (205)	--	--	--	<0.01 (4)	--	0.01 (267)
Total Tree Removal Within ROW[2]	<0.01 (1)	22.75 (990,789)	<0.01 (1)	--	18.76 (817,309)	0.16 (7,186)	2.11 (91,916)	1.49 (64,891)	0.07 (3,035)	0.42 (18,428)	45.77 (1,993,556)
Tree Removal Within ROW Minus Construction Features[3]	<0.01 (1)	20.58 (896,429)	<0.01 (1)	--	14.03 (611,156)	0.03 (1,381)	1.70 (73,893)	0.58 (25,351)	0.04 (1,898)	0.25 (10,798)	37.21 (1,620,908)
Access Routes for Vegetation Removal[5]	0.03 (1,227)	2.40 (104,474)	0.37 (16,037)	<0.01 (25)	3.41 (148,479)	0.01 (298)	0.46 (20,049)	0.13 (5,556)	0.01 (609)	0.04 (1,689)	6.85 (298,443)
Total[6]	1.35 (58,880)	25.34 (1,103,927)	5.11 (222,547)	0.15 (6,481)	33.00 (1,437,679)	0.24 (10,270)	3.20 (139,421)	2.31 (100,772)	0.19 (8,070)	0.52 (22,611)	71.41 (3,110,658)

[1] Where overlap occurs, wetland resource area is accounted for first, then 50' perimeter wetland and lastly floodplain and riverbank areas are areas that do not overlap with resource or 50' perimeter areas.
[2] Includes all tree removal activities occurring within the ROW.
[3] Excludes tree removal associated with access roads, work pads, and pulling pads.
[4] Each occurrence is assumed to be 3 feet wide.
[5] Any of these areas that overlap with forested wetland or upland forest tree removal have been double-counted.
[6] Total includes Tree Removal Within ROW Minus Construction Features only.

Along the Project route, the proposed transmission lines will be constructed and operated in existing ROW, where the wetlands have historically been affected by vegetation maintenance programs. Specifically, pursuant to National Grid's vegetation management practices, these wetlands are maintained in scrub-shrub and emergent wetland cover types.

The development of the proposed transmission lines in the maintained ROW will result in incremental, long-term impacts on wetlands associated with the Project. To minimize or avoid adverse impacts to wetlands, National Grid has attempted to locate new transmission structures in upland areas wherever practical and to limit the access roads required across wetlands if there are practical upland alternative access roads available. Where structures will unavoidably have to be located in wetlands, National Grid will make every effort to limit the impacts to the wetlands, either by reducing the size of the work pad or by re-configuring the work pad, if practical, to avoid placement of temporary fill in wetlands. In general, where a new structure must be located in a wetland, a temporary work pad will be used for construction support. In some wetland areas, field conditions (such as thickness of organics, depth of water or steep slopes, etc.) may require the use of multiple layers of swamp mats placed on stringers. The temporary matting used for the work pads in wetlands will be removed after the completion of structure installation.

Because it is not possible to locate all structures outside of wetlands, the Project will result in a minor amount of permanent wetland fill associated with the structure foundations. Such fill will displace wetland soils and vegetation and thus will constitute a long-term adverse effect. In addition, existing permanent access roads will have to remain in certain wetlands.

To compensate for wetland impacts, National Grid will coordinate with the RIDEM and ACOE to assess compensatory mitigation options. The amount of compensatory mitigation required will depend on the final Project designs and the amount of permanent wetland impacts. Compensatory wetland mitigation options for the Project may include wetlands restoration and/or enhancement along the Project ROW, wetlands restoration and/or enhancement, wetlands creation (on or off the ROW), wetlands preservation, and/or placement of conservation restrictions.

8.6.1 Vegetation Removal and Vegetation Management in Wetlands

Vegetation removal will occur within the wetland and state regulated buffer areas in order to facilitate construction and maintenance of the proposed transmission lines. Appropriate soil erosion and sediment control measures will minimize impacts to wetlands from adjacent impacted areas.

Within the footprint of the new transmission lines, forested wetland vegetation will be have to be removed in order to construct and safely operate the new overhead transmission facilities. As a result, forested wetlands along the expanded ROW will be converted to shrub-scrub or emergent marsh wetland types. This will not create a loss of overall wetland habitat, but rather a change in habitat type, from a conversion of forested wetland to shrub-scrub wetland or emergent marsh.

8.6.2 Vegetation Removal and Vegetation Management Adjacent to Cultural and Historic Resources

Vegetation removal within and adjacent to cultural resources will be carried out using methods to avoid impacts to the resource. Wherever practicable, roads for removing trees will be routed around these areas. Trees will be felled using mechanized tree shears that can cut and lift the trees away from the resource. In addition, to protect these resources from tree forwarding/skidding impacts, some trees will be cut 4 to 6 feet above the ground and left to act as "bollards" or "bumpers". The "bollards" or "bumpers" will remain in place, as necessary, to fence off and preserve these features in place during construction. Some stone walls will have to be breached for vegetation clearing access roads. The stone wall will be restored after vegetation removal and construction is complete.

The historical cemetery located off of Inman Road in Burrillville is a cultural resource requiring special attention. A detailed clearing plan will be developed following consultation with PAL and appropriate officials in the Town of Burrillville.

8.6.3 Access Roads

Following the delineation of wetland boundaries within the 22.5 mile transmission line ROW, thorough constructability field reviews were conducted to determine access to pole structures which would minimize impacts to wetland areas. Access road locations have been chosen to avoid wetlands, to cross wetlands at previously impacted locations or to traverse the edge of the wetland where possible. Temporary crossings using swamp mats will be used where existing access road crossings do not exist.

In certain areas where no upland alternatives are available, existing access roads through wetlands along the ROW will have to be improved or new access routes through wetlands will have to be developed in order to reach structure sites. Access through wetlands will consist primarily of temporary swamp mats, which will be used only for construction and then removed from the wetlands. In some perimeter wetland or upland areas, gravel type roads (approximately 20 feet wide) will be required to provide safe access for construction and for the operation and maintenance of the transmission facilities. Long-term impacts will result where such access roads must remain in place in wetlands to provide access for operation and maintenance activities.

8.6.4 Structures

New poles will be either directly embedded or self-supporting. The installation of a direct embedded structure (e.g., tangent or in-line structures) involves excavating a hole, installing steel culvert, placing the new pole within the culvert, backfilling with crushed stone and final grading around the structure base. The installation of a self-supporting structure supported on a foundation (e.g., angle and dead-end structures) involves drilling a subsurface shaft, installing a reinforced steel cage, pouring concrete to form the foundation, bolting the new structure to the foundation, backfilling and final grading around the base of the structure.

Under the current design of the proposed transmission lines (366 and 341 Lines), engineering and safety requirements necessitate the placement of 58 pole structures within state and federally regulated wetland areas and 2 pole structures within state-regulated 100-year non-wetland floodplain. Along the existing 328 and 347 Lines, modifications to the pole structures will result in the installation of 1 new pole structure on the 328 Line, and 2 new pole structures on the 347 Line in wetlands. The only fill needed for structures is backfill required around the pole embedment. This would amount to approximately four cubic yards of crushed rock per structure. To mitigate this impact, National Grid will assess the need to provide incremental floodplain compensation, in consultation with RIDEM.

National Grid has and will continue to make design modifications, if practical, to avoid the installation of structures in wetlands. However, in certain areas, the location of structures in wetlands will be unavoidable. The installation of structures in wetlands will result in short-term impacts associated with the creation of temporary work pads for equipment, as well as long-term impacts associated with the displacement of wetlands located at the structure footings.

8.7 WILDLIFE

The removal of mature trees in forested areas within the ROW may affect wildlife species composition by favoring species that prefer scrub-shrub, emergent, or open habitats to those that inhabit forested communities. During construction, temporary displacement of wildlife may occur due to the presence of vegetation removal and construction equipment. However, the ability of the area to provide wildlife habitat will not be adversely affected following construction. A study conducted in the region indicated an increase in wildlife use, notably avian species, following removal of trees from ROWs.[29] This study attributed the increase in wildlife use to the conversion of forested areas into wetland and upland shrub and emergent plant communities. ROWs also serve as open corridors connecting non-contiguous natural areas.

Wildlife currently using the forested edge of the cleared ROW may be impacted by the construction of the Project. Larger, more mobile species such as large mammals will leave the construction area and may be temporarily impacted by displacement and disruption of breeding cycles. Some avifauna will also be temporarily displaced, possibly impacting breeding and nesting activities depending on the time of year. Some smaller and less mobile animals such as small mammals and herpetofauna may be affected during the vegetation removal and transmission line construction. Impacts will be localized to the immediate area of construction around structure locations and along access roads. Following construction, wildlife would be expected to return and re-colonize the ROW.

Because the proposed transmission line route would be aligned along an existing utility corridor, impacts on vegetation communities and wildlife assemblages would occur within and parallel to the existing ROW, which are maintained in shrub-scrub or other open habitat types. For the most part,

[29] Nickerson, N.H. and F.R. Thibodeau. 1984. Wetlands and Rights-of-way. Final Report submitted to the New England Power Company, 25 Research Drive, Westboro, Massachusetts.

the vegetative communities that would be affected by the Project along and adjacent to these existing ROW are common to the region.

In order to install and operate the proposed facilities, additional vegetation will have to be removed for construction and thereafter maintained in low-growth shrubs or grasses. In the areas where forested vegetation removal is required, the Project will have long-term, but incremental and localized, impacts on vegetation and associated wildlife habitats.

Based on some of the published literature, the creation of additional shrub land habitat along the maintained ROW would represent a long-term positive effect on disturbance and scrub-shrub dependent species, since shrub land habitat is otherwise declining in New England. This decline is a result of various factors (e.g., development, ecological succession, absence of fire). Additionally, most of the historic shrubland in the Northeast is irreversibly gone due to permanent human development; therefore, management for these species and for biodiversity cannot occur at these locations. Scrub-shrub birds and other disturbance dependent species are now more dependent than ever on human activities to maintain the habitat required for their survival.[30] In this regard, transmission line ROW is considered a major source of shrub land habitat.[31]

Studies conducted in the Northeast have shown that populations of most bird species associated with shrubland habitats and impacted areas in forested habitats have declined sharply. These species have been shown to make use of human-impacted habitats including utility ROWs. [32]

To accommodate the construction of the proposed 345 kV lines, the removal of vegetation within the existing corridors, as well as additional tree and vegetation removal to expand the cleared width of the ROWs will occur. In order to widen the maintained portion of the existing ROWs by approximately 95-125 feet on the 366 Line, and 75-115 feet on the 341 Line 75-85 feet, approximately 166 acres of upland deciduous and coniferous forest and approximately 41 acres of palustrine (mostly deciduous) forested wetland would have to be cleared of woody vegetation on the existing ROW (Table 8-1). Research on the effects of clearing uncleared portions of transmission

[30] King, D.I., R.B. Chandler, J.M. Collins, W.R. Peterson, and T.E. Lautzenheiser. 2009. Effects of Width, Edge and Habitat on the Abundance and Nesting Success of Scrub-Shrub Birds in Powerline Corridors. Biological Conservation 142:2672-2680.

[31] Saucier, L 2003. Shrubland habitat information from "Wildlife Habitat in Connecticut: Shrubland". Habitat Management Program, in Connecticut Wildlife.

Confer, J.L. and S.M. Pascoe. 2003. Avian Communities on Utility Rights-of-Ways and other Managed Shrublands in the Northeastern United States. Forest Ecology and Management 185:193-205.

Confer, J.L., T. Hauck, M-E. Silvia, and V. Frary. 2008. "Avian Shrubland management and Shrubland nesting Success." In Proceeding of the Eighth International Symposium on Environmental Concerns in Rights-of-Way Management. (J. W. Goodrich, L. P. Abrahamson, J. L. Ballard, S. M. Tikalsky, Eds.). Electric Power Research Institute, Washington, D.C., pages 407-412.

[32] Hunter, W.C., D.A. Buehler, R.A.Canterbury, J.L. Confer and P.B. Hamel. 2001. Conservation of disturbance-dependent birds in eastern North America. Wildlife Society Bulletin 29(2):440-455.

line ROWs suggests that this practice improves habitat for some nesting bird species, and that corridors that are too narrow may not provide sufficient habitat to permit successful reproduction.[33]

Vegetation removal to widen the existing cleared width of the ROW and provide equipment access would be performed using mechanized methods. Where removal of woody vegetation is required, vegetation will be cut flush with the ground surface to the extent possible. Where practical, trees will be felled parallel to the ROW to minimize the potential for off-ROW vegetation damage. Vegetation on the existing National Grid ROW is managed in accordance with National Grid's vegetation management program; accordingly, trees that could interfere with the operation transmission lines are routinely removed from the ROW and trees along the edges are periodically pruned or removed. The operation of the new transmission facilities would require the maintenance of a wider ROW in low-growth shrub land and open field habitats.

The management and maintenance of ROW creates early successional habitats dominated by scrub-shrub vegetation and open areas with dense grasses and other herbaceous vegetation. Scrub-shrub habitats within the ROW can provide wildlife habitat such as nesting for birds, browse for deer, and cover for small mammals.[34] These habitat types are increasingly rare in the Northeast (due to the conversion of farms to forest and the loss of habitat caused by development) but tend to offer habitats preferred by particular organisms for certain stages of their annual life-cycles. For example, in the Northeastern United States, neotropical migrants are experiencing significant declines. Over 80% of these declining neo-tropicals use disturbance-dependent ecosystems such as shrublands and forest edges.[35]

Impacts to sensitive habitats of state-listed rare, threatened or endangered species will be avoided through close coordination with the RINHP, and RIDEM in the development of avoidance and mitigation criteria.

8.8 AIR QUALITY

8.8.1 Construction Impacts

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. Dust suppression methods will be used during drilling operations, as deemed necessary, to minimize impact. In addition, minimal quantities of earth will be moved or impacted during construction. Therefore, any impacts from fugitive dust particles will be of short duration and localized. Due to the transitory nature of the construction, air quality in the Study Area will not be significantly affected by construction along the ROW. Emissions produced

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[33] King, et al., 2009.

[34] Ballard, B.D., H.L. Whittier, and C.A. Nowak. 2004. Northeastern Shrubs and Short Tree Identification, A Guide for Right-of-way Vegetation Management. State University of New York-College of Environmental Science and Forestry.

[35] Confer, J.L. and S.M. Pascoe. 2003.

by the operation of construction machinery (nitrogen-oxides (“NO_x”), sulfur oxides (“SO_x”), carbon monoxide (“CO”), VOCs, and particulate matter (“PM”) are short-term and not generally considered significant.

8.8.2 Project Impacts

In part, air quality is a function of area wide emissions of O_3 precursors (CO, NO_x, and VOCs) from the change in daily traffic volumes along lengths of area roadways. The Project will not change traffic emissions parameters, nor affect the travel characteristics of the vehicles traveling in North Smithfield and Burrillville. Therefore, the mobile source emissions will not change due to the Project.

There are no anticipated long-term impacts on air quality associated with the operation of the existing transmission lines or stations.

8.9 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 ROW and the Sherman Road Switching Station.

8.9.1 Social Impacts

The Project will improve the reliability of the regional electric transmission network consistent with ISO-NE and National Grid’s standards and regulatory planning guidelines. 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. The Project will not adversely impact the overall social and economic condition of the Project area. As described in Section 4.0, the proposed transmission lines will be located entirely within the existing ROW presently occupied by other transmission lines or otherwise under the control of National Grid. The Project will not require the acquisition of property to install the transmission network structures or to expand the Sherman Road Switching Station, thus avoiding any adverse impacts to planned developments.

8.9.2 Population

Project construction and maintenance will have no impact on the population but will improve existing electrical service reliability to the population of Southern New England. A reliable source of electric transmission will support existing load demands, as well as future load demands as a result of a projected increase in the population within the region.

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8.9.3 Employment

The construction of the transmission lines and switching station may have minor beneficial effects on the regional economy by creating several hundred FTE jobs for the construction period.[36] Project expenditures may also have a small spin-off impact as funds are re-circulated and spent within the local economy. By meeting the current and projected demands for increased power in the area, the construction of the Project will support the New England states' effort to stimulate additional growth and economic activity in the region, while providing safe, reliable, and economical transmission service to the existing infrastructure.

8.9.4 Municipal Tax Revenue

The Project represents a capital investment of approximately $175 million in North Smithfield and Burrillville. The estimated capital investment in each town and a conservative estimate of first year property tax revenues for each town is provided in Table 8-2. Municipal tax revenues will commence after the facilities are placed in service, and are anticipated to continue at decreasing levels throughout the book-life of the facilities.

Table 8-2: Estimated Tax Revenues by Town

Town	Estimated Capital Investment	Estimated First Year Tax Revenues
North Smithfield	$65,000,000	$2,300,000
Burrillville	$110,000,000	$1,460,000

8.10 LAND USE

The following section addresses the compatibility of the proposed transmission lines with various land uses along the proposed route.

8.10.1 Land Use

Land use impacts can be separated into short-term and long-term impacts. 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. National Grid will provide notification of the intended

[36] Based on estimates provided by New Energy Alliance, 78 FTEs are required to construct the 366 Line in both Massachusetts and Rhode Island, 58 FTEs are required to construct the 341 Line, 49 FTEs are required to reconstruct and reconductor the 328 Line, and up to 22 FTEs are required for the Sherman Road Switching Station reconstruction. A May 2011 study by the Brattle Group finds employment impacts ranging from a low of two FTE-year per million dollars invested to a high of 18 FTE-years per million dollars invested. The Brattle Group, *Employment and Economic Benefits of Transmission Infrastructure Investment in the U.S. and Canada,* prepared for the Working Group for Investment in Reliable and Economic Electric Systems ("WIRES").

construction plan and schedule to affected landowners and abutters so that the effect of any temporary disruptions may be minimized.

The Project is proposed entirely within an existing ROW and on easements or land owned in fee by National Grid, which are already occupied by electric facilities. The construction of the new transmission lines within the existing ROW will be consistent with the established land use and therefore will not present long-term land use impacts. Generally, existing land uses within the existing transmission line ROW will be allowed to continue following construction.

8.10.1.1 Residential

A number of residential areas are located in proximity to the ROW and station sites. In many locations, existing vegetation will continue to provide visual screening of the facilities from residences, although existing vegetative visual buffers may be reduced in width. Because the proposed transmission lines will occupy areas dedicated to use for electrical facilities, the Project will not displace any existing residential uses, nor will it affect any future development proposals.

8.10.1.2 Agriculture

The Project crosses a number of areas which are presently in agricultural use. Minimal impacts to agricultural uses will occur as a result of the Project, and these will be limited to footprints of the transmission line structures and access roads. Temporary displacement of some farming activities may occur during the active construction period along the ROW.

8.10.1.3 Business

The proposed route will cross few business areas. Normal business operations will not be adversely affected by the Project. Traffic management plans will be developed and implemented to minimize construction-phase disturbances on existing business operations. No displacement of business will result from the Project.

8.10.1.4 Institutions

Four institutions are located within the Study Area. There are two home-based daycare facilities in Burrillville, one on Round Top Road and one on Slater Drive. In North Smithfield, there is a home-based daycare facility located on Greenville Road and a separate educational facility, The Dr. Harry L. Halliwell Memorial Elementary School, located off of Route 102 (Victory Highway). Because the Project is located within the existing ROW, no impact to the nearby institutions is anticipated.

8.10.2 Recreation

No existing recreational uses will be displaced long-term by the Project. Impacts to existing parks and recreational areas from the proposed electric transmission lines will be minimal and short-term. Since the Project is located within an existing ROW, potential long-term impacts will be avoided.

The Project route follows the existing ROW across various recreational areas, the use of which may be temporarily affected during construction. In general, the impact of the Project on recreational uses will be short-term, lasting only for the duration of construction. The operation of the new transmission lines will not significant alter the use of the recreational areas along the ROW.

The recreational facilities traversed by the Project route include the Big and Little Round Top Pond, Black Hut Management Areas, and the RIDEM boat launch/parking area at Slatersville Reservoir. National Grid will provide notification to managers of these affected recreational areas, prior to commencement of construction in the areas.

8.10.3 Consistency with Local Planning

As documented in the Purpose and Need section of this report, there is a clear need for improving the electrical reliability in the area. The Towns of North Smithfield and Burrillville have Comprehensive Plans which describe the local viewpoint regarding future development and growth in each community. Each municipality's Comprehensive Plan was evaluated with regard to expressed town-wide goals. The Project was then evaluated for consistency with the local planning initiatives in each community.

Because the Project will use existing ROW or be located on existing station yards, it will not alter existing land use patterns and will not adversely impact future planned development. The Project will provide an adequate supply of electricity for the growth and development envisioned by the Comprehensive Plans of the communities in Northern Rhode Island.

8.11 VISUAL RESOURCES

National Grid engaged EDR, to analyze the potential visibility and visual impact of the Project. The Visibility and Visual Impact Assessment for the Project is included as Appendix M to this filing. The Visual Impact Analysis ("VIA") procedures used by EDR are based on methodologies developed by the U.S. Department of the Interior, Bureau of Land Management ("BLM") (1980 and 1986). They are also consistent with guidance provided by the USDA, National Forest Service (1974), the USDOT, Federal Highway Administration (1981), and the New York State Department of Environmental Conservation (not dated and 2000). Within the visual study area, EDR defined landscape similarity zones ("LSZs") based on the USGS National Land Cover Dataset and field review. LSZs are areas of similar landscape/aesthetic character based on patterns of landform, vegetation, water resources, land use, and user activity. This effort resulted in the definition of five LSZs: 1) Medium/High Density Residential, 2) Commercial/Industrial, 3) Low Density Residential/Developed Open Space, 4) Forested, and 5) Water/Waterfront.

The VIA used a series of evaluation techniques, including viewshed analysis, line of sight cross-sections, field verification of visibility, computer-assisted visual simulations, and the evaluation of the Project's visual contrast and overall impact by a panel of landscape architects. This comprehensive analysis assessed the potential effect of the Project on the aesthetic character and visually sensitive resources of the study area.

Initial viewshed analysis determined the potential visibility of the existing and proposed transmission structures based on the screening effect of topography only. This is a "worst-case" analysis, in that the screening effect of vegetation and built structures is not considered. Comparison of the topographic viewsheds for the existing and proposed transmission line structures revealed there is a 0.9% increase in potential structure visibility with the Project in place (i.e., areas with potential views of transmission structures increases from 92.8% to 93.7% of the study area). This reflects the greater height of the new structures, which range from 60 to 125 feet tall, in comparison to the height of the existing structures, which range from 34 to 105 feet tall. The screening effect of forest vegetation was then taken into consideration by running a vegetation viewshed analysis which assigned a 40 foot height to a base vegetation layer created with USGS land cover data. The vegetation viewshed analysis determined that the proposed 345 kV structures would potentially be visible from 15.4% of the one mile radius study area (i.e., screened from over 80% of the study area). With the effect of vegetation taken into account, the visible viewshed is limited primarily to the existing cleared ROW, agricultural fields, roadways, bodies of water, and areas of higher density development without intervening topographic obstructions.

Four line of sight cross-sections (ranging in length from 3 to 7 miles) were drawn through the study area at locations with specific visually sensitive resources (e.g., trails, water bodies, historic properties) and/or areas of intensive land use. These cross-sections analyze visibility only along selected lines of sight (i.e., from specific receptor locations to specific transmission structures along the proposed line). However, taken together they are representative of potential Project visibility and screening conditions that occur throughout the study area. Comprehensively, the cross-sections demonstrate the significant influence of both vegetation and topography in screening views of the Project from sensitive receptors. Within the Rhode Island portion of the study area, areas of Project visibility covered from between 1.7% and 2.8% of the selected cross-sections. Most of the sensitive sites that occur along these cross-sections are outside of these areas of Project visibility. Areas where Project visibility is indicated are generally already subject to views of the existing transmission line.

Field verification was conducted following the viewshed mapping and cross-section analysis to more accurately evaluate potential visibility of the proposed transmission facilities from ground-level vantage points. This fieldwork confirmed that the visibility of the existing transmission line is generally limited to areas at or adjacent to sites where the ROW crosses or closely parallels public roads, and locations where residential development has occurred in proximity to the existing transmission corridor. This is due to topographic variations and the dense forest vegetation that provides substantial screening throughout the majority of the study area. Longer distance views are limited and generally confined to developed open space, water bodies, or wetlands. Residential neighborhoods are generally well-screened by vegetation, although some settled areas have intermittent views to the transmission corridor. These generally occur where there is a difference in elevation that allows visibility despite intervening vegetation, or where an open corridor, such as a roadway, stream or the ROW itself, provides unobstructed views. Drivers generally will view the Project from locations where the proposed route crosses public roads. At these crossings, open views are generally restricted to the cleared ROW (i.e., under the line, looking down the cleared corridor) although in some circumstances the roadways provide somewhat longer views of the transmission corridor due to their more parallel orientation and/or proximity to the ROW. The forest vegetation that occurs at many sensitive sites generally impedes the viewer's perception of the line and/or cleared ROW from these areas, except within the ROW itself. At sensitive sites where such screening is lacking open views of the existing transmission lines are already available, and therefore additional visual impact will be limited.

EDR also prepared computer-generated visual simulations from seven selected viewpoints that illustrate representative views of the Project from a variety of circumstances under which views are most likely to be available (i.e., views from residential landscapes and road crossings). All of the selected viewpoints are from foreground locations, as unobstructed mid-ground and background views are rare due to the dense forest vegetation prevalent throughout the Study Area. The visual simulations were then presented to a panel of registered landscape architects for evaluation. The evaluation methodology utilized in this study was based on the U.S. Department of the Interior, BLM procedure for evaluating a project's visual contrast with the existing landscape. The BLM rating methodology provides for the description of existing scenic quality, viewer sensitivity, and variable effects such as viewing angles and atmospheric conditions, in addition to the actual rating of contrast between the Project and the existing view. Possible mitigation measures can also be recommended.

The rating panel's conclusion was that, to a large extent, the Project's visual impact from all viewpoints was mitigated by the presence of the existing transmission line(s) and cleared ROW. The rating panel found an insignificant to minimal increase in visual contrast for six of the seven selected viewpoints. A moderate to appreciable level of contrast was noted for the remaining viewpoints. The most important contributor to contrast for the selected viewpoints was a perceived incompatibility with adjacent land use. Contrast with existing vegetation was also noted by raters due to the proposed structures' increased contrast in scale, or the removal of trees to accommodate a wider ROW. The bolder appearance of the new structures also contributed to the increase in visual contrast. However, taken together with other existing landscape components, the overall additional contrast created by the new structures was never deemed to be appreciable. In all of the views, the existing transmission lines and cleared ROW served to reduce the perception of visual contrast resulting from the new structures. The presence of the existing transmission facilities tends to reduce initial scenic quality and the perception of significant change in land use. Although the new transmission line requires a widening of the existing ROW, the utilization of an existing utility corridor was considered preferable to the clearing of an entirely new ROW. The rating panel recommended that National Grid evaluate the feasibility of screen plantings to mitigate the visual impact of the Project.

8.12 CULTURAL AND HISTORIC RESOURCES

PAL made the following recommendations to minimize impacts to cultural and historic resources.

Archaeological Resources

Upon completing archaeological site evaluations on six potentially significant sites, PAL recommended that none of the six sites meet the criteria for listing in the National Register of Historic Places (National Register) because they are limited in complexity, lack overall contextual integrity, and are not expected to provide data beyond those collected to date. Based on the results of the reconnaissance survey and archaeological testing completed at the Sherman Road Switching Station, PAL concluded that no further cultural resource surveys were recommended.

PAL recommended that impacts during pole installation of one pole on the 341 Line be localized to avoid and preserve in-place a small rock shelter and the immediate area surrounding the above-ground rock shelter. PAL further recommended that archaeologists monitor any clearing and construction activity within a 50-foot radius of the rock shelter to assist in preserving it and an area of limited quarrying on the adjacent rock face.

Additional Areas of Native American Concern

PAL's recommendations include avoidance of locations and features identified by tribal representatives as *Areas of Native American Concern*.

Historic Resources

PAL recommended that National Grid adhere to its best management practices relative to stone walls, and that National Grid avoid impacts where pole installations will take place in proximity to historic cemeteries. There is an historic cemetery located partially within the ROW off Inman Road in Burrillville along the 341 Line. Removing trees within the cemetery will require special attention. A detailed clearing plan will be developed following consultation with PAL and appropriate officials in the Town of Burrillville.

Unanticipated Discovery Plan

If additional archaeological materials or potential historic properties are discovered, National Grid will conduct additional evaluation investigations to determine the spatial extent of the resource and its eligibility for listing in the National Register. Once this is established, National Grid will, if possible, relocate or redesign the structure, access road, or work/storage area to avoid the resource. In the event that the resource cannot be avoided, National Grid will work closely with the THPO's and RIHPHC to develop a strategy to minimize or mitigate any impacts. If further archaeological data recovery is warranted, any identified properties will be documented and all recovered cultural materials will be processed and cataloged in accordance with the *Secretary of the Interior Standards and Guidelines* and RIHPHC procedures.

8.13 NOISE

The existing ambient noise levels will not be altered by the proposed transmission lines or substation/switching station modifications. Temporary noise impacts will occur during the construction of the Project. Proper mufflers will be required to control noise levels generated by construction equipment.

Construction-related noise will be intermittent, and will last only for the duration of the construction period. It will result from the operation of construction equipment such as trucks, excavating equipment, drilling equipment, structure erection equipment (cranes), and wire stringing rigs. Overall, the development of the transmission facilities will result in sound levels that are typical of construction projects. The Towns of North Smithfield and Burrillville have local ordinances which regulate the emission of sound. The Project is exempted from both town noise ordinances (Burrillville Municipal Code, Article II Section 16-35(b) and North Smithfield Code of Ordinances, Chapter 8, Article VII Section 8-114(b)) as sound relative to allowed construction.

Construction-related noise may affect certain receptors including residences, schools, daycare facilities, and designated recreational areas. The extent of a noise impact to humans at a sensitive receptor is dependent upon a number of factors, including the change in noise level from the ambient; the duration and character of the noise; the presence of other, non-project sources of noise; people's attitudes concerning the Project; the number of people exposed to the noise; and the type of activity affected by the noise (e.g., sleep, recreation, conversation).

The impact of construction-generated noise also would depend on the location of the noise source, because sound attenuates with distance, and with the presence of vegetative buffers or other barriers.

While most transmission lines do not generate appreciable noise during normal operations, 345 kV transmission lines may be audible under certain weather conditions. Any operational noise associated with the proposed new transmission line would attenuate quickly with distance from the transmission line. Noise would be increase somewhat during wet weather; however, there typically would be few receptors near the transmission lines to hear the increase in sound levels.

Modifications to the Sherman Road Switching Station proposed as part of this Project will not alter the current noise levels from this facility.

8.14 TRANSPORTATION

During construction, personnel traveling to and from work sites, as well as the movement of construction equipment, may cause temporary and localized increases in traffic volumes, and may require temporary detours. However, any such increases in traffic volume will be short-term. Further, National Grid will employ local police to direct traffic at construction work sites along roads, as needed, and will erect appropriate traffic signs to indicate the presence of construction work zones. In addition, National Grid would develop access and traffic control plans for the construction contractor(s); the objective of this plan will be to define requirements for traffic controls and to provide for the safe ingress and egress to the ROW for construction equipment and other vehicles.

National Grid and its contractor 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 light, 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 have to be inspected or maintained. As a result, the construction and operation of the transmission lines will have minimal impact on the traffic of the surrounding area roadways.

The route of the Project crosses various local and state roads, including Route 146. The transmission line conductors would span these roads and would not affect the long-term use of the transportation facilities.

8.15 SAFETY AND PUBLIC HEALTH

National Grid substations are locked and enclosed with chain link fence topped with barbed wire to prevent unauthorized entry. Following construction of the facilities, all transmission line structures and substation facilities will be clearly marked with warning signs to alert the public to potential hazards if climbed or entered. Trespassing on the ROW will be inhibited by the installation of gates and/or barriers at entrances from public roads.

Although SF_6 is defined as hazardous by DOT, there is no risk of general public exposure. The existing GIS facilities at the Sherman Road Switching Station will be removed upon energization of the new AIS equipment. The new circuit breakers, which will contain SF_6 will be installed and maintained by trained technical staff. It will be checked for integrity during routine inspections by company personnel.

Because the proposed facilities will be designed, built and maintained in accordance with the standards and codes as described in Section 4.5, the public health and safety will be protected.

8.16 ELECTRIC AND MAGNETIC FIELDS

The electric and magnetic fields produced by the existing transmission lines at the edges of the ROW in 2015 are compared here to the expected field levels after completion of the Project in 2015 and five years later (2020).

8.16.1 Electric Fields

Electric field levels, which are a function of voltage and line configuration, were calculated and are shown in Table 8-3 for eight segments of the ROW both prior to and after construction. The electric field level at the edge of the ROW increases in some segments, is unchanged in others, and decreases in one segment after the Project is completed. The changes are not uniform because of variations in the configuration and spacing of the lines in the eight segments.

Table 8-3: Calculated Pre-IRP and Post-IRP Electric Fields (kV/m) for Segments RI-1 through RI-8

Segments	Cross- Section Number / Figure 2-2 Map Sheet Number	Description	Configuration	Calculated Electric Fields (kV/m)	
				−ROW edge[1]	+ROW edge[1]
RI-1	RI-366-1 of 6 33-36 of 41	MA/RI border to southeast of Old Great Road	Pre-IRP	0.02	0.24
			Post-IRP	1.98	0.22
RI-2	RI-366-2 of 6 36-37 of 41	southeast of Old Great Road to south of School St.(N)/Main St.	Pre-IRP	0.01	0.30
			Post-IRP	1.83	0.22
RI-3	RI-366-4 of 6 38-39 of 41	Pound Hill Road northwest of Greenville Road	Pre-IRP	0.03	0.18
			Post-IRP	0.93	0.15
RI-4	RI-366-5 of 6 39-41 of 41	southwest from Greenville Rd. parallel to Greenville Rd.	Pre-IRP	0.56	0.03
			Post-IRP	0.54	1.61
RI-5	RI-341-5 of 5 26-32 of 41	West Farnum Substation to L&RR Superfund Site	Pre-IRP	0.06	1.21
			Post-IRP	1.25	1.24
RI-6	RI-341-3 of 5 16-25 of 41	west of L&RR Superfund Site to Sherman Road Switching Station	Pre-IRP	0.09	1.19
			Post-IRP	0.39	1.22
RI-7	RI-341-2 of 5 9-16 of 41	Sherman Rd. Switching Station to west of Clear River	Pre-IRP	0.04	0.09
			Post-IRP	0.05	0.39
RI-8	RI-341-1 of 5 1-8 of 41	west of Clear River to RI/CT border	Pre-IRP	1.19	0.09
			Post-IRP	1.22	0.39

[1] -ROW edge is the east edge in ROW segments RI-1-3, the southeast edge in ROW segment RI-4, and the south edge in ROW segments RI-5-8.

+ROW edge is the west edge in ROW segments RI-1-3, the northwest edge in ROW segment RI-4, and the north edge in ROW segments RI-5-8.

8.16.2 Magnetic Fields

For projects involving construction of new or reconfigured transmission lines, it is National Grid's standard practice to evaluate low cost/no cost options for reducing edge of ROW magnetic field levels through optimization of phase configurations.

Consistent with this practice, Exponent calculated the effect of different phase combinations for the proposed and rebuilt lines on edge of ROW magnetic field levels. The phase combinations were then reviewed with consideration given to constructability, to implement the optimal phase combinations.

Between the Massachusetts/Rhode Island border and the West Farnum Substation, (Sections RI-1 through RI-4) the proposed 366 Line is phased ABC, east to west. Between the West Farnum Substation and the Sherman Road Switching Station (Sections RI-6 and RI-7), the proposed 341 Line is phased CBA from south to north and the existing 328 Line is phased ABC from south to north. Between the Sherman Road Switching Station and the Rhode Island/Connecticut border (Section RI-8), the existing 347 Line is phased ABC, from south to north and the proposed 341 Line is phased CBA from south to north.

Magnetic field levels were calculated for the eight segments of the ROW for annual average load and annual peak load, before (pre-construction 2015), immediately after construction (2015), and five years after construction (2020). The results are summarized in Tables 8-4 and 8-5.

In Sections RI-1 through RI-3, the calculated magnetic-field levels increase at the eastern edge of the ROW which is closest to the proposed 366 Line. The calculated magnetic field level for average-load conditions increases by 22-24 mG on the eastern ROW edge where the centerline of the 366 Line approaches within 65 feet of the ROW edge (Sections RI-1 and RI-3). This increase is less, 13-15 mG, where the centerline of the 366 Line is located further away from the eastern ROW edge (85 feet, as in Section RI-2). On the western edge of the ROW, adjacent to the existing 115 kV circuits, calculated magnetic-field levels increase by less, 3-4 mG, under 2015 and 2020 AAL conditions.

In Section RI-4, calculated magnetic-field levels likewise increase on the side of the ROW nearest the proposed 366 Line. On the northwestern edge of the ROW, the calculated magnetic-field level for average-load conditions increases by 22-24 mG, compared to the pre-IRP configuration. On the southeastern edge of the ROW, adjacent to the existing 115 kV circuits, calculated magnetic-field levels increase by 6-7 mG under 2015 and 2020 AAL conditions.

Between the West Farnum Substation and the Sherman Road Switching Station (Sections RI-5 and RI-6), calculated magnetic-field levels at the ROW northern edge decreases compared to the pre-construction case. The decrease on the northern ROW edge adjacent to the rebuilt 328 Line is approximately 14 mG under AAL conditions, and is primarily due to the decreased average load on the 328 Line in the post-IRP load projections. In Section RI-5, the calculated magnetic field levels decrease from Pre-IRP (2015) to Post-IRP (2015) but increase slightly (2.5 mG) under the Post-IRP (2020) conditions. In Section RI-6, the magnetic field level decreases slightly. The phasing of the

345 kV lines in this segment of the proposed route was selected to maximize mutual cancellation of magnetic fields for anti-parallel load flow on the 328 and 341 Lines, as projected in the post-IRP 2020 load scenario.

Between the Sherman Road Switching Station and the Rhode Island/Connecticut border (Sections RI-7 and RI-8), calculated magnetic-field levels at the ROW edges increase compared to the pre-construction case. This increase is greatest on the southern ROW edge adjacent to the existing 347 Line on the 300-foot ROW in Section RI-8 (6-14 mG for the AAL case). The increase in the calculated magnetic-field level is primarily due to the increased average load on the 347 Line in the post-IRP load projections.

Table 8-4: Calculated Pre-IRP and Post-IRP (2015 and 2020) Magnetic Fields (mG) for Segments RI-1 through RI-8 (Annual Average Load)

Segment	Cross- Section Number / Figure 2-2 Map Sheet Number	Description	Configuration	Calculated Magnetic Fields (mG)	
				−ROW edge[1]	+ROW edge[1]
RI-1	RI-366-1 of 6 33-36 of 41	MA/RI border to southeast of Old Great Road	Pre-IRP (2015)	1.0	0.7
			Post-IRP (2015)	23.0	3.7
			Post-IRP (2020)	25.3	4.3
RI-2	RI-366-2 of 6 36-37 of 41	southeast of Old Great Road to south of School St.(N)/Main Street	Pre-IRP (2015)	0.8	1.2
			Post-IRP (2015)	14.4	4.4
			Post-IRP (2020)	15.8	5.2
RI-3	RI-366-4 of 6 38-39 of 41	Pound Hill Road to northwest of Greenville Road	Pre-IRP (2015)	1.0	0.8
			Post-IRP (2015)	22.4	3.4
			Post-IRP (2020)	24.6	4.0
RI-4	RI-366-5 of 6 39-41 of 41	southwest from Greenville Road parallel to Greenville Road	Pre-IRP (2015)	22.7	3.7
			Post-IRP (2015)	29.3	25.4
			Post-IRP (2020)	28.9	27.4
RI-5	RI-341-5 of 5/ 26-32 of 41	West Farnum Substation to L&RR Superfund Site	Pre-IRP (2015)	5.7	35.3
			Post-IRP (2015)	4.1	21.7
			Post-IRP (2020)	8.3	23.1
RI-6	RI-341-3 of 5 16-25 of 41	west of L&RR Superfund Site to Sherman Road Switching Station	Pre-IRP (2015)	5.8	35.5
			Post-IRP (2015)	3.6	21.6
			Post-IRP (2020)	5.7	23.3
RI-7	RI-341-2 of 5 9-16 of 41	Sherman Road Switching Station to west of Clear River	Pre-IRP (2015)	0.6	1.1
			Post-IRP (2015)	1.2	2.3
			Post-IRP (2020)	1.8	1.8
RI-8	RI-341-1 of 5/ 1-8 of 41	west of Clear River to RI/CT border	Pre-IRP (2015)	6.6	1.1
			Post-IRP (2015)	12.7	2.3
			Post-IRP (2020)	20.5	1.8

[1] -ROW edge is the east edge in ROW segments RI-1-3, the southeast edge in ROW segment RI-4, and the south edge in ROW segments RI-5-8.

+ROW edge is the west edge in ROW segments R-1-3, the northwest edge in ROW segment RI-4, and the north edge in ROW segments RI-5-8.

Table 8-5: Calculated Pre-IRP and Post-IRP (2015 and 2020) Magnetic Fields (mG) for Segments RI-1 through RI-8 (Annual Peak Load)

Segment	Cross- Section Number / Figure 2-2 Map Sheet Number	Description	Configuration	Calculated Magnetic Fields (mG)	
				−ROW edge[1]	+ROW edge[1]
RI-1	RI-366-1 of 6 33-36 of 41	MA/RI border to southeast of Old Great Road	Pre-IRP (2015)	3.0	11.9
			Post-IRP (2015)	44.3	8.3
			Post-IRP (2020)	39.3	8.6
RI-2	RI-366-2 of 6 36-37 of 41	southeast of Old Great Road to south of School St.(N)/Main Street	Pre-IRP (2015)	2.3	15.5
			Post-IRP (2015)	28.5	12.0
			Post-IRP (2020)	25.4	12.2
RI-3	RI-366-4 of 6 38-39 of 41	Pound Hill Road to northwest of Greenville Road	Pre-IRP (2015)	3.1	9.8
			Post-IRP (2015)	43.3	6.5
			Post-IRP (2020)	38.5	6.7
RI-4	RI-366-5 of 6 39-41 of 41	southwest from Greenville Road parallel to Greenville Road	Pre-IRP (2015)	57.9	9.3
			Post-IRP (2015)	51.8	31.3
			Post-IRP (2020)	54.5	26.6
RI-5	RI-341-5 of 5 26-32 of 41	West Farnum Substation to L&RR Superfund Site	Pre-IRP (2015)	4.9	31.1
			Post-IRP (2015)	21.2	32.1
			Post-IRP (2020)	21.6	33.9
RI-6	RI-341-3 of 5 16-25 of 41	west of L&RR Superfund Site to Sherman Road Switching Station	Pre-IRP (2015)	5.2	31.5
			Post-IRP (2015)	6.4	29.6
			Post-IRP (2020)	6.5	31.3
RI-7	RI-341-2 of 5 9-16 of 41	Sherman Road Switching Station to west of Clear River	Pre-IRP (2015)	2.4	4.2
			Post-IRP (2015)	1.1	7.6
			Post-IRP (2020)	1.1	7.9
RI-8	RI-341-1 of 5/ 1-8 of 41	west of Clear River to RI/CT border	Pre-IRP (2015)	25.5	4.2
			Post-IRP (2015)	21.4	7.6
			Post-IRP (2020)	21.3	7.9

[1] -ROW edge is the east edge in ROW segments RI-1-3, the southeast edge in ROW segment RI-4, and the south edge in ROW segments RI-5-8.

+ROW edge is the west edge in ROW segments RI-1-3, the northwest edge in ROW segment RI-4, and the north edge in ROW segments RI-5-8.

9 MITIGATION MEASURES

The proposed 345 kV transmission lines are aligned to avoid or minimize adverse environmental impacts. For example, for the entire 22.5 mile route in Rhode Island, the new 345 kV transmission lines will be aligned along National Grid's existing utility ROWs or fee-owned sites, which have long been dedicated as energy corridors and along which National Grid routinely manages vegetation consistent with mandatory standards for overhead transmission lines. Additional mitigation measures are designed to minimize Project impacts on the natural and social environments. Mitigation measures have been designed for the Project to reduce impacts associated with each phase of construction. Many of these measures are standard proven procedures that National Grid incorporates in all transmission line and substation construction projects. Others are site specific measures designed to meet the needs of this particular Project. These measures are described in the following sections.

9.1 DESIGN PHASE

In order to reduce the impacts associated with the construction and operation of the transmission line facilities, National Grid has incorporated design measures to minimize the impacts of the Project. These measures, which include alignment of existing and proposed structure locations, structure design and configuration, selection of structure locations and the use of existing access roads where possible, have resulted in the avoidance and minimization of land use, wetland/water resource impacts, and soil disturbance to the greatest extent practicable. Land use impacts are minimized by locating the proposed electric transmission lines in the existing ROW. The design and construction of the proposed electric transmission lines incorporates measures which minimize impacts to wetlands and water resources and other natural features within the ROW. To evaluate the location of the new structures, constructability field reviews of the entire Project ROW were conducted in the summer, fall and winter of 2011 and early 2012. These reviews were conducted to assess the constructability of the Project and to identify options for avoiding and/or minimizing impacts from construction. The constructability field reviews resulted in recommendations regarding shifting the locations of certain structures to avoid and/or reduce impacts to wetlands, watercourses, cultural resources, rare species habitats and other physical constraints (ledge, steep topography, existing structures etc.) that were observed in the field. Where practicable, structure locations were adjusted and custom-shaped construction pads were designed to abut, but not impact, wetlands and other resources.

Likewise, the use of existing access roads was maximized to the extent practicable. New access roads required for construction were located within the ROW, or from points off-ROW, in a manner that will result in the fewest impacts to wetlands, surface waters, rare species habitats, and other environmentally sensitive areas. Where wetland or watercourse crossings are required, temporary swamp mats or mat bridges (or similar bridging techniques) will be used to reduce adverse impacts. Swamp matting, or similar bridging techniques, will also be used for temporary crossings of underground pipelines using approved temporary pipeline crossing methods.

Construction of the new 345 kV transmission lines will result in the installation of 141 new structures along the 341 Line and 52 new structures along the 366 Line. In addition, the rebuild of the existing 328 Line will involve the replacement of 74 structures. The constructability field reviews included a structure-by-structure evaluation to identify practicable options to avoid or minimize impacts on wetlands, watercourses, or vernal pools. These structure modifications are summarized as follows:

341 Line Structure Shifts:

- 18 new structure locations were shifted to avoid wetlands;
- 1 new structure location was shifted to avoid a wetland and vernal pool;
- 1 new structure location was shifted to avoid a wetland and stream channel;
- 2 new structure locations were shifted to avoid stream channels; and
- 1 new structure location was shifted to the edge of a wetland to avoid the central portion of the wetland.

366 Line Structure Shifts:

- 1 new structure was eliminated entirely to avoid a wetland;
- 5 new structure locations were shifted to avoid wetlands;
- 3 new structure locations were shifted to avoid a stream and/or open water body; and
- 1 new structure location was shifted to the edge of a wetland to avoid the central portion of the wetland.

328 Line Structure Shifts:

- 2 replacement structure locations were shifted to avoid wetlands.

In total, 34 structure locations were shifted and one structure was entirely eliminated to avoid impacts to wetlands, watercourses or vernal pools.

National Grid sought a Project alignment that would maximize the use of upland areas that does not contain sensitive environmental features for structure locations, construction pads and access roads. Further, construction BMPs will be implemented during and following construction to minimize impacts associated with the Project, and a compensatory wetland mitigation plan is being developed to address federal and state mitigation requirements.

The following sections detail the various measures implemented during the design phase of the Project to reduce impacts to the natural and social environment.

9.1.1 Mitigation of Natural Resource Impacts

The design of the transmission line facilities has been developed to reduce wetland impacts through avoidance, minimization, and mitigation compensation. Consequently, unavoidable wetland impacts associated with the construction of pole structures for the Project in Rhode Island have been limited to approximately 57,055 square feet of permanent wetland disturbance due to filling for new structure installation, access road improvements, and switching station reconstruction. Mitigation for these alterations of wetland will be provided in order to comply with federal wetland regulations.

The RIDEM requires compensation for any loss of 100-year flood storage. In accordance with these requirements, National Grid will provide, as necessary, floodplain compensation for fills related to structure placement. Soil erosion and sediment controls will be installed along the perimeter of the excavation area to avoid sedimentation of the adjacent wetlands. Following excavation, the impacted area will be restored, seeded and/or mulched.

Potential short-term and long-term impacts to wildlife will be mitigated. Wildlife impacts in the short-term will be mitigated by limiting ground disturbances to pole structure and access road locations, and restoring and/or stabilizing areas following construction. Vehicle and equipment traffic will be limited to established access roads as much as practical. Long-term mitigation efforts will include minimizing permanent wetland disturbance and maintaining wetland functions following construction. Plant species that are generally encouraged on the ROWs include low growing herbaceous growth and vegetation. These types of successional communities have various benefits to flora and fauna. Scrub-shrub habitats within the ROW can provide wildlife habitat such as nesting for birds, browse for deer, and cover for small mammals, as discussed in Section 8.7 of this report.

9.1.1.1 Transmission Line Facilities

Adverse Project-related wetland impacts were avoided and minimized to the maximum extent practicable through the Project design process. The result is a practical alternative with minimal wetland impacts.

Comprehensive constructability field reviews were conducted by National Grid following the wetland boundary determinations to make siting adjustments to the preliminary transmission line layout which will minimize wetland impacts. The proposed pole structure locations were reviewed to ensure that impacts to the natural and social environment would be reduced.

9.1.1.2 Access Roads

The existing National Grid ROW includes a network of existing access roads. National Grid proposes to use the existing access roads to the greatest extent possible, incorporating improvements to these roads to accommodate the required construction vehicles and equipment to construct a new 345 kV transmission line. As further mitigation, proposed access routes have been situated to cross streams and wetlands at the narrowest practical point to minimize disturbance. Each of the proposed access ways through wetlands was thoroughly scrutinized for consistency with the *Rhode Island Stormwater Design and Installation Standards Manual*, the *Rhode Island Wetland BMP Manual: Techniques for Avoidance and Mitigation*, and the *Rhode Island Freshwater Wetland Rules and Regulations*. The locations of proposed access roads and improvements to existing roads were determined by what is necessary to gain required access to the structure locations and to safely construct the proposed facilities. The Freshwater Wetland Rules require that the project proponent demonstrate that impacts to freshwater wetlands will not be a random, unnecessary, or undesirable alteration. Each location was selected to traverse the wetland fringe or a previously impacted area within the wetland. Wetland and watercourse crossings will be accomplished using temporary mat/bridge crossings where no existing access road crossing exists.

9.1.2 Mitigation of Social Resource Impacts

In addition to avoiding and minimizing impacts to the natural environment within the Project ROW, several design practices have been incorporated to minimize or avoid impacts to the surrounding social environment. To minimize impacts to adjacent residences and undisturbed areas, National Grid will locate the Project within an existing ROW parallel to existing transmission lines. National Grid also proposes to locate new pole structures adjacent to existing structures, where feasible, to minimize the potential for visual impact. Vegetation removal will be limited so that the maximum practical visual buffer between residences and the Project is maintained.

9.1.3 L&RR Superfund Site

Construction within the limits of and adjacent to the L&RR Superfund Site will be conducted in compliance with the pending Environmental Land Use Restrictions, including associated Soil and Groundwater Management Plans.

9.2 CONSTRUCTION PHASE

National Grid will implement several measures during construction which will minimize impacts to the environment. These include the use of existing access roads and work pad locations where possible, installation of soil erosion and sediment controls, supervision and inspection of construction activities within resource areas by an environmental monitor and minimization of impacted areas. The following section details various mitigation measures which will be implemented to minimize construction-related impacts.

9.2.1 Mitigation of Natural Resource Impacts

9.2.1.1 Wetlands and Watercourses

Throughout the planning and design process for the Project, wetland impacts have been minimized to the greatest extent possible by aligning the new transmission line along an existing ROW, utilizing existing access roads, and avoiding the placement and construction of structures and access roads in wetlands and watercourses, wherever possible. However, given the scale of the Project, certain wetland and watercourse resource impacts associated with the development of the Project cannot be avoided. In order to offset environmental impacts associated with the Project, appropriate compensatory mitigation (in collaborative consultation with local, state, and federal resource agencies and other stakeholders) will be provided, as a component of the final Project design.

Because certain structures will unavoidably have to be located in wetlands, the Project will result in a minor amount of permanent wetland fill associated with the structure foundations. The amount of compensatory mitigation required will depend on the final Project design and the amount of wetland impacts. Compensatory wetland mitigation options for the Project may include wetlands restoration and/or enhancement along the project ROW, wetlands creation (on or off the ROW), wetlands preservation, and/or placement of conservation restrictions to preserve open spaces. Installation of transmission line structures within floodplains is anticipated to have de minimus impact on flood storage capacity and not result in an increase in flood stages in a meaningful way. The removal of existing structures and replacement with new structures is not expected to result in any significant displacement of flood waters. Engineering analyses are being completed to confirm these preliminary conclusions. If the impact within the floodplains is not determined to be negligible in comparison to the extent of the floodplains, compensatory flood storage volume would be designed to mitigate permanent impacts on 100-year floodplains.

Best management practices, as detailed in EG-303, will be employed to minimize disturbances to wetlands during construction of the Project. The boundaries of the wetlands along the ROW would be clearly demarcated by a qualified wetland scientist prior to the commencement of work. When working in or traversing such wetlands, National Grid would:

- Install, inspect, and maintain soil erosion and sediment controls and other applicable construction BMPs.
- Limit grading for access roads and structure foundations in wetlands to the amount necessary to provide a safe workspace.
- Install temporary swamp matting or geotextile and stone pads for access roads across wetlands or to establish safe and stable construction work areas/ pads within wetlands, where necessary. The type of stabilization measures to be used in wetlands will depend on soil saturation and depth of organic matter.

- Restore wetlands, after transmission facility construction, to pre-construction configurations and contours to the extent practicable.
- Comply with the conditions of federal and state permit conditions related to wetlands.
- Pile cut woody wetland vegetation so as to avoid blocking surface water flows within or otherwise to adversely affect the integrity of the wetland.
- Cut forested wetland vegetation without removing stumps unless it is determined that intact stumps pose a safety concern for the installation of structures, movement of equipment, or the safety of personnel.
- Avoid or minimize access through wetlands to the extent practical. Where access roads must be improved or developed, the roads would be designed, where practical, so as not to interfere with surface water flow or the functions of the wetland.
- Install temporary soil erosion controls around work sites in or near wetlands to minimize the potential for soil erosion and sedimentation.
- Refuel construction equipment (apart from equipment that cannot practically be moved) 100 feet or more from a wetland. If refueling must occur within a wetland, secondary containment will be used.
- Store petroleum products at least 100 feet from a wetland.
- Restore structure work sites in and temporary accessways through wetlands following the completion of line installation activities.

National Grid would implement the following mitigation measures to minimize the potential impacts of construction activities in or near watercourses:

- Maintain ambient water flows (if water is present at the time of construction) and not constrain or interrupt the flow at any time during construction.
- Installing new culverts at currently day-lighted stream reaches will be avoided to the greatest extent feasible.
- Maintain existing riparian zone vegetation, to the extent feasible, along the banks of the watercourse.
- Install controls to prevent or minimize turbidity and sediment loading into watercourses. These controls may include the use of crushed stone approach aprons onto mat bridges, stone check dams, water bars, diversion channels, soil erosion controls, turbidity curtains and floating booms.
- Install clean materials (e.g., clean riprap or equivalent, rock fords) where existing access roads that cross stream bottoms must be improved. To the extent possible, improvements to existing access roads across streams that support fishery resources will be scheduled to avoid conflicts with fish spawning/migration.

- Install mat bridges or other bridging techniques to span watercourses, or use other stream crossing techniques, such as temporary or permanent culvert crossings. Avoid installing temporary bridging during peak flows, or when the waterway to be crossed is above bankfull width conditions; with the exception of emergency situations or other unforeseen circumstances.

National Grid has identified the following types of measures that may be implemented to minimize adverse Project impacts on vernal pools:

- Where feasible in areas proximate to vernal pools (and to the extent that circuit outage constraints allow), adhere to the seasonal windows for tree removal to avoid negative impacts on amphibians during migration periods.
- Locate new transmission line structures outside of confirmed vernal pools and amphibian breeding habitats to the extent practical.
- Install appropriate soil erosion and sediment controls around distinct work sites and access roads to minimize the potential for sediment deposition into vernal pools, and remove such controls promptly after final site stabilization.
- Evaluate the use of temporary mat access roads in wetlands in lieu of constructing gravel access roads in the vicinity of vernal pools.
- During tree and vegetation removal along the ROW, access through vernal pools will be avoided to the extent feasible. Limited access will be required therefore vehicle/equipment access will be supported on temporary swamp mats. Minimize the removal of low-growing vegetation surrounding vernal pools.
- To the extent practicable trees to be removed will not be directly felled into vernal pool depressions. Directional felling using mechanized equipment (feller/buncher) allows complete control of trees during felling. The feller/buncher lifts the tree from the stump, allowing careful removal. Aerial cable winching and other forestry practices will be utilized as appropriate. If trees are felled within a vernal pool, whether out of necessity or inadvertently, and removal is likely to cause more harm than good (as determined by a Company assigned biologist and forester), some slash may be left in place to serve as coarse woody debris.
- During the operation and maintenance of the new transmission lines, incorporate measures to protect vernal pools (e.g., maintain as much vegetative cover within and around vernal pools as possible) into the ROW vegetation management program

The specific measures that would be implemented to protect amphibians would be defined in consultation with the involved regulatory agencies.

Compensatory wetland mitigation, for the unavoidable impacts to wetlands, streams, and/or other aquatic resources, as a result of the proposed Project, is necessary in order to meet environmental criteria for activities to be permitted under the federal requirements (i.e., Sections 401 and 404 of the

Clean Water Act ("CWA") – 33 U.S.C § 1344 and 33 U.S.C. § 1251, respectively), and the April 10, 2008 Final Compensatory Rule (33 CFR 332). The ACOE, New England District has developed the New England District Compensatory Mitigation Guidance, dated July 20, 2010, for use in reviewing all mitigation for unavoidable impacts to aquatic resources.

National Grid will comply with all applicable wetland regulatory permit requirements and conditions, as well as the associated Project plans and specifications submitted in support of these permit applications. EG-303 describes typical BMPs for construction activities and includes guidance from the *ROW Vegetation Management Policies and Procedures*.

9.2.1.2 Surface Water and Groundwater Resources

For work along the Project ROW, National Grid will require its contractor to adhere to BMPs regarding the storage and handling of oil and potentially hazardous materials during construction of the Project. Further, National Grid will require its contractors to adhere to a standard emergency response plan or a Project-specific spill prevention, containment, response, and reporting plan. Equipment refueling and equipment/material storage will not be permitted within 100 feet of any wetland or waterbody, with the exception of equipment that cannot be feasibly moved from its working location (e.g., drilling equipment, dewatering pumps). Secondary containment will be used at these refueling locations. Contractor staging areas and contractor yards typically will be located at existing developed areas (parking lots, existing yards), where the storage of construction materials and equipment, including fuels and lubricants, would not conflict with protection of public surface water supplies or wetland resources. If blasting is required, National Grid will follow RIDEM's recommendations with respect to perchlorate within groundwater recharge areas.

Dewatering will be necessary during excavations for pole structures adjacent to or within wetland areas. If there is adequate vegetation in upland areas to function as a filter medium, the water generally will be discharged to the vegetated land surface. Where vegetation is absent or where slope prohibits, water will be pumped into a straw bale or silt fence settling basin which will be located in approved areas outside wetland resource areas. Other dewatering options include pumping into a temporary storage tank; or implementation of tremi-pours. The pump intake hose will be suspended above the bottom of the excavation throughout dewatering. Additionally, mud boxes will be used to temporarily store drilling muds. The basin and all accumulated sediment will be removed following dewatering operations and the area will be seeded and mulched.

9.2.1.3 Rare, Threatened, and Endangered Species

The following state-listed rare plant species have been identified on or within the immediate vicinity of the ROW: slender gerardia, rock harlequin, American yew, zigzag bladderwort, and grass-leaved arrowhead. In general, these species are adapted to the existing site conditions promoted by the on-going vegetation management practices implemented along the ROWs; and, in some cases, have shown an affinity to disturbed areas, such as those found along the regularly maintained ROW. Potential impacts on these species could include damaging and/or destroying the plants communities through the expansion of existing access roads or by equipment travel over the ROW. However, periodic disturbances to the vegetative community associated with management and maintenance of the ROW can create early successional habitats that could promote the further establishment of these plant species on the ROWs.

As a mitigation measure, National Grid will conduct pre-construction reconnaissance sweeps/surveys to locate any populations of these plant species within the ROWs. Any identified plant locations will be marked for avoidance during construction. If avoidance is not possible, National Grid, in consultation with the RIDEM and RINHS, would seek alternative access routes, transplant the affected plants to a protected location outside of the construction area, or undertake other mitigation.

National Grid will be coordinating with the RIDEM and RINHS to complete biological surveys for the whiteface dragonfly and green adder's mouth, first to determine their presence and extent on the ROWS, and to determine appropriate avoidance/protection measures that should be implemented during construction.

9.2.1.4 Soil Erosion and Sediment Control

Soil 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 excess soil piles and other impacted soil areas are confined and do not result in downslope sedimentation of sensitive areas. Woody species with a mature height greater than 10 feet will be cleared within specified portions of the ROW. Low growing tree species, shrubs, and grasses will only be mowed along access roads and at pole locations. To avoid disturbing the root mat, tree stumps will be left in place except at structure locations and within the footprint of proposed access roads or construction work pads. Soil erosion controls will be inspected on a regular basis and maintained or replaced as necessary.

The soil erosion and sediment control measures selected will be appropriate to minimize the potential for soil erosion and sedimentation in areas where soils are impacted. National Grid will adhere to EG-303, and would prepare a project-specific Stormwater/Erosion and Sedimentation Control Plan, in compliance with the *Rhode Island Soil Erosion and Sediment Control Handbook*, the *Rhode Island Stormwater Design and Installation Standards Manual*, and the *Wetland BMP Manual: Techniques for Avoidance and Mitigation*. Typically, temporary soil erosion controls would be installed based on the specifications in the Stormwater/Erosion and Sediment Control Plan.

9.2.1.5 Supervision and Monitoring

Throughout the entire construction process, National Grid 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, on a routine basis to ensure compliance with all federal, state, and local permit commitments. The environmental monitor will be a trained environmental scientist responsible for supervising construction activities relative to environmental issues. The environmental monitor will be experienced in soil erosion control techniques described in this report and will have an understanding of wetland resources to be protected.

During periods of prolonged precipitation, the monitor will inspect all locations to confirm that the environmental controls are functioning properly. In addition to retaining the services of an environmental monitor, National Grid 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.

9.2.2 Mitigation of Social Resource Impacts

National Grid will minimize social resource impacts during construction by incorporating several standard mitigation measures. The use of an established transmission line ROW rather than a new ROW, confines the potential for disruption of existing land uses due to construction activities to an area already dedicated to transmission line uses. Construction generated noise will be limited by the use of mufflers on all construction equipment. 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.

In order to mitigate impacts to social resources, National Grid will designate an ombudsman for the Project who will be responsible for outreach during construction and who will provide a consistent point of contact for the public. By notifying landowners and abutters of planned construction activities before and during Project construction, National Grid will minimize the potential for disturbance from construction, or be positioned to address concerns expressed by local residents.

Some short-term impacts are unavoidable, even though they have been minimized. By carrying out the construction of the line in a timely fashion, National Grid will keep these impacts to a minimum. The construction of the new lines in the existing ROW may cause some temporary disturbance to the abutting property owners.

National Grid will prepare traffic management plans which will minimize impacts associated with increased construction traffic on local roadways.

If cultural or archaeological resources or properties are discovered during construction, National Grid will respond as described in Section 8.12 of this report, and consult with the RIHPHC and THPOs. Removal or alteration of stonewalls will be minimized to the extent practical. As appropriate, stone walls that are removed or breached by construction activities will be repaired or rebuilt. Rebuilt stone walls shall be placed on the same alignment that existed prior to temporary removal, to the extent that it will not interfere with transmission line operation or maintenance. An archaeologist will monitor tree removal and construction activities that occur within a 50-foot radius of identified cultural resource sites.

9.3 POST-CONSTRUCTION PHASE

Following the completion of construction, National Grid will implement the following standard and site specific mitigation measures to minimize the impact of the Project on the natural and social environment.

9.3.1 Mitigation of Natural Resource Impacts

Restoration efforts, including final grading and installation of permanent soil erosion control devices, and seeding of impacted areas, will be completed following construction. Construction debris will be removed from the Project site and disposed of in accordance with National Grid's policies and procedures. Pre-existing drainage patterns, ditches, roads, fences and stone walls will be restored to their former condition, where appropriate. Permanent slope breakers and soil erosion control devices will be installed in areas where the impacted 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 vegetation along the existing lines on the ROW. National Grid's ROW vegetation practices encourage the growth of low-growing shrubs and other vegetation which provides a degree of natural vegetation control. In addition to reducing the need to remove tall growing tree species from the ROW, the vegetation maintained on the ROW inhibits soil erosion.

National Grid's existing transmission line easements restrict certain activities within the ROWs. Easements typically prohibit the construction of buildings, pools, and other structures within the ROWs. In addition, National Grid routinely works with landowners to discourage unwarranted access onto and use of its ROWs, by third party users of off-road vehicles such as all-terrain vehicles ("ATVs") and snowmobiles. Locked gates are installed along the ROW at public access points to prevent unauthorized off-road vehicular use of the ROWs.

9.3.2 Mitigation of Social Resource Impacts

Where possible, and where it would be effective, National Grid will limit access to the ROW by installing permanent gates and barriers where access roads enter the ROW from public ways.

Where National Grid holds an easement rather than land ownership in fee, National Grid must receive landowner approval prior to installing barriers (such as fences, gates, and access control berms) to discourage such access onto the ROWs.

10 PERMIT REQUIREMENTS

National Grid will obtain permits under the following state,[37] local and federal statutes and regulations, as applicable, prior to the construction of the Project.

10.1 STATE PERMITS

10.1.1 EFSB License

The Project will require a license to construct a major energy facility from the EFSB pursuant to Rhode Island General Laws (R.I.G.L.) Sec. 42-98-1 et seq.

10.1.2 RIDEM Freshwater Wetlands Permit

The Project will require a permit to alter freshwater wetlands from RIDEM pursuant to R.I.G.L. Sec. 2-1-18 et seq. for alteration of freshwater wetlands in connection with the construction of certain structures and access roads. The RIDEM Freshwater Wetland Program has regulatory authority over proposed work activities that may affect freshwater wetlands, 50-foot perimeter wetlands associated with emergent marshes (1+ acres in size) and wooded swamps (3+ acres in size), and 100-foot and 200-foot riverbank wetlands associated with perennial streams. National Grid submitted a Freshwater Wetlands Application to the RIDEM on July 12, 2012.

10.1.3 Water Quality Certification

In accordance with Rule 13 of the Rhode Island Water Quality Regulations, the Project will need a water quality certification from RIDEM under Section 401 of the Clean Water Act. It is expected that the water quality certification will be issued as part of the freshwater wetlands permit. National Grid submitted a Clean Water Act Section 401 Water Quality Certification Application to the RIDEM on July 12, 2012.

10.1.4 RIPDES Stormwater Discharge Associated with Construction Activities

The Project will require a permit from RIDEM for approval of stormwater discharge associated with construction activities pursuant to Rule 31 of the Rhode Island Pollutant Discharge Elimination System ("RIPDES") Regulations. It is expected that the Project will qualify for authorization under the General Permit and will be automatically authorized as part of the freshwater wetlands permit. National Grid submitted a RIPDES Application to the RIDEM on July 12, 2012.

10.1.5 RIDOT Permits

The Project will require freeway and highway utility permits from the RIDOT for the installation of wires across freeways and state highways, and access from freeways or state highways during

[37] The IRP is a three-state Project (Rhode Island, Massachusetts, and Connecticut). This section addresses federal permits and state and local permit requirements in Rhode Island only.

construction pursuant to R.I.G.L. Chapters 10 and 8 of Title 24. National Grid will prepare, as necessary, traffic management plans for proposed work activities which will cross over state highways and may occur within the shoulders of the state highways.

10.2 LOCAL PERMITS

10.2.1 Zoning

North Smithfield

In North Smithfield, a dimensional variance from the height restrictions will be required in all of the zoning districts. North Smithfield Zoning Ordinance, §§ 5.5 and 9.3. A development permit will be required for any portion of the Project located in the Flood Hazard Overlay District. North Smithfield Zoning Ordinance, §§ 6.18.4, 6.18.5(1) and 9.2. The Project will require site plan review, unless an exemption is granted by the Building Inspector and Town Planner. North Smithfield Zoning Ordinance, §17.0.

Burrillville

The Burrillville Zoning Ordinance does not specifically authorize transmission lines or even public utility structures. The Project will require a dimensional variance from the height restrictions of the zoning ordinance. Burrillville Zoning Ordinance, § 30-111 (Table III). The Project right-of-way appears to overlap aquifer zones as identified by the Ordinance and the permitted uses in such zones do not include a transmission line. Burrillville Zoning Ordinance, §§ 30-202(c), 30-202(f). The Zoning Official's position regarding the applicability of the aquifer zone restrictions to the Project will need to be ascertained. Planning Board review is also required because the Project is subject to Energy Facility Siting Board licensure. Burrillville Zoning Ordinance, § 30-201(c)(8).

10.2.2 Construction Work Hours

Both North Smithfield and Burrillville limit construction work hours. As part of the permitting for the Project, National Grid will seek relief from these restrictions to allow construction during additional hours.

North Smithfield

Section 8-114(B) of the North Smithfield Town Ordinances, limits the emission of sound relative to construction activities between 7:30 am and 6:00 pm, Monday through Friday, and 7:30 am to 4:30 pm on Saturdays, and prohibits it on Sundays and legal holidays.

Burrillville

Section 16-35(b) of the Burrillville General Ordinances limits the emission of sound relative to construction activities between 7:00 am and 6:00 pm during normal Eastern Standard Time, between 7:00 am and 8:30 pm during Daylight Savings Time, and prohibits it on Sundays.

10.2.3 Soil Erosion and Sediment Control

The Towns of North Smithfield and Burrillville have adopted local soil erosion and sediment control ordinances. Accordingly, Requests for a Determination of Applicability will be required to determine if Project specific soil erosion and sediment control plans are to be submitted and approved by the affected towns.

North Smithfield

The Town of North Smithfield local ordinance requires that a Determination of Applicability be filed with the Building Inspector to determine if a soil erosion and sediment control plan must be filed. (North Smithfield Code Sections 18.2-3). If a soil erosion and sediment control plan is necessary, the Building Inspector shall approve, approve with conditions or disapprove such soil erosion and sediment control plan. National Grid will consult with the North Smithfield Building Inspector and incorporate the town's requirements into the overall Project soil erosion and sediment control plan.

Burrillville

The Town of Burrillville code requires that a Determination of Applicability must be filed with the Building Inspector for approval. (Burrillville Code Sections 12-61-73). The Code exempts certain activities including the following: excavations for an improvement that a) does not result in a total displacement of more than 50 cubic yards of material; b) has no slopes greater than 10 feet vertical in 100 feet horizontal or approximately 10 percent; and c) has all impacted surface areas promptly and effectively protected to prevent soil erosion and sedimentation. National Grid will consult with the Burrillville Building Inspector and incorporate the town's requirements into the overall Project soil erosion and sediment control plan.

10.3 FEDERAL PERMITS

10.3.1 United States Army Corps of Engineers

The project requires a ACOE - Section 404 Permit for the discharge of fill material to waters of the U.S., including wetlands, in connection with tree removal in wetlands, structure installation in wetlands, and the improvements to and construction of certain access roads in jurisdictional wetlands and watercourses.

The Project also requires authorization from the ACOE for the construction of any structure in or over any navigable water of the United States, the excavation/dredging or deposition of material in these waters or any obstruction or alteration in navigable water. Structure or work outside the limits defined for navigable waters of the U.S. require a Section10 permit if the structure or work affects the course, location, condition, or capacity of the water body No waters along the ROW are subject to Section 10 jurisdiction.

The ACOE review of the Project will involve joint coordination with other federal agencies including the USFWS, the USEPA, the National Marine Fisheries Service, and the National Park Service. National Grid and NU made a joint filing for a Clean Water Act Section 404 Application with the ACOE for the IRP on May 25, 2012.

10.3.2 Historic Preservation

The Project will require consultation with the RIHPHC, SHPO and the applicable THPOs in compliance with Section 106 of the National Historic Preservation Act.

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