THE CONNECTICUT PORTION

OF THE INTERSTATE RELIABILITY PROJECT

BY

THE CONNECTICUT LIGHT AND POWER COMPANY

VOLUME 1: PROPOSED PROJECT: DETAILED DESCRIPTION

DECEMBER 2011

EXECUTIVE SUMMARY

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ES.1 INTRODUCTION

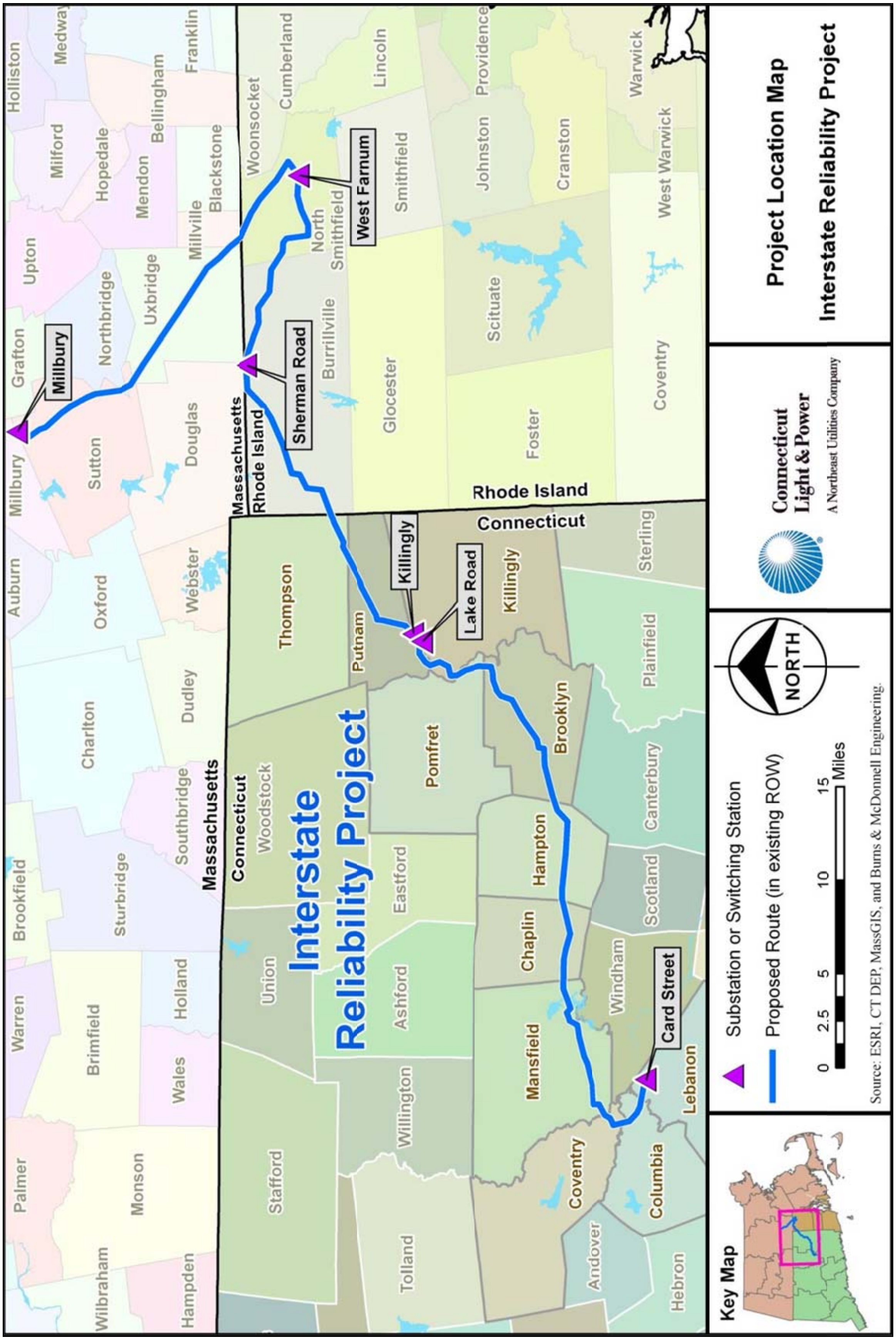
ES.1.1 Interstate Reliability Project: Purpose and Location

The Connecticut Light and Power Company (CL&P), a wholly-owned subsidiary of Northeast Utilities (NU), along with The Narragansett Electric Company and New England Power Company, both of which are wholly-owned subsidiaries of National Grid USA (National Grid), propose to construct and operate new 345-kilovolt (kV) electric transmission lines and to make related modifications and improvements to existing 345-kV and 115-kV transmission lines and facilities in northeastern Connecticut, northwestern Rhode Island, and south-central Massachusetts. These proposed electric transmission system improvements, referred to as the Interstate Reliability Project, are part of a family of four projects, collectively known as the New England East-West Solution (NEEWS) projects[1]. Together, the NEEWS projects would address electric system problems in Southern New England.

As part of NEEWS, the Interstate Reliability Project would improve the bulk power electric transmission system Southern New England and achieve future compliance with applicable national and regional reliability standards and criteria. Figure ES-1 illustrates the locations of the electric transmission facilities that CL&P and National Grid propose as part of the Interstate Reliability Project. These proposed facilities include approximately 75 miles of new 345-kV transmission lines to be developed predominantly within existing utility rights-of-way (ROWs), as well as modifications to substations and switching stations.

[1] The Greater Springfield Reliability Project, one of the four NEEWS projects, was approved by the Connecticut Siting Council in 2010 under Docket 370.

Figure ES-1: Project Location Map: Interstate Reliability Project

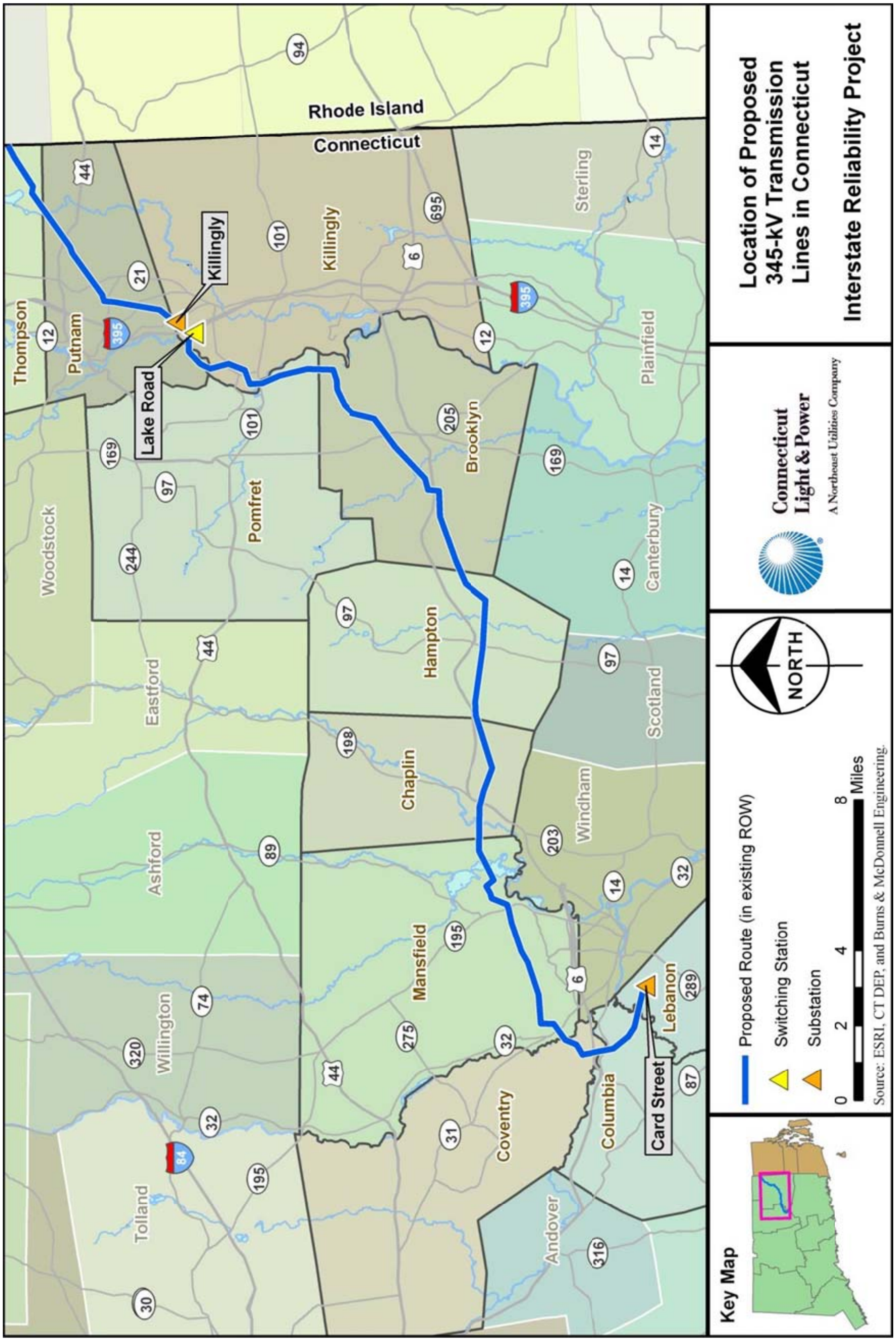


The Interstate Reliability Project would increase the capability of the transmission system to move power into Connecticut from the rest of New England, to move power from resources in eastern New England to load in western New England, and to move power from resources in western New England to load in eastern New England. In addition, the Interstate Reliability Project would eliminate violations of reliability standards that exist in Rhode Island at current load levels, specifically overloads and non-compliant voltages. By reinforcing the electrical connections between key substations and switching stations in Connecticut, Rhode Island, and Massachusetts, the proposed improvements would address reliability violations that would otherwise occur within the 10-year period for which the system must be planned, and would provide long-term flexibility to maintain and operate the transmission system serving all three states and flexibility to dispatch existing and potential future generation resources efficiently for all three states and the New England region.

ES.1.2 Connecticut Portion of the Interstate Reliability Project

The Connecticut facilities proposed as part of the Interstate Reliability Project represent the culmination of extensive analyses. During this process, CL&P, in partnership with the Independent System Operator – New England (ISO-NE) and National Grid, initially conducted detailed evaluations of system alternatives. After these studies led to the selection of a preferred system solution for the new 345-kV lines and related facilities in the three-state area, CL&P then identified and investigated potential line-route alternatives, route variations, and transmission line designs before selecting a Proposed Route and overhead transmission line configurations for the Connecticut portion of the Interstate Reliability Project. The Connecticut portion of the Interstate Reliability Project is hereinafter referred to as “the Project”. The Proposed Route and overhead transmission line configurations, consisting of the following facilities (refer to Figure ES-2), best meet CL&P’s objectives for providing reliable, cost-effective, and environmentally sound improvements to the regional electric transmission system:

Figure ES-2: Location of Proposed 345-kV Transmission Lines and Substation / Switching Stations to be Modified in Connecticut



- New overhead 345-kV electric transmission lines and associated facilities extending between CL&P's Card Street Substation in the Town of Lebanon, Lake Road Switching Station in the Town of Killingly, and the Connecticut/Rhode Island border (in the Town of Thompson). The overhead line design along this Proposed Route incorporates CL&P's preferred Best Management Practices (BMPs) designs for reducing magnetic fields.

- Related additions at CL&P's existing Card Street Substation, Lake Road Switching Station, and Killingly Substation.

The proposed 345-kV transmission lines between Card Street Substation, Lake Road Switching Station, and the Connecticut / Rhode Island border would traverse approximately 36.8 miles, crossing portions of 11 towns in northeastern Connecticut. The new 345-kV transmission lines (which are proposed for designation in the CL&P system as the 3271 Line and the 341 Line) would be constructed overhead and aligned adjacent to the existing 345-kV overhead transmission lines that presently occupy existing CL&P ROWs.[2] The existing 345-kV transmission lines were constructed in the early 1970s. Segments of the existing ROWs also include other overhead transmission lines (e.g., 69 kV and 115 kV), as well as distribution lines (23 kV).

Table ES-1 identifies the width of the existing CL&P ROWs that the Proposed Route would follow through the 11 Connecticut towns. With the exception of 1.4 miles in the towns of Mansfield and Chaplin (representing approximately 4% of the 36.8-mile Proposed Route), the existing CL&P ROWs along which the proposed 345-kV lines would be aligned are approximately 300 feet wide (or more), and have sufficient un-used width to accommodate a new overhead 345-kV transmission line without the need for additional easement acquisition or a need to rebuild and reconfigure the existing line. However, for 0.9 mile in the Town of Mansfield and 0.5 mile in the Town of Chaplin (referred to collectively as the "Mansfield Hollow area"), the existing CL&P ROW is 150 feet wide and traverses property owned by the federal government under the auspices of the U.S. Army Corps of Engineers (USACE).

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[2] The 3271 Line would extend approximately 29.3 miles from Card Street Substation to Lake Road Switching Station adjacent to the existing 330 Line, whereas the 341 Line would extend approximately 7.5 miles from Lake Road Switching Station to the Connecticut / Rhode Island border adjacent to the 3348 Line and then the 347 Line.

Table ES-1: Proposed 345-kV Transmission Lines, By ROW (Miles) in Connecticut Towns

Town	ROW	
	Miles	Width Range (Feet, Typical)
Lebanon	0.6	350
Columbia	1.7	300-350
Coventry	1.2	300
Mansfield	6.4	150*-300
Chaplin	3.3	150*-300
Hampton	4.3	300
Brooklyn	7.2	300-360
Pomfret	1.7	360
Killingly^	3.0	250-400
Putnam^	5.6	340-400
Thompson	1.8	300
Total	**36.8**	

* = CL&P's existing easement is 150 feet wide across federally-owned properties for approximately 0.9 mile in the Town of Mansfield and 0.5 mile in the Town of Chaplin.
^= Following CL&P's existing ROWs, the Proposed Route extends northeast across Killingly into Putnam, back into Killingly, and then into Putnam.

The Mansfield Hollow area property was acquired by the federal government approximately 60 years ago in conjunction with federal projects, such as the creation of Mansfield Hollow Dam and Lake, designed to control flooding on the Thames River. The USACE currently leases the property to the Connecticut Department of Energy and Environmental Protection (CT DEEP), which manages it as Mansfield Hollow State Park and the Mansfield Hollow Wildlife Management Area (WMA).

CL&P's existing overhead 345-kV transmission line is centered within the 150-foot-wide ROW across the 1.4 miles of federally-owned properties, leaving insufficient width to install and properly separate the new overhead 345-kV line adjacent to the existing 345-kV line within the current easement. After investigating various alternative routes and transmission line designs for the 1.4 miles of ROW in the Mansfield Hollow area, CL&P determined that the acquisition of additional easement from the USACE to build and operate a new overhead 345-kV line adjacent to the existing 345-kV line, using structures of similar height and appearance, would be best.[3]

Accordingly, the Proposed Route reflects CL&P's proposed acquisition from the USACE of approximately 11[4] additional acres of easement to expand the ROW and allow the development of the new overhead 345-kV line structures, adjacent to and generally matching the appearance of the existing 345-kV line, through the 1.4 miles of federal property. CL&P is presently engaged in consultations with the USACE regarding the alignment of the proposed 345-kV transmission line across the federally-owned lands.

ES.1.3 The Connecticut Siting Council Application: Organization and Content

The Connecticut portion of the Interstate Reliability Project is subject to the regulations of the Connecticut Siting Council (Council) and other state and federal regulatory agencies. Accordingly, CL&P submits this Application for a Certificate of Environmental Compatibility and Public Need (Application) to the Council.

The Application consists of 11 volumes, as follows:

- Volume 1 presents detailed information concerning the proposed Project, including the Proposed Route, transmission facilities design, construction and operation procedures, existing environmental conditions, potential environmental effects and mitigation measures, and electric and magnetic field (EMF) information.

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[3] CL&P identified and evaluated two other feasible options for aligning the new 345-kV line across the federally-owned properties: a No ROW Expansion Option, which would involve rebuilding the existing 345-kV line through the federally-owned properties, but would not require any additional easement from the USACE, and a Minimal ROW Expansion Option, which would require only approximately 4.8 acres of additional easement from the USACE. Both of these options would, however, require the use of taller line structures and would be more costly than the Proposed Configuration. Section ES.8 summarizes these options, which are discussed in detail in Volume 1, Section 10.

[4] This additional easement acreage calculation is estimated based on preliminary survey data and takes into consideration the configuration of the existing CL&P easement. Final easement acreages would be determined based on final legal surveys and agreements with the USACE.

- Volume 1A describes the Project alternatives considered and presents detailed information concerning overhead and underground transmission line variations to portions of the Proposed Route.

- Volume 2 provides detailed information concerning water resource (wetlands and watercourse) field investigations conducted along the Proposed Route.

- Volume 3 presents data regarding archaeological and historic (cultural) resources in the Project region and in the vicinity of the Proposed Route.

- Volume 4 consists of technical reports concerning biological resources along the Proposed Route, including vernal pools and amphibian breeding habitat, breeding birds, and insects (moth / butterflies), as well as copies of correspondence between CL&P and regulatory agencies.

- Volume 5 includes detailed electric transmission system planning reports. Some of these documents have been redacted for public review to protect Critical Energy Infrastructure Information (CEII). Unredacted versions of these documents will be provided to the Council and to qualified participants in the Council proceedings on this Application, in a CEII Appendix to Volume 5, subject to a protective order that the Council is expected to issue.

- Volume 6 consists of NU standards and best management practices for erosion and sedimentation control, as well as vegetation management along ROWs.

- Volume 7 includes detailed drawings of the proposed modifications to the Card Street Substation, Killingly Substation, and Lake Road Switching Station.

- Volume 8 contains a visual resource assessment study of the Proposed Route, including photographic simulations that illustrate the anticipated appearance of the proposed transmission lines at specific visual resource sites along the Proposed Route.

- Volume 9 includes aerial photography based maps, at a scale of 1" = 400', that depict the location of the Proposed Route, Mansfield Hollow ROW options, and variations in relation to land uses and environmental resources. The maps include accompanying facing-page text that summarizes the key resource features both in the vicinity of and along the Proposed Route, Mansfield Hollow ROW options, and variations. Cross-sections that illustrate the proposed configuration of the transmission lines along each alignment also are included.

- Volume 10 consists of Plan & Profile drawings of the proposed lines, as well as full-size cross-sections of the Proposed Route. Photographs of the existing ROW and photo-simulations that illustrate views of the ROW with the new 345-kV line are included on the page facing the cross-sections of the Proposed Route.

- Volume 11 provides aerial-photography based maps, at a scale of 1" = 100' that provide a closer view of the Proposed Route, including proposed structure locations and structure location envelopes, existing and potential access roads, and environmental features such as wetlands, streams, vernal pools / amphibian breeding habitat, and various land uses.

ES.2 PROJECT NEED AND CONNECTICUT BENEFITS

The New England region's bulk-power electric system (including Connecticut) serves 14 million people living in a 68,000 square-mile area. There are more than 300 New England electric generating units, which are capable of producing a total of approximately 32,000 megawatts (MW) of electricity; most of these generating units are connected to approximately 8,000 miles of high-voltage transmission lines. Twelve transmission tie lines interconnect New England with neighboring electric systems in New York and the Canadian provinces of New Brunswick and Québec. In addition to these power-supply resources and transmission interconnections, New England depends upon significant demand-reducing resources. As of the summer 2011, approximately 2,035 MW of demand-reducing resources, including "behind the meter" generators, were registered as part of the ISO-NE Forward Capacity Market. Customers in these programs agree to reduce load quickly when needed to enhance system reliability.

The Federal Energy Regulatory Commission (FERC) has designated all of New England as a single operating control area, and has designated ISO-NE as the independent system operator for the New England region. As such, ISO-NE is responsible for operating New England's bulk-power generation and transmission system, overseeing and administering the region's wholesale electricity markets, and managing the regional bulk-power system planning process.

New England's bulk-power supply system is planned to be fully integrated and seeks to use all regional generating resources to serve all regional load, regardless of state boundaries. Most of the transmission lines are relatively short and networked as a tightly integrated grid. Therefore, the electrical performance of one part of the system affects all areas of the system.

The New England region reached a record summer peak load of 28,130 MW on August 2, 2006, due to extreme temperatures and humidity throughout the region. In accordance with ISO-NE operating procedures, demand-response programs were activated, and this action reduced the peak demand for electric power by approximately 640 MW. In the absence of these programs, the peak load would have been 28,770 MW. Although this peak load level has not been exceeded since 2006, it has been approached. For example, notwithstanding the recent economic downturn, on July 22, 2011, load peaked at 27,702 MW – the second highest peak ever recorded in New England. This load was net of 643 MW of real-time demand resources that were dispatched by ISO-NE.

The Southern New England area (SNE), which encompasses Massachusetts, Rhode Island, and Connecticut, accounts for approximately 80% of the total New England load. Customer load in SNE is concentrated in the Boston area, central Massachusetts, Springfield, Rhode Island, Hartford, and southwestern Connecticut, and exceeds available local generation capacity. Accordingly, power is routinely transmitted to SNE from generators in northern New England and Canada.

The Interstate Reliability Project is needed to better integrate the electric supply systems of the three Southern New England states for the benefit of all of New England. It will also yield significant benefits to Connecticut electric customers. Such benefits will include increasing Connecticut's ability to import power and providing increased access to newer, less-polluting power generating resources.

Of all the New England states, Connecticut is the least able to import power to supplement its internal supply resources. New Hampshire, Vermont and Rhode Island have enough import capability to serve 100% of their peak load. Massachusetts and Maine can import slightly less than 50% of their peak load. Connecticut, however, can import only approximately 33% of its peak load even after the improvement in its import capability following completion of the Greater Springfield Reliability Project (one of the NEEWs projects involving the development of new 345-kV facilities [currently being constructed] in the Greater Springfield – north-central Connecticut region).

In sum, the Interstate Reliability Project is needed to fully integrate generation with load throughout SNE by eliminating transmission constraints on the transfer of power from east to west and from west to east.

At the same time, the Project will resolve remaining reliability issues within Rhode Island and provide needed power-import capability to Connecticut. It will ensure that the approximately 2,500 MW of generation along the Card Street Substation (Connecticut) – West Medway (Massachusetts) corridor[5], most of which is relatively new and efficient, can be called upon to more reliably serve load in both western and eastern New England, as needed, over the long-term planning horizon. The bulk-power transmission system will be capable of carrying sufficient power to meet peak customer demand needs in the event one of the 345-kV transmission lines (interfaces) that transfer power across the region is lost suddenly, or other design contingencies occur. Moreover, the Interstate Reliability Project will have potential environmental benefits, serving as an essential link to the regional transmission network that provides access to out-of-state renewable energy resources.

ES.3 TECHNICAL DESCRIPTION OF THE PROPOSED PROJECT FACILITIES

Approximately 96% (35.4 miles) of the Proposed Route for the new transmission lines would be located entirely within existing CL&P ROWs. Of the 35.4 miles of the Proposed Route in CL&P's existing ROWs, approximately 5 miles would extend across property that CL&P owns. CL&P is only seeking approximately 11 additional acres of easement along the 1.4 miles of USACE-owned property in the Mansfield Hollow area. All proposed modifications to the existing Card Street Substation, Lake Road Switching Station, and Killingly Substation would be accomplished within the existing station fence lines (i.e., on already-developed portions of these utility sites).

All of the existing CL&P ROWs along which the new 345-kV lines would be located are occupied by an existing 345-kV transmission line (i.e., the 330, 3348, or 347 Line), and in some areas 115-kV and 69-kV transmission lines and 23-kV distribution lines. The existing 345-kV lines are supported mostly on wood, two-pole H-frame structures with a typical height of 80 feet, with some shorter wood-pole H-frame structures and some taller steel-pole structures in limited areas. Although H-frame structures, which are

[5] West Medway is an NSTAR substation located in Medway, Massachusetts.

the predominant type of structure along existing 345-kV lines, usually consist of two poles, three-pole structures are used at angles (turns in the ROW) to maintain required tension on the conductors.

The new 345-kV transmission line structures would typically be placed along the ROWs adjacent to the existing line structures. In general, proposed tangent structures for the new 345-kV lines would be steel or laminated wood H-frames, with a typical height of 85 feet. In certain areas along the route, taller steel poles with a delta conductor configuration are proposed. One of these areas is in the Town of Mansfield, through the 0.9-mile segment across federally-owned properties (i.e., Mansfield Hollow State Park, WMA, and Mansfield Hollow Lake). In this area, the proposed delta steel-pole design would match the structure type of the existing transmission line and would require 55 feet of ROW expansion.

To illustrate the proposed configuration of the new 345-kV transmission line structures in relation to the existing structures, the 36.8-mile Proposed Route is divided into 14 segments. Cross-sections (XSs) depicting the proposed structure types and general location in relation to the existing structures on each ROW segment are included in Volume 1, Section 3, Appendix 3A, as well as in Volume 9 and Volume 10.

In addition, CL&P evaluated Electric and Magnetic Field (EMF) Best Management Practices (BMP) line-design alternatives for potential use in five focus areas along the Proposed Route designated Focus Areas A through E (refer to Volume 1, Section 7, Appendix 7B). As a result, in three locations, CL&P proposes to use taller steel poles with a delta conductor configuration, instead of an H-frame line design. These locations are Focus Area A in the towns of Coventry and Mansfield (refer to XS-2 BMP), Focus Area D in the Town of Brooklyn (refer to XS-6 BMP), and Focus Area E in the Town of Putnam (refer to XS-12 BMP). If the Council approves CL&P's BMP design in Focus Area E, a 0.6-mile segment of the existing 345-kV line (H-frame structures) also would be removed and rebuilt with taller, steel-pole structures with a delta conductor configuration.

Along the Proposed Route, the preliminary location of each proposed transmission line structure was determined using transmission line design software (Power Line System's "PLS-CADD"TM). Initially, the proposed 345-kV line structures were aligned adjacent to existing 345-kV line structures. This design approach was based on the assumptions that an alignment of the new structures adjacent to the existing structures would maximize the use of existing on-ROW access roads (which are already situated to reach existing structures), minimize changes to the visual environment, and mimic existing span lengths to minimize potential clearance violations under high wind conditions.

However, following these initial analyses, each proposed structure site was further evaluated to account for other factors, such as potential environmental effects. Based on these additional analyses, CL&P determined that the initial sites (adjacent to existing structures) would have placed 57 new 345-kV line structures in wetlands. As constructability evaluations and transmission line design progressed, structure locations were shifted, where practical, to reduce effects on environmental resources (e.g., wetlands) and to improve constructability. As a result of this process, 33 of the 57 structures initially proposed for location in wetlands were shifted to uplands; however, the remaining 24 proposed structures could not be adjusted to avoid wetland locations.[6]

Structure locations may change as the Project planning process continues. Future changes could occur based on information obtained from more detailed field studies (e.g., subsurface investigations, final engineering and environmental surveys, constructability reviews), as well as input from the Council and other regulatory agencies. After this additional information is analyzed, final detailed line engineering would be performed to determine the exact locations of the new structures. Typically, the final structure locations are expected to be within 100 feet (longitudinally) of the preliminary proposed structure locations.

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[6] In addition, along a 0.6-mile segment in the Town of Putnam where six existing structures would be removed and replaced per XS-12 BMP, two of the relocated structures would be in wetlands. These two structures also are presently in wetlands.

ES.4 CONSTRUCTION AND OPERATION / MAINTENANCE PROCEDURES

CL&P would construct, operate, and maintain the proposed Project in accordance with all regulatory approvals and standard company practices. Construction of the new transmission facilities would typically be performed in several stages, some overlapping in time.

New 345-kV Transmission Lines. The primary activities generally expected in the construction of the overhead transmission lines include the following:[7]

- Survey to stake the ROW boundaries (where necessary), vegetation clearing boundaries, and proposed structure locations.
- Mark the boundaries of previously delineated wetland and watercourse areas.
- Identify and mark areas to be avoided (e.g. sensitive cultural or environmental resource areas).
- Establish construction field office area(s), typically including space for an office trailer, sanitary facilities, and parking.
- Prepare material staging sites (e.g., storage, staging and laydown areas) to support the construction effort. The preferred locations for such areas are typically in the immediate vicinity of the ROWs.
- Install erosion and sedimentation controls in accordance with best management practices (controls are deployed using pickups and other small trucks, or small track vehicles). Erosion and sedimentation controls may be installed before vegetation removal, depending on site-specific characteristics. After vegetation removal, soil erosion and sedimentation controls typically are installed around work limits (e.g., access roads, crane pads) in or near wetlands and streams.
- Perform vegetation clearing. Vegetation would be removed along those portions of the ROWs to be used for the construction of the new transmission lines, as well as areas that contain undesirable, tall-growing, woody species that could grow to interfere with the operation of the proposed transmission lines should they not be removed. For example, as part of construction, vegetation would be removed to the designated limits of clearing, as required, including at work sites (crane pads), as well as along existing or new access roads. Vegetation also would be removed, as necessary, along existing or new access roads that may be on the ROW (but outside the designated limits of clearing) or off the ROW (but required to reach the ROW). In addition,

[7] These procedures refer to the development of the new 345-kV transmission lines, adjacent to the existing 345-kV lines. If the Council approves CL&P's Focus Area E BMP, then six existing structures along CL&P's existing 347 Line would be removed and replaced. Specific work procedures and sequencing would be required to construct the transmission lines along this 0.6-mile segment while minimizing outages.

danger trees outside the limits of clearing (on or off the ROW) would be removed as necessary to protect the integrity of the proposed or existing transmission lines. Depending on soil saturation, vegetation removal activities in wetlands may involve the use of temporary support (e.g., timber mats or timber riprap) to provide a stable base for clearing equipment.

- Construct new access roads or improve existing roads to provide a minimum travel-way of 12 to 16 feet in width. This typically requires bulldozers or front loaders, dump trucks for crushed stone or gravel, pickups or stake-body trucks for culverts, and/or mat installers for wetland mats. Roads may be temporary (for use during construction only) or permanent (for use during both construction and the subsequent maintenance of the lines). Temporary roads may be constructed of wood mats, whereas permanent access roads may be graveled. Roads must have sufficient width and capacity for heavy construction equipment for both over-the-road and off-road vehicles, including oversized tractor trailers. The need for access by flat-bed trailers and concrete trucks often determines the scope of access road improvements. Road grades must be negotiable for over-the-road trucks; grades are typically 10% maximum, and less if wet weather or surface conditions provide traction problems. Vehicles with tracks or low-ground-pressure tires are typically used in wetlands.

- Prepare staging and material laydown areas both on and off the ROW.

- Prepare level work sites (e.g., crane pads) as necessary at new structures sites. Crane pad installation may involve grading and requires the installation of a stable base (consisting of gravel, timber mats, or equivalent) in order to create a level surface for structure installation equipment.

- Construct foundations and erect/assemble new structures.

- Install conductors and shield wires. The equipment required for these activities would include conductor reels, conductor pulling and tensioner rigs, and bucket trucks. Helicopters also may be used to install the initial pulling lines for the conductors or shield wires.

- Install counterpoise where needed. Depending on site-specific soil resistivity, supplemental grounding systems also may be installed.

- Remove construction debris and restore disturbed sites. Haul construction debris off the ROW for disposal. Vegetative materials cut along the ROWs and not otherwise planned for use by the landowner (e.g., brush) may be piled, scattered, or chipped on the ROW, depending on site-specific environmental features. In some areas, if allowed, disturbed ground will be back-bladed to preconstruction contours, unless directed otherwise. If the ROW is in an agricultural field, the soil may be de-compacted by disking.

- Maintain temporary erosion and sedimentation controls until vegetation is re-established or disturbed areas are otherwise stabilized. Steep areas may be stabilized with jute netting or pre-made erosion control fabric containing seed, mulch, and fertilizer. Culverts or crushed stone fords installed along access roads would be either left in place or removed, as directed by the Council or pursuant to other agency approvals.

After the installation of the new 345-kV transmission lines, CL&P would manage the ROWs in accordance with its established vegetation management program. This program includes the removal of targeted species (e.g., tall-growing trees and selected state-listed invasive woody shrubs) within the portions of the ROWs occupied by transmission lines, as well as the trimming or removal of trees within adjacent areas that may grow closer than minimum allowed distances to conductors. Brush control within CL&P's ROWs is performed every four years, and tree clearing and trimming along the edges of the ROW (as well as outside of the easement if necessary to remove danger trees) is performed every 10 years. All work is performed in accordance with NU's *Specification for Rights-of-Way Vegetation Management* (2011).

Substation and Switching Station Modifications. The modifications to the existing Card Street and Killingly Substations and the Lake Road Switching Station would be performed within the existing station fence lines. These modifications would involve standard construction procedures (e.g., site preparation, implementation of erosion and sedimentation controls, installation of foundations and equipment, and site stabilization with crushed stone or equivalent). The operation and maintenance of the substation and switching station modifications would not substantially affect or alter existing practices at these facilities.

ES.5 ENVIRONMENTAL RESOURCES, POTENTIAL EFFECTS, AND MITIGATION

ES.5.1 Characterization of the Existing Environment

To evaluate the proposed Project, CL&P conducted comprehensive research to compile existing baseline environmental data concerning the Project region, as well as ROW-specific field surveys to characterize the existing environmental resources along the Proposed Route. Environmental information for the Project was compiled, mapped, and described in accordance with the Council's A*pplication Guide for an Electric Transmission and Fuel Transmission Line Facility* (April 2010).

Specifically, existing environmental conditions for the Project were characterized using a combination of baseline research, field investigations, aerial photographic interpretation, and consultations with representatives of environmental agencies and the public. Information was collected using available published resources, the CT DEEP GIS database, and the Environmental Systems Research Institute, Inc. database.

CL&P also contacted representatives of various federal, state and local agencies, and considered public input relating to environmental and cultural features. In addition, baseline research was performed concerning the relationship of the Project to specially designated environmental features, such as federal or Connecticut Heritage Areas, aquifer protection zones, protected rivers, state parks, state forests, state hiking trails, scenic areas, and critical wildlife and plant habitats.

Along the proposed transmission line ROWs and at the substations and switching station, field investigations were performed to identify and characterize site-specific natural resources (e.g., soils, topography, wetlands, watercourses, vegetative communities, vernal pools and amphibian breeding habitats, breeding bird habitat), cultural resources, and visual resources. As a result of this baseline research and field studies, the Proposed Route is described in terms of the following principal environmental conditions, land-use features, and natural resources; most of these features also are depicted on the Volume 9 and Volume 11 maps.

- Locations of existing transmission line ROWs, transmission line structures, and access roads, as well as substations and switching stations
- Locations of CL&P-owned properties
- Vegetative community types, including areas of upland and deciduous and mixed forest
- Areas of steep slopes and rock outcrops
- Land uses, including agricultural, residential, commercial, and industrial areas

- Municipal boundaries
- Municipal zoning classifications
- Federal and state jurisdictional wetlands, depicting field-surveyed wetland boundaries
- Watercourses and waterbodies, including streams, rivers and lakes, as well as drainage ditches and culverts
- Floodplain boundaries, as identified by the Federal Emergency Management Agency, and Stream Channel Encroachment Lines as identified by CT DEEP
- Public recreational, scenic, open space, and other protected areas, including forests, parks, water supply areas, hunting/wildlife management areas, and designated recreational trails
- Statutory Facilities, defined by Connecticut General Statutes Section 16-50p(i) as residential areas, public or private schools, licensed child day-care centers, licensed youth camps, and public playgrounds
- Designated cultural resources (historic sites)
- Habitat for endangered, threatened, or special concern species
- Existing infrastructure, including roads, major pipeline/utility corridors, and railroads

ES.5.2 Environmental Effects and Mitigation Measures

Using the baseline environmental data compared to the plans for the development of the proposed Project, CL&P identified and analyzed the potential short- and long-term effects that the construction and operation of the proposed Project would have on the environment, ecology, and scenic, historic, and recreational values. CL&P also identified possible measures for avoiding, minimizing, or mitigating adverse effects.

The avoidance, minimization, and mitigation of adverse effects to environmental resources, land uses, and cultural resources were key considerations in the Project planning process and will continue to be important during the finalization of Project design and the preparation of a Development & Management

(D&M) Plan. The Project D&M Plan would include specifications for Project construction, operation, and maintenance, including environmental mitigation measures. A D&M Plan is a pre-requisite condition of the Council's issuance of an approval to construct the Project.

Based on current Project engineering plans and analyses of the existing environmental data, the proposed Project would have the following potential environmental effects:

- Result in minimal, short-term, and localized soil disturbance as a result of on-ROW construction activities and substation and switching station modifications.

- Traverse 104 watercourses, including 54 perennial waterbodies and 50 intermittent watercourses. The primary waterbody crossings include the Tenmile River, Hop River, Willimantic River, Mansfield Hollow Lake, Quinebaug River, and Fivemile River. No structures would be located within major waterbodies and no construction access would be required across larger rivers or streams. Construction access across smaller watercourses would be performed in accordance with regulatory requirements.

- Extend across the Stream Channel Encroachment Line (SCEL) of the Willimantic River (which forms the boundary between the towns of Coventry and Mansfield). The new 345-kV line conductors would span the river, and no new 345-kV structures would be located within the SCEL.

- Affect approximately 127 wetlands, out of a total of 227 wetlands delineated within the width of CL&P's ROWs. Of the 227 wetlands within the ROWs, 222 meet both federal and state wetland jurisdictional criteria, whereas five meet the criteria (based on soils) only as state wetlands. The principal effects to the 127 wetlands will occur as a result of forested vegetation removal, temporary or permanent access roads, or structure placement (where no upland sites area available). Based on current Project design information, CL&P estimates that approximately 1.5 acres of wetland would be filled as a result of permanent access roads, new structures, and guys. Approximately 8.9 acres of wetlands would be temporarily affected by construction activities, whereas an estimated 51 acres of forested wetlands would be permanently converted to scrub-shrub wetland habitat. CL&P has avoided the proposed placement of new transmission line structures in wetlands to the extent practical and would minimize permanent access roads in wetlands where possible. Work in wetlands would be in accordance with the conditions of permits from the Council, CT DEEP and USACE.

- Affect approximately 273 acres of forested habitat (222 acres of forested upland and 51 acres of forested wetland).

- Involve the acquisition of approximately 11 acres of additional easement, based on the proposed transmission line configuration across USACE-owned lands in the Mansfield Hollow area of Mansfield and Chaplin (Mansfield Hollow State Park and WMA).

- Traverse or be located near approximately 88 vernal pools, as well as 29 additional areas used by amphibians for breeding.

- Extend across the reported habitat of 29 state-listed threatened, endangered, or special concern species including seven bird species, one turtle species, two snake species, one aquatic snail species, one dragonfly species, and 17 butterfly and moth species. CL&P commissioned surveys of certain of these species as requested by CT DEEP and expects to work with CT DEEP to define appropriate avoidance or mitigation strategies for the species determined to occupy the proposed Project ROWs. Many of the reported species depend on shrubland or grassland habitat, which is found on ROWs and would increase as a result of the proposed Project. (Note: there are no federally-listed species within the Project vicinity.)

- Result in incremental and generally localized visual effects associated with the installation of a second 345-kV overhead line along the existing ROWs.

- Require cultural resource studies, including consultations with Native American tribes, to identify and minimize potential effects on archaeological and historic sites.

In general, the proposed Project would minimize adverse environmental effects by collocating the new 345-kV transmission lines along CL&P ROWs, adjacent to existing overhead 345-kV transmission lines (with 96% of the Proposed Route and Proposed Configurations for the new transmission lines entirely within existing CL&P ROWs) and by developing the proposed substation and switching station modifications within the existing station fence lines on property that is already designated for utility use. Although 10 of the 11 towns traversed by the Proposed Route are within the Quinebaug and Shetucket Rivers Valley National Heritage Corridor (the Connecticut portion of which corresponds to the state-designated heritage corridor), the new transmission lines would follow existing ROWs and would be consistent with current land-use plans. The construction and operation of the Project would result in unavoidable short- and long-term effects on certain environmental, ecologic, cultural, and recreational / scenic resources; however, CL&P has identified measures that can be effectively applied to mitigate these effects to the extent practical.

The identified mitigation measures are based on CL&P's historical experience in the construction, operation, and maintenance of the existing transmission lines along the Project ROWs; on the results of the field investigations and agency consultations conducted for the Project; and on recent, directly relevant expertise in siting and constructing 345-kV transmission facilities elsewhere in Connecticut.

For example, as part of the Project planning process, CL&P has already modified the new 345-kV transmission line design to place new structures outside of wetlands where possible. Similarly, as has been the case on other recent 345-kV transmission line projects, CL&P would commit to prepare Project-specific construction plans related to erosion and sedimentation control, spill prevention, and ROW revegetation. CL&P also would preserve riparian vegetation (compatible with overhead transmission lines) near streams to the extent practical, and would make every effort to align new permanent access roads in upland (rather than wetland) areas where possible.

Furthermore, along with the mitigation methods identified thus far by CL&P, additional measures to avoid or minimize adverse effects on the environment may be identified during the course of the Council proceedings and during the process of acquiring Project-specific permits and approvals from other state and federal agencies, including the CT DEEP and the USACE. In addition, CL&P understands that both the CT DEEP and the USACE will require mitigation (consisting of wetland enhancement, restoration, preservation, creation, or some combination thereof) to compensate for the Project's effects on water resources. Such compensatory mitigation is typically a condition of regulatory approvals from these agencies. Mitigation measures related to construction activities would be reflected in the final Project design and incorporated into the D&M Plan or other Project specifications, as appropriate.

After the completion of Project construction (including restoration of the ROWs and staging areas), CL&P would implement a post-construction monitoring program, which would be designed and executed pursuant to the conditions of permits and certificates from the Council, CT DEEP, and the USACE. In general, the post-construction monitoring would be performed to verify the success of Project restoration and, as necessary, to identify additional restoration measures that may be required. Monitoring may include, for instance, inspections of percent vegetative cover, wetlands functions, and permanent erosion controls on the restored ROWs.

ES.6 EMF ANALYSES

CL&P conducted detailed modeling to project future EMF levels associated with the existing and proposed lines along each segment of the Proposed Route. The proposed overhead 345-kV line modeled for these projections is a base-case horizontally configured line using H-frame structures, except along four segments of the Proposed Route.

One of the four segments is along the ROW in Mansfield Hollow State Park and Mansfield Hollow WMA (i.e., Mansfield Hollow Segment 1, located in the Town of Mansfield) where the existing 345-kV line employs a delta configuration on steel monopoles. In this area, CL&P's proposal for the new 345-kV line is to match this delta configuration.

The other three segments along portions of the Proposed Route in the Towns of Coventry / Mansfield, Brooklyn, and Putnam would employ taller steel monopoles with a delta conductor configuration. Along these segments, CL&P proposes a delta 345-kV line configuration instead of H-frame structures to comply with the Council's EMF *Best Management Practices for the Construction of Electric Transmission Lines* (Best Management Practices).

These three segments, as well as two others in Mansfield, were CL&P's five "focus areas" for BMP review in a Field Management Design Plan (refer to Volume 1, Section 7, Appendix 7B). Under the Council's BMPs, the priority areas for extra spending (4% guideline) on low-cost magnetic field mitigation design features are where portions of the proposed new lines are adjacent to residential areas, public or private schools, licensed child day-care facilities, licensed youth camps, or public playgrounds. The five focus areas have such facilities near the Proposed Route, although not in all cases adjacent to the proposed line.

The Council's BMP establishes a benchmark for additional Project spending on these modified designs of up to 4% of the estimated Project cost in Connecticut using the base-case line design, including the cost of the Project's related substation and switching station work in Connecticut. The BMP also specifies that this extra cost allowance should be used on measures that achieve magnetic field reductions at ROW edges of 15% or more, as compared to the levels associated with the base-case line design. The intention of the BMP is to achieve magnetic field reductions using some or all of the 4% allowance. However, the BMP recognizes that projects can vary widely with regard to numbers of adjacent statutory facilities and magnetic field levels, justifying some variances above and below the Council's spending and field reduction guidelines.

In Section III of the BMP, the Council recommends an overall total of low-cost design features calculated at 4% of the initial "base design" project cost including substation costs. The estimated capital cost for the Project in Connecticut (including substation costs) is $213.7 million, assuming that CL&P's base-line design is used throughout. Under the Council's 4% guideline, $8.5 million ($213.7 million x 0.04) is the guideline budget for low-cost magnetic field mitigation on the Project.

CL&P anticipates that the Council will review CL&P's preferences for magnetic field mitigation spending in this Plan, and then, applying the guidelines of the BMP, designate specific field reduction strategies to be employed in specific Project locations.

ES.7 ALTERNATIVES ANALYSES

ES.7.1 Overview of Alternatives Considered

The proposed Interstate Reliability Project is the result of a comprehensive evaluation process, conducted over more than six years, by ISO-NE, National Grid, and CL&P. This process began with a determination of the need for the project, then continued with the identification and analysis of alternative solutions for addressing the need, and concluded with the examination of specific alternative routes and sites for the proposed transmission facilities. As a result of these analyses, the Proposed Route and proposed transmission line configurations were selected as the preferred alternative for the Connecticut portion of the Project.

The following types of alternatives were considered:

- **No Action Alternative**. Under this alternative, the Interstate Reliability Project would not be developed and the Southern New England electric transmission system would not be improved. The No Action Alternative was rejected because it would not resolve the regional electric reliability problems that ISO-NE, CL&P, and National Grid have been studying for more than six years. Under the No Action Alternative, the electric supply system in the region, particularly in Connecticut, Rhode Island, and Massachusetts, would not comply with national and regional reliability standards and criteria.

- **System Alternatives**. Following the evaluations of the need for the Interstate Reliability Project, various transmission system alternatives that would potentially meet that need were identified and evaluated. The results of these analyses led to the selection of a 345-kV transmission solution that would connect CL&P's Card Street Substation, CL&P's Lake Road Switching Station, National Grid's West Farnum Substation, and National Grid's Millbury Switching Station. In addition, potential non-transmission system alternatives that would address the need served by the transmission solution were investigated. These included both generation and demand reduction alternatives. No practical non-transmission alternative could be identified.

- **Overhead and Underground Transmission Line and Route Alternatives**. After the preferred system alternative was selected for the Interstate Reliability Project (based on the results of the detailed systems alternatives analyses), CL&P conducted detailed studies to identify and evaluate potential routes and associated line configurations for the Connecticut portion of the proposed 345-kV transmission lines. These alternatives all necessarily had to interconnect CL&P's Card Street and Lake Road stations with the National Grid facilities. As part of this process, CL&P evaluated both overhead and underground transmission line designs, with potential alignments along various existing ROWs and "greenfield" corridors. All of the route alternatives were evaluated against standard CL&P criteria and objectives for overhead and underground transmission lines. These objectives and criteria are summarized in Tables ES-2, ES-3, and ES-4. The route alternatives that were identified, evaluated, and then dismissed from consideration due to overriding environmental, engineering, or cost considerations are illustrated in Figure ES-3.

- **Potential Variations to the Proposed Transmission Line Configuration and Route**. CL&P prefers the Proposed Route and overhead transmission line configurations. However, during the alternatives analysis process, six route variations and transmission line configurations were identified that could potentially be developed, replacing certain segments of the Proposed Route or the overhead line design. Detailed technical information, impact analyses, and estimated costs were compiled for each variation, and each variation was compared to the portion of the Proposed Route that would be replaced. The Volume 9 maps include environmental data for each of these six variations, at a comparable level of detail to that presented for the Proposed Route.

Table ES-2: CL&P Transmission Line Route Selection Objectives

• Comply with all statutory requirements, regulations, and state and federal siting agency policies
• Maximize the reasonable, practical and feasible use of existing linear corridors (e.g., transmission line, highways, railroads, pipelines)
• Minimize adverse effects to sensitive environmental resources
• Minimize adverse effects to significant cultural resources (archaeological and historical)
• Minimize adverse effects on designated scenic resources
• Minimize conflicts with local, state and federal land use plans and resource policies
• Minimize the need to acquire property by eminent domain
• Maintain public health and safety
• Achieve a reliable, operable and cost-effective solution

Table ES-3: Route Evaluation Criteria for Overhead Transmission Line Siting

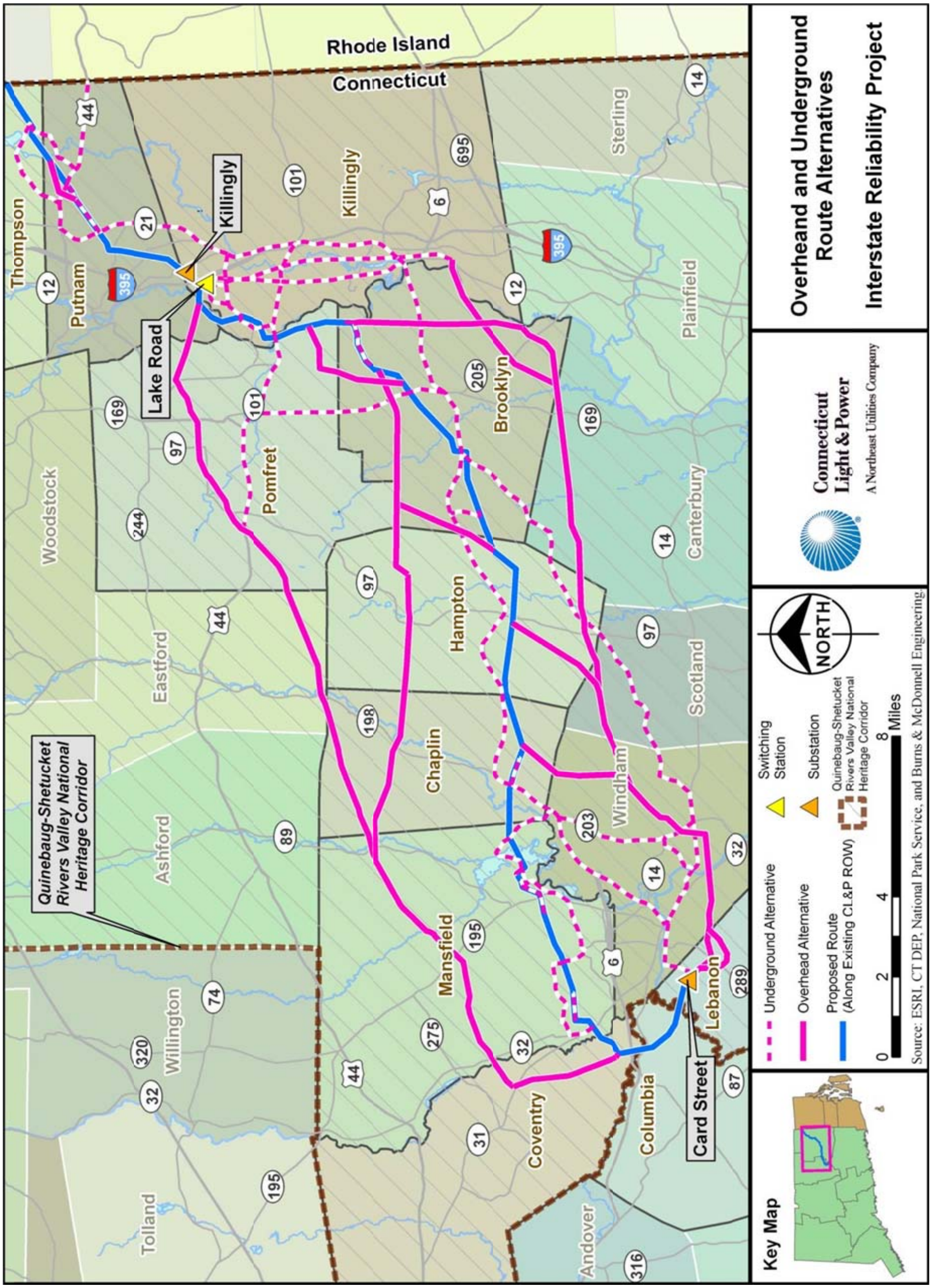
ROUTING CRITERIA	DESCRIPTION
Availability of Existing ROWs for the New Lines to Follow	The potential collocation of the 345-kV transmission facilities along existing ROWs where linear uses are already established (e.g., transmission lines, highways, railroads, pipelines) is a primary routing consideration. The collocation of linear utilities within existing utility corridors is strongly favored by the Federal Energy Regulatory Commission's *Guidelines for the Protection of Natural, Historic, Scenic, and Recreational Values in the Design and Location of Rights-of-Way and Transmission Facilities*, with which any electric transmission line approved by the Council must be consistent.[8] An entirely new 345-kV overhead line route would require a minimum 100-foot-wide ROW to accommodate a line with vertically arranged line conductors and a minimum 150-foot-wide ROW for horizontally arranged line conductors. The placement of the same new 345-kV transmission line on an existing corridor (parallel to existing transmission lines) may require a lesser expansion of an existing ROW or may not require any additional ROW at all, providing that the existing ROW is wide enough and has sufficient un-used space for the new 345-kV transmission line. Typically, to accommodate a new 345-kV H-frame transmission line adjacent to an existing transmission line, approximately 90 feet of ROW would have to be cleared of tall-growing woody vegetation and managed in low-growth vegetation. The use of new steel-monopole structures, built adjacent to an existing overhead line of steel-monopole structures, each supporting conductors in a delta configuration, would require approximately 70 feet of new vegetation clearing.
Engineering Considerations	Whether on existing or new ROWs, the terrain and location of the transmission line route and constructability issues must be considered since both may have a significant bearing on cost and effects on environmental resources. Among the constructability factors considered is the ability to avoid or minimize the location of structures along steep slopes or embankments, in areas of rock outcroppings, or within environmentally sensitive areas such as wetlands. Engineering requirements for the transmission line and access roads (as necessary) to cross streams, railroads, and other facilities are also assessed.
Avoidance or Minimization of Conflicts with Developed Areas	Where possible, it is preferable to avoid or minimize conflicts with residential, commercial, and industrial land uses such as homes, businesses, and airport approach zones. One of CL&P's primary routing objectives for any proposed transmission line is to minimize the need to acquire (by condemnation or voluntary sale) homes or commercial buildings to accommodate the new transmission facilities (refer to Table 14-1). Further, in Connecticut, statutory provisions[9] discourage the construction of a new 345-kV overhead transmission line "adjacent to" certain land uses (collectively referred to herein as "Statutory Facilities"), including residential areas, private and public schools, licensed child day-care facilities (residential and commercial day-cares), licensed youth camps, and public playgrounds.
Consideration of Visual Effects	Because 345-kV line structures are typically at least 85 feet tall (for an H-frame configuration), structure visibility is a design consideration. In recognition of public opinion regarding structure visibility, it is desirable to avoid placing structures in areas of visual or historic sensitivity; to consider designs for minimizing structure height; and to assess the potential visual effects of removing mature trees along ROWs, as required to conform to electrical clearance requirements (i.e., the potential implications of removing trees that provide vegetative screening).
Avoidance or Minimization of Environmental Resource	In accordance with federal, state, and municipal environmental protection policies, the avoidance or minimization of new or expanded corridors through sensitive environmental resource areas such as parks, wildlife areas, and wetlands is desired.
Accessibility	An overhead line must be accessible to both construction and maintenance equipment. Although access along the entire overhead line route is typically not needed, vehicular access to each structure location from some access point is required.

[8] Connecticut General Statutes Section 16-50p(a)(2)(D)
[9] Connecticut General Statutes Section 16-50p(i)

Table ES-4: Route Evaluation Criteria for Underground Transmission Cable System Siting

ROUTING CRITERIA	DESCRIPTION
Environmental Considerations	Underground cables are preferably sited away from, rather than through, significant environmental resources. Whereas an overhead transmission line can span wetlands, watercourses, vegetation, rock outcroppings and steep slopes, the installation of an underground cable system requires the excavation of a continuous trench. The operation of the cable system requires continuous permanent access along the entire route so that any splice vault or portion of the cable duct bank can be reached by heavy equipment as necessary for maintenance and repairs. Therefore, any sensitive environmental resources (such as watercourses, wetlands, or endangered species habitat) located along an underground cable route would be directly affected by the excavations required for the cable system, as well as by the access roads that must be permanently maintained along the underground route. To mitigate such impacts, the cables can be installed for short distances beneath these resources using subsurface construction technology, such as jack and bore or horizontal directional drilling, but at great expense. Existing public road corridors are usually considered for the installation of underground cables in preference to overland electric transmission line ROWs. Road corridors typically provide continuous permanent access along the underground cable route and often are characterized by gradual slopes. However, when sited in or adjacent to roadways, underground cables must avoid conflicts with existing underground utilities. Furthermore, alignment of underground cables along road ROWs may pose other potential environmental issues, such as excavation through areas of contaminated groundwater or soils; traffic congestion; difficult crossings of watercourses and wetlands that the roads traverse or bridge; and disturbance to vegetation and land uses adjacent to the roads (due to construction staging, heavy equipment operation, etc.).
Engineering Considerations	Steep terrain poses serious problems for underground cable construction and may cause down-hill migration and overstressing of the cable and cable splices (the point where two cables are physically connected together). Accordingly, one of the primary engineering objectives for an underground cable system is to identify routes that are relatively straight, direct, and have gradual slopes and inclines to minimize construction and maintenance costs, and to avoid downhill cable migration.
Availability of Useable ROW	A new 345-kV underground cable system typically requires a minimum 40-foot-wide work area for construction. Additionally, land must be available for burying splice vaults, each approximately 10 feet wide by 10 feet deep and up to 32 feet in length. Such vaults, which must be placed at approximately 1,600-foot intervals along a 345-kV cable route, are required to allow the individual cable lengths to be spliced together and also must be accessible, via manholes, for cable system maintenance and repair. Due to constraints posed by buried utilities within road travel lanes or conflicts with public highway use policies, vaults must sometimes be located beneath road shoulders or on private lands adjacent to public road corridors.
Social Considerations	Cable construction requires considerable time and results in noise, disruptions to traffic and access to adjacent land uses, and potential conflicts with other in-ground utilities. Consequently, where possible, a routing consideration is to limit the length of cable installation through densely developed residential areas and central business districts. These social effects must be carefully considered and balanced against the potential lesser effects of constructing and operating overhead line segments in comparable areas.
Availability of Land for Transition Stations	Unless terminated at a substation, underground transmission systems require separate above-ground transition stations at each location where the underground cables interconnect to overhead transmission lines. In general, transition stations require the purchase and conversion of land to industrial (utility) use, and consist of above-ground facilities within a graded, fenced area, similar in appearance to a transmission substation. Routing analyses must consider the availability of land required for transition stations, as well as the environmental and social effects resulting from station development (e.g., surrounding land uses and potential effects on natural resources, cultural resources, neighborhoods, and the visual environment).

Figure ES-3: Transmission Line Route Alternatives Initially Identified



ES.7.2 Summary of Variations to Portions of the Proposed Route

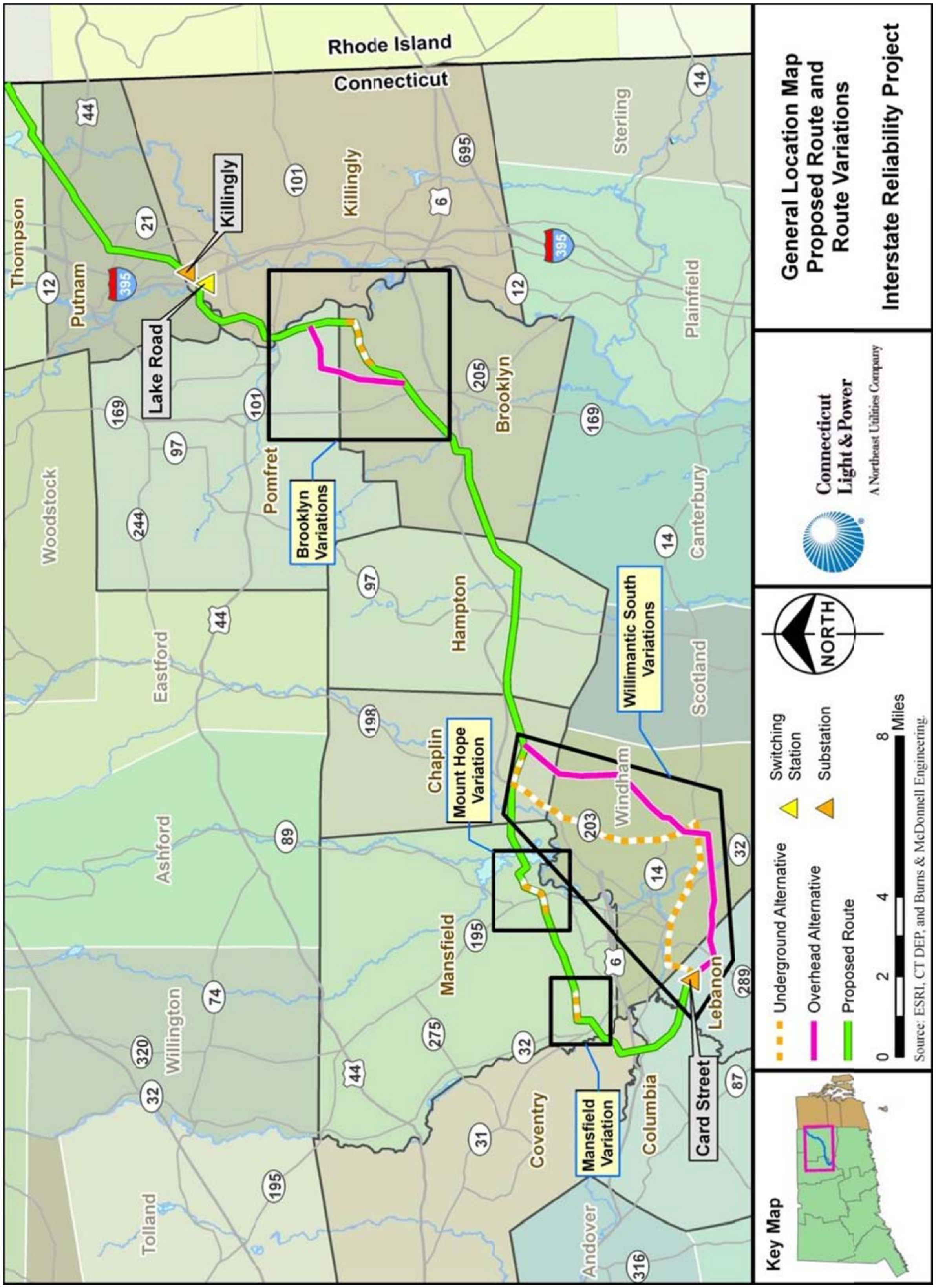
As part of the alternatives evaluation process that led to the selection of the proposed Project, CL&P identified and conducted detailed evaluations of six 345-kV transmission line route variations (two overhead and four underground line configurations[10]). As illustrated on Figure ES-4, the six route variations are:

- Mansfield Underground Variation
- Mount Hope Underground Variation
- Brooklyn Overhead Variation
- Brooklyn Underground Variation
- Willimantic South Overhead Variation
- Willimantic South Underground Variation

Each of these route variations represents a potential alternative to the alignment of the proposed overhead 345-kV transmission line along certain segments of CL&P's existing ROWs. Although CL&P prefers to develop the proposed Project configuration and line route, these route variations were determined to be potentially feasible to construct and operate, and thus each was evaluated in more detail. However, compared to the portions of the proposed overhead transmission line that these variations would replace, CL&P found each of the variations to be much less desirable due to constructability, engineering, environmental, social, and/or cost factors. These variations are described in Volume 1A, Section 15 and are shown on the Volume 9 maps.

[10] While CL&P eliminated an "all-underground" cable system route from consideration for the reasons discussed in Volume 1A, Section 14, shorter underground cable segments were evaluated as potential variations to portions of the proposed overhead transmission line route or overhead line design. For the purposes of this discussion, "route variation" or "variation" denotes either a potential alternative alignment to a segment of the proposed Project (i.e., the overhead 345-kV line along CL&P's existing ROWs) or a potential transmission line configuration alternative (e.g., underground cable) within CL&P's existing ROWs. Overhead line design variations for EMF BMPs and the Mansfield Hollow area are addressed in Volume 1, Sections 7 and 10, respectively.

Figure ES-4: Proposed Route and Route Variations



ES.8 MANSFIELD HOLLOW AREA DESIGN OPTIONS

Along the 36.8-mile Proposed Route, the new overhead 345-kV transmission line would follow CL&P's existing ROWs across two segments of federally-owned property, totaling 1.4 miles, in the Mansfield Hollow area in the towns of Mansfield and Chaplin. These federal lands, which are owned by the USACE and are leased to the CT DEEP, are identified in relation to CL&P's ROW as follows (refer to Figure ES-5):

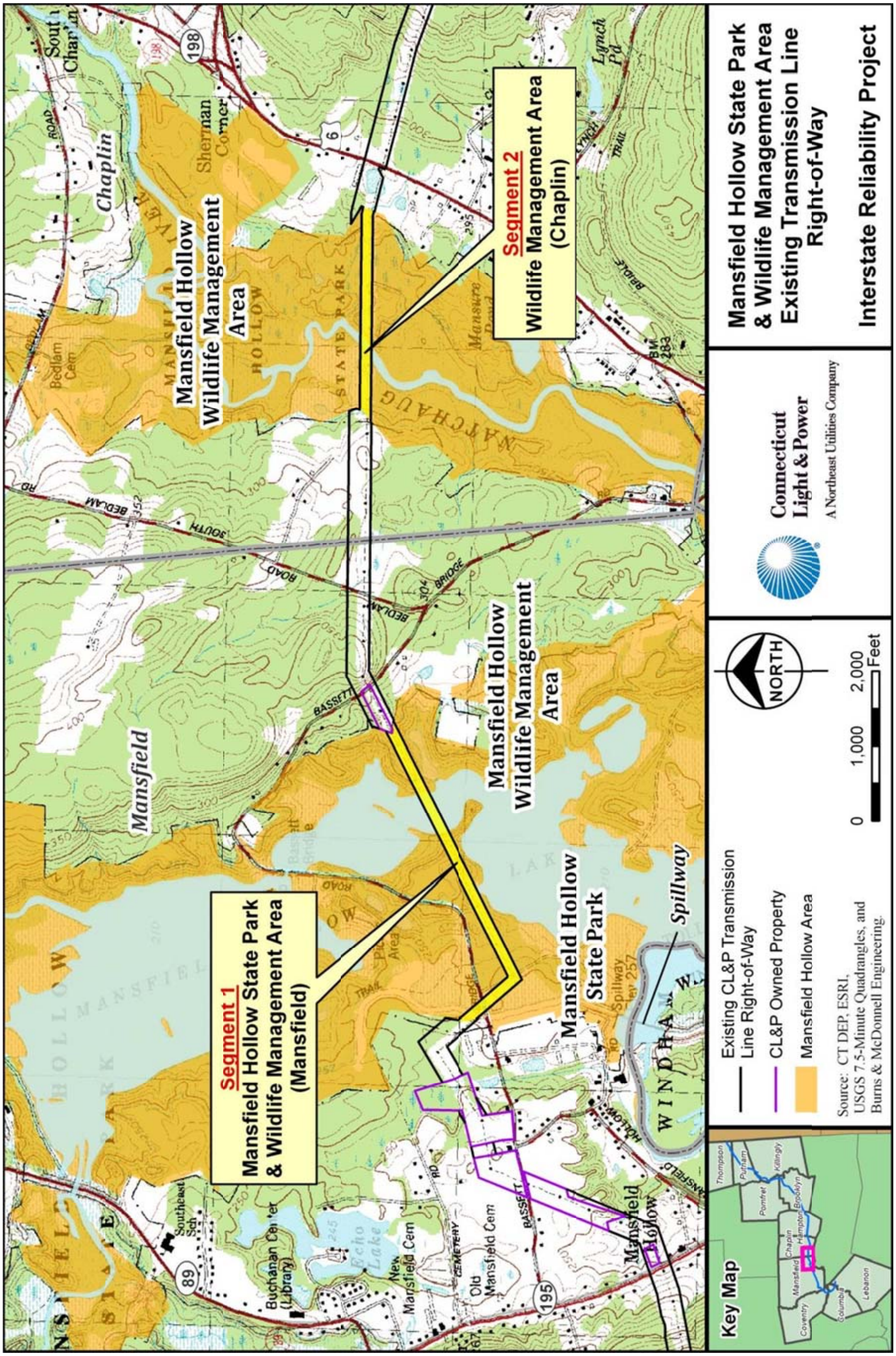
- Segment 1: An approximately 0.9-mile segment of CL&P's existing transmission line ROW traverses Mansfield Hollow State Park, including an approximately 600-foot span of Mansfield Hollow Lake, as well as a portion of the Mansfield Hollow WMA on the eastern side of the lake (Town of Mansfield, Tolland County).

- Segment 2: CL&P's existing transmission line ROW traverses a second portion of the WMA for approximately 0.5 mile across and in the vicinity of the Natchaug River (Town of Chaplin, Windham County).

Across these federally-owned properties, CL&P's existing ROW is 150 feet wide, and CL&P's existing 345-kV transmission line is generally positioned in the center. Because of needed conductor separations, the 150-foot easement is not wide enough to accommodate the new 345-kV Line as proposed (i.e., using structure types that would match the existing 345-kV line structure types in each segment) alongside the existing 330 Line.

To construct and operate the new overhead 345-kV transmission line north of and adjacent to the existing 330 Line through the 1.4 miles of federally-owned lands, CL&P proposes that the USACE grant a conveyance of expanded easement rights. Specifically, CL&P's Proposed Configuration through the Mansfield Hollow properties (as described in the preceding sections of this section) would involve expanding the 150-foot-wide easement by 55 feet (approximately 5.8 acres) along Segment 1 in the Town of Mansfield and by 85 feet (approximately 5.2 acres) along Segment 2 in the Town of Chaplin.

Figure ES-5: Location of the Existing CL&P ROWs across the Mansfield Hollow Federally-Owned Properties: Segments 1 and 2



The expanded easement, which would total approximately 11 acres, would allow the development of the new 345-kV transmission line parallel and adjacent to (north of) the existing 330 Line. This wider easement would allow CL&P to build the new transmission line using structures that would generally match (in terms of appearance and height) the existing 330 Line structure types.

Although CL&P's preference is to construct the Project in the Proposed Configuration through Mansfield Hollow, CL&P has identified two feasible overhead line configuration options that also would allow the development of the new 345-kV transmission line adjacent to the 330 Line across the federal property.[11] These configuration options are:

- **No ROW Expansion Option**. In the event that a grant of conveyance for the additional easement rights cannot be obtained from the USACE, this overhead line design option would allow the installation of the proposed 345-kV transmission line within the existing 150-foot-wide ROW through the Mansfield Hollow area. This option would require the removal and reconstruction of the existing 330 Line closer to the southern edge of the 150-foot-wide ROW and the development of the new 345-kV overhead line adjacent to and north of the reconfigured 330 Line. Complex construction sequencing and 330 Line outages would be needed to build this option. While no additional easements from the USACE would be required under this option, both 345-kV lines through Mansfield Hollow would be constructed using vertical conductor configurations and taller monopole structures.

- **Minimal ROW Expansion Option**. This configuration option would limit the amount of additional easement required from the USACE to approximately 4.8 acres by using taller monopole structures to support the new 345-kV line, north of and adjacent to the existing 330 Line, within both Segments 1 and 2. The existing 330 Line would remain in place. Using this overhead transmission line design, 25 feet of additional easement width would be required along Segment 1, while 35 feet would be required along Segment 2.

Tables ES-5 and ES-6 provide a summary comparison of these two options to the Proposed Configuration through the USACE-owned properties.

[11] In addition to these configuration options for constructing the new 345-kV line across the federally-owned properties, CL&P identified and evaluated two route variations that would avoid Mansfield Hollow. These route variations, the Willimantic South Overhead Variation and the Willimantic South Underground Variation, would replace the western 11-12 miles of the Proposed Route, generally between Card Street Substation and U.S. Route 6 in the Town of Chaplin. CL&P determined that any of the Mansfield Hollow configuration options would be preferable to the Willimantic South Variations, based on cost and environmental factors.

Table ES-5: No ROW Expansion Option: Summary of Potential Environmental Effects, by ROW Segment (Assumes use of the entire 150-foot-wide ROW)

ENVIRONMENTAL FEATURE	POTENTIAL ENVIRONMENTAL EFFECTS, BY SEGMENT		OPTION TOTAL
	1	2	
ROW Length (miles)	1.0	0.5	1.5
Construction ROW Width (feet)	150	150	
New ROW Width Required (feet)	0	0	0
Water Resources			
Waterbody Crossings (number)	1 span Mansfield Hollow Lake	2 1 span (Natchaug River) 1 crossing (S20-24 with permanent culvert*)	2 spans 1 crossing with permanent culvert)
Wetlands			
Number Affected	2 (W20-65) (W20-66)	5 (W20-70, W20-73, W20-75, W20-76, W20-77)	7
Vernal Pools Affected (number)	0	2 (CH-1-VP and CH-2-VP)	2
Wetlands, Temporary Effects (estimated acres)	0.0 acre	0.3 acre	0.3 acre
Wetlands, Permanent Fill Effects (estimated acres)	0.0 acre	< 0.1 acre	< 0.1 acre
Biological Resources			
Vegetation Potentially Affected (estimated acres)			
• Forested Upland	4.2 acres	1.5 acres	5.7 acres
• Forested Wetland	0.1 acre	0.7 acre	0.8 acre
• Scrub-shrub Upland	7.1 acres	4.6 acres	11.7 acres
• Open Field Upland	2.0 acres	0	2.0 acres
• Scrub-shrub Wetland	<0.1 acre	2.3 acres	2.3 acres
Natural Diversity Data Base Areas (No.)	1	1	2
Land Uses			
Recreational Areas (linear miles traversed along ROW)			
• Mansfield Hollow State Park	0.9 mile	0	0.9 mile
• Mansfield Hollow WMA	0.1 mile	0.5 mile	0.6 mile
• Trails	2 Red Trail (within Park) Nipmuck Trail East Branch (within WMA)	0	2
Visual Resources			
Structure Appearance	Weathering Steel Finish	Weathering Steel Finish	

Notes:
1. All vegetation within the 150-foot-wide ROW assumed to be affected by the complex construction sequence required for this configuration.
2.The wetland bordering Mansfield Hollow Lake (designated as Wetland W20-66) would be spanned.
3.Wetland effects determined based on preliminary locations of structures, crane pads, and access roads. All effects except structure locations and permanent access roads are assumed to be temporary (i.e., crane pads and wood mat roads across wetlands will be removed after the completion of construction. All access roads are assumed to be within the 150-foot-wide ROW. Estimates for forested wetland vegetation clearing assume wetland W20-73 near Natchaug River (Segment 2) would be affected across the entire 150-foot-wide ROW. Stream S20-24 would be crossed on USACE property, but the permanent culvert would be installed on privately-owned easement just to the east of the federal lands.

Table ES-6: Minimal ROW Expansion Option: Summary of Potential Environmental Effects, by ROW Segment

ENVIRONMENTAL FEATURE	POTENTIAL ENVIRONMENTAL EFFECTS, BY SEGMENT		OPTION TOTAL
	1	2	
ROW Length (miles)	1.0	0.5	1.5
Construction ROW Width (feet)	70	80	
New ROW Width Required (feet)	25	35	0
Water Resources			
Waterbody Crossings (number)	1 span Mansfield Hollow Lake	3 1 span (Natchaug River) 1 crossing (S20-23); permanent culvert at S20-24	2 spans 2 crossings (1 permanent culvert)
Wetlands			
Number Affected	1 (W20-66, Mansfield Hollow Lake border, possible tree trimming)	5 (W20-70, W20-72/73, W20-74, W20-75, W20-76)	6
Vernal Pools Affected (number)	0	2 (CH-1-VP, CH-2, VP)	2
Wetlands, Temporary Effects (estimated acres)	0	0.3 acre	0.3 acre
Wetlands, Permanent Fill Effects (estimated acres)	0	<0.1 acre	<0.1 acre
Biological Resources			
Vegetation Potentially Affected (estimated acres)			
• Forested Upland Vegetation Removal (Permanent)	3.7 acres*	1.7 acres*	5.4 acres*
• Forested Wetland Vegetation Removal (Permanent)	< 0.1 acre*	1.5 acres*	1.5 acres*
• Scrub-shrub Upland Vegetation Potentially Affected	7.3 acres	4.7 acres	12.0 acres
• Open Field Upland Vegetation Potentially Affected	2.1 acres	0	2.1 acres
• Scrub-shrub Wetland Vegetation Potentially Affected	< 0.1 acre	2.3 acre	2.3 acres
Natural Diversity Data Base Areas (No.)	1	1	2
Land Uses			
Recreational Areas (linear miles traversed along ROW)			
• Mansfield Hollow State Park	0.9 mile	0	0.9 mile
• Mansfield Hollow WMA	0.1 mile	0.5 mile	0.6 mile
• Trails	2 Red Trail (within Park) Nipmuck Trail East Branch (within WMA)	0	2
Visual Resources			
Structure Appearance	Galvanized Steel Finish	Weathering Steel Finish	

Notes:
1. The wetland bordering Mansfield Hollow Lake (designated as Wetland W20-66) would be spanned. Some tops of trees in this wetland may need to be cut to maintain clearance from conductors.
2. Wetland effects determined based on preliminary locations of structures, crane pads, and access roads. All effects except structure locations and permanent access roads are assumed to be temporary (i.e., crane pads and temporary roads across wetlands will be removed after the completion of construction.). Wetland W20-72/73, which would be traversed along the expanded ROW west of the Natchaug River is assumed to require forested vegetation clearing along a 300-foot length of the 35-foot-wide expanded ROW width.

* Assumes that the forested areas south of Line 330 (totaling approximately 3.5 acres) would remain in place and would not be affected by the proposed Project (refer to XS-3-MRE and XS-5-MRE).

Both the No ROW Expansion Option and the Minimal ROW Expansion Option represent viable configurations for the alignment of the new 345-kV line along Segments 1 and 2. However, compared to the Proposed Configuration, each of these options offers significant trade-offs in terms of cost, structure design and appearance, and environmental resource effects (principally forested vegetation clearing). Table ES-7 summarizes and compares the principal characteristics of each of the three configuration options.

As this table illustrates, the proposed overhead line configuration represents the least-cost option for aligning the new 345-kV line through the federally-owned Mansfield Hollow properties. Compared to the existing 330 Line, this option would also minimize differences in the appearance (design and height) of the new 345-kV line structures. However, this configuration would require the acquisition of the most new easement from the USACE (11 acres) and the most forested upland and wetland vegetation removal (approximately 12 acres) within the existing and expanded easement areas.

In comparison, whereas the No ROW Expansion Option would not require any additional easement from the USACE, the construction complexities associated with the removing and rebuilding of the 330 Line make this the most expensive of the three options. Further, to accommodate both the 330 and 3271 Lines within the 150-foot-wide ROW, steel monopoles would have to be used along both Segments 1 and 2. Along Segment 2 in particular, these monopoles would be substantially taller than the existing 330 Line's H-frame structures. The Minimal ROW Expansion Option provides a configuration that minimizes the amount of additional easement required from the USACE (4.8 acres) by using tall steel-pole structures. These structures would not match the appearance of the existing 330 Line structures in Segments 1 or 2, and would be the same type and general height as the structures required for the No ROW Expansion Option. The Minimal ROW Expansion Option would be substantially less costly than the No ROW Expansion Option, and only $1.3 million more expensive than the Proposed Configuration.

Table ES-7: Summary Comparison of Mansfield Hollow Configuration Options (Federal Properties, Combined Segments 1 and 2)

Factor	Proposed Configuration	No ROW Expansion Option	Minimal ROW Expansion Option
Location, Design, and Appearance			
Length (miles) [12]	1.5	1.5	1.5
New ROW Required (acres)	11.0	0	4.8
Structure Type	Delta Steel Pole (Segment 1) H-Frame (Segment 2)	Vertical Steel Pole (Segments 1 and 2) Rebuilt 330 Line and 3271 Line	Vertical Steel Pole (Segments 1 and 2)
Structure Height Range (feet) SEE NOTE 1	115-145 (Segment 1) 70-85 (Segment 2)	130-160 (Segment 1) 110-135 (Segment 2)	125-155 (Segment 1) 115-135 (Segment 2)
Environmental Resources			
Water Resources			
Waterbody crossings (No.)	4	3	3
Wetlands, Temporary Effects (acres)	0.4 acre	0.3 acre	0.3 acre
Wetlands, Permanent Effects (fill) (acres)	<0.1 acre	<0.1 acre	<0.1 acre
Vegetation			
Wetlands, Forested Vegetation Removal (acres)	2.8 acres	0.8 acre	1.5 acres
Wetlands, Scrub-Shrub Vegetation Potentially Affected (acres)	2.3 acre	2.3 acres	2.3 acres
Upland Forested Vegetation Removal (acres)	9.5 acres	5.7 acre	5.4 acres
Upland Scrub-Shrub Vegetation Potentially Affected (acres)	12.2 acres	7.1 acres	12.0 acres
Open Field Upland Vegetation Potentially Affected (acres)	2.3 acres	2.0 acres	2.1 acres
Biological Resources			
Vernal Pools Potentially Affected (No.)	2	2	2
State-listed Species Habitat Traversed (No.)	2	2	2
Visual Resources			
Difference in existing and proposed structure heights (feet)	-7 to +24 feet (Segment 1) -13 to +13 feet (Segment 2)	-8 to +49 (Segment 1) +34-55 (Segment 2)	-7 to +39 feet (Segment 1) +27-60 feet (Segment 2)
Estimated Cost			
Capital Cost	$13.0 million	$28.5 million	$14.3 million
Cost to Connecticut Consumers	$3.5 million	$19.0 million	$4.8 million

Notes:

1. Existing 330 Line structure height ranges are 106-137 feet in Segment 1 and 68-81 feet in Segment 2.
2. For each configuration option, preliminary analyses have been performed to identify anticipated locations of structures, crane pads, and access roads. Potential effects on wetlands vary for each configuration as a result of the differences in ROW widths, structure types and locations, anticipated crane pad sites, and access roads. For all configuration options, potential effects on wetlands have been minimized to the extent practical.
3. Assumes that the cost of the Proposed Configuration is regionalized (i.e., 27% of cost applied to Connecticut consumers) and any expenditures in excess of the Proposed Configuration costs are localized (i.e., Connecticut consumers bear 100% of costs).

[12] Each option would include 1.4 miles across federally-owned lands.

ES.9 COST

The estimated capital cost for the three-state Interstate Reliability Project is $511 million. Of this amount, transmission line construction accounts for $407 million, whereas substation and switching station modifications total $104 million.[13] The $511 million total is itemized, by company, as follows:

- CL&P: $218 million
- National Grid: $293 million

In accordance with the Council's *Life-Cycle Cost Studies for Overhead and Underground Transmission Lines* (2007), CL&P performed a present-value analysis of capital and operating costs over a 35-year economic life of the Project. The following items were considered:

- Annual carrying charges of the capital cost
- Annual operation and maintenance costs
- Cost of energy losses
- Cost of capacity

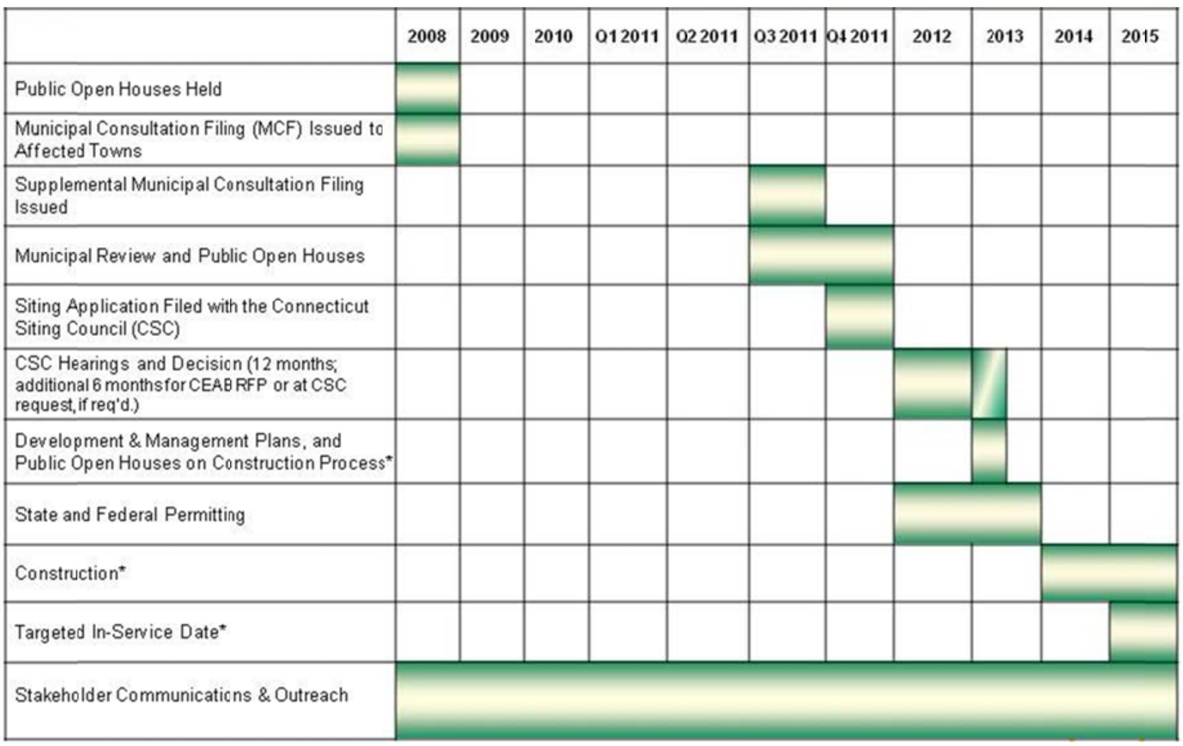
Applying these factors, the life-cycle cost for the Connecticut portion of the Interstate Reliability Project is $319 million.

[13] The Interstate Reliability Project cost estimates reflect conformance with the FERC's May 27, 2011 Order authorizing recovery of 100% of transmission construction work in progress (CWIP) costs for the NEEWS projects, including the Interstate Reliability Project. Under this FERC Order, on June 1, 2011, CL&P, Western Massachusetts Electric Company, and the New England Power Company ceased their accrual of Allowances for Funds Used During Construction (AFUDC) associated with expenditures on the NEEWS projects. Accordingly, project cost estimates no longer include AFUDC beyond June 1, 2011.

ES.10 SCHEDULE

The key activities in CL&P's proposed schedule for developing the Connecticut portion of the Interstate Reliability Project are illustrated in Figure ES-6. This schedule does not illustrate the detailed Project studies and investigations that CL&P performed prior to 2011, such as the initial Project system and transmission line planning (which began in 2004) and the environmental and engineering studies of the ROW (some of which also were performed in 2004 and 2007-2011).

Figure ES-6: Connecticut Portion of the Interstate Reliability Project – Estimated Timeline



*Pending receipt of approvals from the Council and federal / state regulatory agencies.
*Note that the construction timeline refers to the installation of the new 345-kV transmission lines and station modifications, and does not necessarily include the completion of all ROW restoration and post-installation monitoring activities.

ES.11 AGENCY COORDINATION AND REGULATORY APPROVALS

In addition to a Certificate from the Council, the Project will require approvals from various other state agencies and from federal agencies. As part of the Project planning process, CL&P initiated consultations with representatives of the federal and state regulatory agencies from whom approvals for the Project would be required.

At the federal level, the entire three-state Interstate Reliability Project must comply with the Clean Water Act (CWA), Endangered Species Act, and National Historic Preservation Act. Furthermore, CL&P would need USACE approval for the expansion of the existing ROW across the USACE-owned properties in the Mansfield Hollow area.

At the state level, along with compliance with the Council's regulations, CL&P would have to obtain Project-specific permits or approvals from CT DEEP pertaining to water quality (pursuant to Section 401 of the CWA), stormwater management, and threatened and endangered species. Cultural resources approvals would be required from the State Historic Preservation Office.

Table ES-8 summarizes the federal and state permits and approvals expected to be required for the proposed Project. This summary is based on currently available data concerning the Project, and may be modified as the Project planning, design, and review process moves forward.

ES.12 MUNICIPAL CONSULTATION AND PUBLIC OUTREACH

CL&P has conducted extensive community outreach throughout the planning and municipal consultation phases of the Project. As part of the Project planning process, CL&P initiated consultations with the public and representatives of the 11 towns that would be traversed by the new 345-kV transmission lines along the Proposed Route. CL&P also has consulted with the Town of Windham, the only additional municipality that would be affected by the route variations (refer to Volume 1A, Section 15.5).

Table ES-8: Potential Permits, Reviews, and Approvals Required for the Project

Agency	Certificate, Permit, Review, Approval or Confirmation	Activity Regulated
FEDERAL		
U.S. Army Corps of Engineers (USACE), New England District	Section 404 CWA Easement Expansion Approval	Discharge of dredge or fill material into waters of the U.S. (wetlands or watercourses) Real Estate Approval: easement expansion across Mansfield Hollow properties
U.S. Fish and Wildlife Service	Coordinates with USACE regarding endangered or threatened species (non-marine); provides input to USACE permit application review	Construction or operation activities that may affect federally-listed endangered or threatened species
U.S. Environmental Protection Agency	Provides input to USACE permit application review	Construction or operation activities that may affect water, air, or other resources
Advisory Council on Historic Preservation	Involved if cultural resource sites would be potentially affected by the Project	Section 106 National Historic Preservation Act compliance; input to USACE permit review, if applicable
CONNECTICUT		
Connecticut Siting Council	Certificate of Environmental Compatibility and Public Need Development & Management Plan approval prior to construction	General transmission line need, siting, construction, environmental compatibility, safety, and operation / maintenance and ROW management procedures
Department of Energy and Environmental Protection (CT DEEP)	401 Water Quality Certification	Conformance to Section 401 of the CWA; Section 401 approval from CTDEEP is required prior to USACE permit issuance
	General Permit	Stormwater management during construction
	Stream Channel Encroachment Line (SCEL) Permit: Span of Willimantic River	Construction activities riverward of SCEL (if applicable; currently, no new structures are proposed within the SCEL)
	Water Diversion Permit	Installation of permanent culverts across streams with a watershed of 100 acres or more
	Threatened, Endangered, and Special Concern Species	Approval of species-specific mitigation plans as part of Council's process, 401 Water Quality Certification approval
CT DEEP Public Utilities Regulatory Authority	Approval pursuant to C.G.S. Section 16-243	Method & Manner of Construction Approval to Energize Lines
Connecticut Department of Transportation (ConnDOT)	Encroachment permit	Transmission line crossing of state highways
State Historic Preservation Office (SHPO)[14]	Approval of proposed Project consistency with the National Historic Preservation Act; comments during Council and USACE processes	Construction and operation activities that may affect archaeological or historic resources.

14 The SHPO is part of the Connecticut Commission on Culture and Tourism, Historic Preservation and Museum Division.

CL&P also prepared a Municipal Consultation Filing (MCF), as required pursuant to the Council's regulations. In August 2008, CL&P issued a MCF concerning the Connecticut portion of the proposed Interstate Reliability Project. The August 2008 MCF was provided to all of the towns in which the then-identified primary route under consideration for the new 345-kV facilities and any potential route variations were located. In September and October, public open houses were held in the towns of Brooklyn, Mansfield, and Willimantic. CL&P also consulted with the chief elected officials of the 12 potentially affected municipalities.

Subsequently, the Project was held in abeyance while ISO-NE conducted a regional electric system needs reassessment. As the needs reassessment was being performed, CL&P and National Grid continued to evaluate and refine the Project. After the issuance of the August 2008 MCF, CL&P and National Grid conducted additional planning and routing studies, engineering analyses, and environmental evaluations, leading to their identification of a Proposed Route for the planned 345-kV transmission lines and related substation and switching station modifications.

To provide the public and potentially affected municipalities the opportunity to review the updated Project information, CL&P issued a Supplemental MCF in July 2011 which augmented the original 2008 MCF, presenting the results of additional studies concerning the Project that were completed since August 2008. After the issuance of the Supplemental MCF, CL&P held two additional "open houses" – one in the Town of Mansfield and one in the Town of Killingly (Danielson area). Overall, these municipal consultations were designed to obtain additional input regarding the proposed Project from representatives of each of the Connecticut towns potentially affected by the proposed transmission facilities, as well as from the interested public.

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Connecticut Light & Power

The Northeast Utilities System

NEW ENGLAND EAST–WEST SOLUTION

FORMAL REQUIREMENTS

FORMAL REQUIREMENTS

A. PURPOSE

The Connecticut Light and Power Company (CL&P) is submitting this Application to the Connecticut Siting Council ("Council") for the issuance of a Certificate of Environmental Compatibility and Public Need for the construction and operation of the Connecticut portion of the Interstate Reliability Project, consisting of new 345-kilovolt ("kV") electric transmission lines and associated facilities between the Card Street Substation in the Town of Lebanon, New London County and an interconnection at the Connecticut / Rhode Island border in the Town of Thompson, Windham County, to a new 345-kV transmission line to be constructed and operated by National Grid, U.S.A. (National Grid). The Interstate Reliability Project, which also includes new 345-kV transmission facilities in Rhode Island and Massachusetts that will be developed by National Grid, is part of the New England East-West Solution (NEEWS), a comprehensive plan to improve electric transmission in southern New England.

B. STATUTORY AUTHORITY

The Connecticut Light and Power Company (CL&P) is applying to the Connecticut Siting Council pursuant to Connecticut General Statutes Section 16-50g et seq.

C. LEGAL NAME AND ADDRESS OF APPLICANT

The Connecticut Light and Power Company (CL&P), a specially-chartered Connecticut corporation:

Street Address:	Mailing Address:	Internet Address:
107 Selden Street	P.O. Box 270	Northeast Utilities
Berlin, Connecticut 06037	Hartford, CT 06141-0270	Transmission Web Site
Telephone: (860) 665-5000		www.transmission-nu.com

In filing and presenting this application, CL&P is acting through its agent, Northeast Utilities Service Company (NUSCO). CL&P and NUSCO are both wholly-owned subsidiaries of Northeast Utilities (NU). NUSCO performs services, including transmission planning and permitting services, for affiliated NU companies, including CL&P. NUSCO shares CL&P's address, listed above.

D. APPLICANT'S CONTACTS

Correspondence and other communications with regard to the application are to be addressed to, and notices, orders and other papers may be served upon the following:

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E. QUANTITY, FORM, AND FILING REQUIREMENTS

(Regs. Conn. State Agencies § 16-50j-12)

1. Pursuant to § 16-50j-12, CL&P is furnishing to the Council an original and 20 paper copies of the Application, as well as electronic copies of the Application.

2. CL&P requests administrative notice of the following Council docket records, generic hearings or statements prepared by the Council as a result of generic hearings, and other pertinent documents.

IEEE Guide for the Design, Construction, and Operation of Electric Power Substations for Community Acceptance and Environmental Compatibility, IEEE Std 1127-1998 (Reaffirmed 2009), December 5, 2009.

National Electrical Safety Code, ANSI C2-2012. August 1, 2011.

United States Code of Federal Regulations Title 33, Clean Water Act, Sections 401 and 404.

Connecticut General Statutes Section 16-243 and Sections 16-11-134, and 135 of the Regulations of Connecticut State Agencies.

2009-2018 Forecast Report of Capacity, Energy, Loads & Transmission (CELT). ISO New England Inc. System Planning, April 2009. http://www.iso-ne.com/trans/celt/report/2009/2009_celt_report_final_20090415.pdf

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2008 Regional System Plan. ISO New England Inc. October 16, 2008. http://www.iso-ne.com/trans/rsp/2008/rsp08_final_101608_public_version.pdf

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2010 Regional System Plan. ISO New England Inc. October 28, 2010. http://www.iso-ne.com/trans/rsp/2010/rsp10_final.docx

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ISO New England Planning Procedure 3, PP 3 - Reliability Standards for the New England Area Bulk Power Supply System. Effective Date: March 5, 2010. http://www.iso-ne.com/rules_proceds/isone_plan/pp3_r5.pdf

ISO New England Planning Procedure 5-3, PP5-3: Guidelines for Conducting and Evaluating Proposed Plan Application Analyses. Effective Date: March 5, 2010.
http://www.iso-ne.com/rules_proceds/isone_plan/pp5_3_r3.pdf

ISO New England Inc. FERC Electric Tariff No. 3, Open Access Transmission Tariff, Section II – Attachment K – Regional System Planning Process. Effective: December 7, 2007.
http://www.iso-ne.com/committees/comm_wkgrps/othr/econ_stdy/mtrls/2008/mar262008/k_regional.pdf

ISO New England Operating Procedure No. 4 (OP-4), Action During a Capacity Deficiency. Effective Date: December 10, 2010, Revision No. 10.
http://www.iso-ne.com/rules_proceds/operating/isone/op4/op4_rto_final.pdf

ISO New England Inc. Transmission, Markets and Services Tariff (formerly known as FERC Electric Tariff No. 3). October 1, 2011.
http://www.iso-ne.com/regulatory/tariff/sect_1/sect_i.pdf

ISO New England Inc. Transmission Operating Agreement among ISO New England Inc. and Participating Transmission Owners. February 1, 2005.
http://www.iso-ne.com/regulatory/toa/v1_er07-1289-000_toa_composite.pdf

ISO New England Inc. Planning the New England Transmission System for Reliable Operation. August 11, 2009.

Northeast Power Coordinating Council, Inc. Regional Reliability Reference Directory #1, Design and Operation of the Bulk Power System. December 1, 2009 (replaced Document A-2)
https://www.npcc.org/Standards/Directories/Directory%201%20-%20Design%20and%20Operation%20of%20the%20Bulk%20Power%20System%20Full%20Member%20Approval%20December%2001,%202009%20GJD.pdf

Northeast Power Coordinating Council, Inc. Regional Reliability Reference Directory #4, Bulk Power System Protection Criteria. December 1, 2009 (replaced Document A-5)
https://www.npcc.org/Standards/Directories/Directory%204%20-%20System%20Protection%20Criteria%20Full%20Member%20Approval%20December%2001,%202009%20GJD.pdf

Federal Energy Regulatory Commission, Florida Blackout, Order Approving Stipulation and Consent Agreement, Docket No. IN08-5-000, 129 FERC ¶ 61,016, Issued October 8, 2009.
http://www.ferc.gov/EventCalendar/Files/20091008102212-IN08-5-0001.pdf

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The Connecticut Light and Power Company, 2009 Forecast of Loads and Resources for the Period 2009-2018. March 2, 2009. http://www.ct.gov/csc/lib/csc/f2009/filings/dof2009-20090302_nufiling.pdf

The Connecticut Light and Power Company, 2010 Forecast of Loads and Resources for the Period 2010-2019. March 1, 2010. http://www.ct.gov/csc/lib/csc/pendingproceeds/forecast2010/forecastfilingsfrommarch2010/2010_clp_flr.pdf

The Connecticut Light and Power Company, 2011 Forecast of Loads and Resources for the Period 2011-2020. March 1, 2011. http://www.ct.gov/csc/lib/csc/pendingproceeds/forecast_2011/f2011-clp.pdf

Department of Public Utility Control Docket (DPUC) 08-07-01, DPUC Review of 2008 Integrated Resource Plan, Decision, February 18, 2009. http://www.ct.gov/dpuc/site/default.asp

Department of Public Utility Control Docket (DPUC) 09-05-02, DPUC Review of the 2009 Integrated Resource Plan, Decision, September 30, 2009. http://www.ct.gov/dpuc/site/default.asp

Department of Public Utility Control Docket (DPUC) 10-02-07, DPUC Review of the 2010 Integrated Resource Plan, Decision, September 15, 2010. http://www.ct.gov/dpuc/site/default.asp

Connecticut Siting Council Investigation into the Life Cycle Costs of Electric Transmission Lines. CT Siting Council. Prepared by Kema Inc. February 2007. http://www.ct.gov/csc/lib/csc/life_cycle_rfp/43714q1.pdf and Comment Letter of R. Zaklukiewicz. April 13, 2007.

The New England Energy Alliance. Electricity Transmission Infrastructure Development in New England Value through Reliability, Economic and Environmental Benefits. Polestar Communications & Strategic Analysis. December 2007. http://www.newenglandenergyalliance.org/

Federal Power Commission (now FERC). Electric Power Transmission and the Environment. Federal Power Commission Guidelines for the Protection of Natural, Historic, Scenic and Recreational Values in the Design, and Location of Rights-of-Way and Transmission Facilities. November 27, 1990.

North American Electric Reliability Corporation. Special Report: Electric Industry Concerns on the Reliability Impacts of Climate Change Initiatives. Version 1.1. November 12, 2008. http://www.nerc.com/files/2008-climate-initiatives-report.pdf

Connecticut Siting Council Docket No. 370 - Consolidated proceeding pursuant to the Connecticut Energy Advisory Board (CEAB) Request for Proposal (RFP) process under C.G.S. §16a-7c. Original application: The Connecticut Light & Power Company application for Certificates of Environmental Compatibility and Public Need for the Connecticut Valley Electric Transmission Reliability Projects which consist of (1) The Connecticut portion of the Greater Springfield Reliability Project that traverses the municipalities of Bloomfield, East Granby, and Suffield, or potentially including an alternate portion that traverses the municipalities of Suffield and Enfield, terminating at the North Bloomfield Substation; and (2) the Manchester Substation to Meekville Junction Circuit Separation Project in Manchester, Connecticut. Competing application: NRG Energy, Inc. application pursuant to C.G.S. §16-50*l*(a)(3) for consideration of a 530 MW combined cycle generating plant in Meriden, Connecticut. Record.

Connecticut Siting Council Docket No. 370A-MR - The Connecticut Light & Power Company application for a Certificate of Environmental Compatibility and Public Need for the Manchester Substation to Meekville Junction Circuit Separation Project in Manchester, Connecticut. Record.

Connecticut Siting Council Docket No. 346 - White Paper on the Security of Siting Energy Facilities (Public Act 07-242, Section 8: October 8, 2009) http://www.ct.gov/csc/lib/csc/pendingproceeds/docket_346/whiteppr_final_20091009114810.pdf

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World Health Organization. Electromagnetic Fields and Public Health, Exposure to Extremely Low Frequency Fields – Fact Sheet #322. June 2007. http://www.who.int/mediacentre/factsheets/fs322/en/index.html

Electric and Magnetic Fields (EMF); Health Concerns – Fact Sheet. Connecticut Department of Public Health, Environmental Health Section Environmental & Occupational Health Assessment Program. Revised April 2008. http://www.ct.gov/csc/lib/csc/publications/emf_fact_sheet_-_2008[1].pdf

3. This Application is presented based on the Council's April 2010 A*pplication Guide for an Electric and Fuel Transmission Line Facility* to assist applicants in filing for a Certificate from the Council for the construction of an electric or fuel transmission line as defined in Connecticut General Statutes § 16-50i (a) (1) and (2).

CL&P also consulted Connecticut General Statutes §§ 16-50g through 16-50z and §§ 16-50j-1 through 16-50z-4 of the Regulations of Connecticut State Agencies in preparing this Application.

CL&P has provided a reference table which acts as a directory between the Council's Application Guide and this Application. Section 17 provides a summary of the Application Guide and identifies the corresponding section of the Application where the information is addressed.

Pre-Application Process (General Statutes § 16-50*l*(e))

CL&P met with representatives of each of the affected municipalities prior to distribution of the Municipal Consultation Filing (MCF). In August 2008, an MCF for the Connecticut portion of the proposed Interstate Reliability Project was distributed to the Chief Elected Official of each of these municipalities. In July 2011, a Supplemental MCF, which augmented the August 2008 MCF with the results of additional studies, was distributed to the Chief Elected Official of each of these municipalities, thereby commencing the municipal consultation period for this Application. During this time, CL&P sought input from the public and local government representatives on the primary route under consideration and alternative routes as presented in the MCF.

F. APPLICATION FILING FEES

(General Statutes § 16-50v(a); Application Guide § IV; General Statutes § 16-50*l*(a))

The filing fee for this Application is determined by the following schedule:

Estimated Construction Cost		Fee
Up to	$5,000,000	0.05% or $1,250.00, whichever is greater
Above	$5,000,000	0.1% or $25,250.00, whichever is less

Based on this schedule and the estimated construction cost for the Project presented in Section ES.9, a check for the filing fee in the amount of $25,250.00 accompanies this Application. CL&P understands that additional assessments may be made for expenses in excess of the filing fee, and that fees in excess of the Council's actual costs will be refunded to CL&P.

Pursuant to §16-50*l*(a)(3*)*, CL&P also encloses a check in the amount of $25,000.00 for the municipal participation fees.

G. PROOF OF SERVICE
(General Statutes § 16-50*l*(b))

This Application was served on the following:

- The chief elected official, the zoning commission, planning commission, the planning and zoning commissions, and the conservation and wetlands commissions of the site municipality and any adjoining municipality having a boundary not more than 2,500 feet from the facility;
- The regional planning agency that encompasses the route municipalities;
- The State Attorney General;
- Each member of the Legislature in whose district the facility is proposed;
- Any federal agency which has jurisdiction over the proposed facility;
- The State Departments of Energy and Environmental Protection (includes former Department of Public Utility Control), Public Health, Economic and Community Development, Agriculture and Transportation; the Council on Environmental Quality; and the Office of Policy and Management.
- Other state and municipal bodies as the Council may by regulation designate, including but not limited to, the State Historic Preservation Officer of the Commission on Culture and Tourism (consolidated with Economic and Community Development) and the Department of Emergency Management and Homeland Security.

Attachments to the cover letter accompanying the filing of this Application to the Council include the transmittal memos sent to these officials and agencies as well as a copy of the service list and an affidavit attesting that appropriate service was made.

H. NOTICE TO COMMUNITY ORGANIZATIONS
(Guide, § VIII)

The applicant made reasonable efforts to provide notice of this Application on the following:

- Affected community groups including Chambers of Commerce, land trusts, environmental groups, trail organizations, historic preservation groups, advocacy groups for the protection of Long Island Sound, and river protection organizations within the watershed affected by the proposed facility that have been identified by a municipality where the facility is proposed to be located, or those that have registered with the Council to be provided notice, as follows: Farmington River Watershed Association and Farmington River Coordinating Committee.

- Any affected water company within the watershed affected by the proposed facility.

Attachments to the cover letter accompanying the filing of this Application to the Council include a listing of the community groups and water companies to whom notice of this Application is being provided as well as the transmittal memo sent to these organizations and an affidavit that such notice was given.

I. PUBLIC NOTICE
(General Statutes § 16-50l(b))

Notice of this Application was published at least twice prior to the filing of the Application in newspapers having general circulation in the site municipalities. The notice included the name of the applicant, the date of filing, and a summary of the Application. The notice was published in not less than ten point type. Affidavits of publication are attached to the cover letter accompanying the filing of this Application to the Council.

J. NOTICE IN UTILITY BILLS
(General Statutes § 16-50*l*(b))

Notice of the proposed Project was provided to each CL&P customer located within the municipalities of the proposed and alternative routes on a separate enclosure with each customer's monthly bill for one or more months not earlier than 60 days prior to the filing of this Application with the Council. This included all CL&P customers in the towns of Lebanon, Columbia, Coventry, Mansfield, Chaplin, Hampton, Brooklyn, Pomfret, Killingly, Putnam, Thompson and Windham.

An affidavit attesting to delivery of the bill insert and a copy of the actual insert itself are attached to the cover letter accompanying the filing of this Application to the Council.

K. NOTICE TO OWNERS OF PROPERTY ABUTTING SUBSTATION AND SWITCHING STATION SITES

(General Statutes § 16-50*l*(b))

Notice of the proposed modifications to the Card Street Substation in Lebanon, Connecticut, Killingly Substation in Killingly, Connecticut, and Lake Road Switching Station in Killingly, Connecticut, was provided to abutters of each substation or switching station, respectively, via certified mail, return receipt requested. An affidavit regarding this notice is attached to the cover letter accompanying the filing of this Application to the Council.

SECTION 1

DESCRIPTION OF THE PROPOSED PROJECT

1. DESCRIPTION OF THE PROPOSED PROJECT

The Connecticut Light and Power Company (CL&P), a wholly-owned subsidiary of Northeast Utilities (NU), along with The Narragansett Electric Company and New England Power Company, both of which are wholly-owned subsidiaries of National Grid USA (National Grid), propose to construct and operate new 345-kilovolt (kV) electric transmission lines and to make related modifications and improvements to existing 345-kV and 115-kV transmission lines and facilities in northeastern Connecticut, northwestern Rhode Island, and south-central Massachusetts. These proposed electric transmission system improvements, referred to as the Interstate Reliability Project, are part of a family of four projects, collectively known as the New England East-West Solution (NEEWS) projects. Together, the NEEWS projects would address electric system problems in Southern New England.

As part of NEEWS, the Interstate Reliability Project would improve the bulk power electric transmission system in Southern New England and achieve compliance with applicable national and regional reliability standards and criteria. It would increase the capability of the system to move power into Connecticut from the rest of New England, to move power from resources in eastern New England to load in western New England, and to move power from resources in western New England to load in eastern New England. When the electric system is under stress, such transfers are needed to maintain continuity of service.

The Interstate Reliability Project also would eliminate violations of reliability standards existing in Rhode Island at current load levels, specifically overloads and non-compliant voltages. By reinforcing the electrical connections between key substations and switching stations in Connecticut, Rhode Island, and Massachusetts, the proposed improvements not only would address reliability violations that would otherwise occur within the 10-year period for which the system must be planned, but also would provide long-term flexibility to maintain and operate the transmission system serving all three states and to dispatch existing and potential future generation resources efficiently in all three states and within the New England region.

This section first provides an overview of the proposed Interstate Reliability Project, and then describes the Connecticut portion of the transmission system improvements, as proposed by CL&P. For the purposes of this Application for a Certificate of Environmental Compatibility and Public Need (Application) to the Connecticut Siting Council (Council), "the Project" refers to the Connecticut portion of the Interstate Reliability Project. The "Proposed Route" refers to CL&P's preferred location for the new 345-kV transmission lines in Connecticut.

1.1 SUMMARY OF THE INTERSTATE RELIABILITY PROJECT

1.1.1 Overview of Interstate Reliability Project Facilities

The Interstate Reliability Project is a proposed set of improvements to the electric transmission systems of Connecticut, Rhode Island, and Massachusetts. Table 1-1 summarizes the Interstate Reliability Project facilities, while Figure 1-1 illustrates the general locations of these facilities.

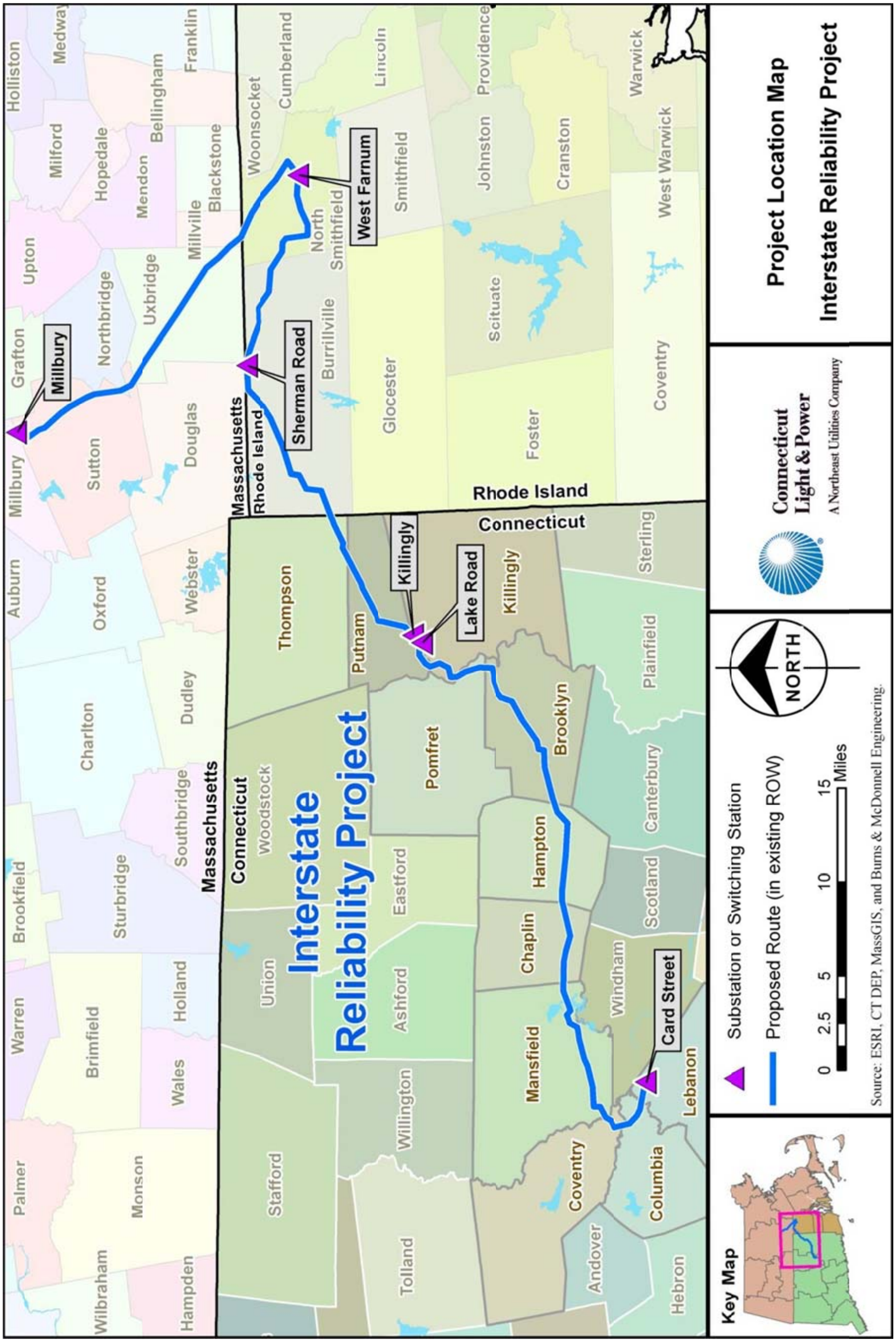
As Figure 1-1 and Table 1-1 show, the Interstate Reliability Project would involve the construction and operation of approximately 75 miles of new 345-kV transmission lines, located predominantly within existing transmission line rights-of-way (ROWs), that would connect CL&P's Card Street Substation (in the Town of Lebanon, Connecticut), CL&P's Lake Road Switching Station (in the Town of Killingly, Connecticut), National Grid's West Farnum Substation (in the Town of North Smithfield, Rhode Island), and National Grid's Millbury Switching Station (in the Town of Millbury, Massachusetts).[1] The Interstate Reliability Project would entail equipment additions and upgrades to these two substations and two switching stations.

[1] The new 345-kV transmission lines would extend through, but would electrically bypass, CL&P's Killingly Substation (Town of Killingly, Connecticut), and would pass by Narragansett Electric's Sherman Road Switching Station in the Town of Burrillville, Rhode Island.

Table 1-1: Interstate Reliability Project: Summary of 345-kV Components

Utility Company / State	Transmission Lines			Substation/Switching Station Improvements
	Voltage (Location)	Approximate Distance (Miles)	Municipalities Traversed	
Connecticut				
CL&P	345 kV (new) Card Street Substation to Lake Road Switching Station to CT/RI Border	36.8	Lebanon, Columbia, Coventry, Mansfield, Chaplin, Hampton, Brooklyn, Pomfret, Killingly, Putnam, Thompson	Card Street Substation Lake Road Switching Station Killingly Substation
Rhode Island				
National Grid (The Narragansett Electric Company)	345 kV (CT/RI Border to West Farnum Substation; West Farnum Substation to RI/MA Border)	22.5	Burrillville, North Smithfield	Sherman Road Switching Station West Farnum Substation
National Grid (The Narragansett Electric Company)	345-kV (rebuild/reconductor) 328 circuit Sherman Road to West Farnum	9.0	Burrillville, North Smithfield	
Massachusetts				
National Grid (New England Power Company)	345 kV (RI/MA Border to Millbury Switching Station)	15.4	Millville, Uxbridge, Sutton, Northbridge, Millbury	Millbury Switching Station
TOTAL	**345 kV (new)** **345 kV (reconductored)**	**74.7** **9.0**		**Modifications to three substations and three switching stations**

Figure 1-1: Interstate Reliability Project: Proposed 345-kV Transmission Line Location Map



As part of the Interstate Reliability Project, National Grid also would rebuild the Sherman Road Switching Station, located in the Town of Burrillville, Rhode Island. In addition, National Grid would reconstruct (reconductor and rebuild) its existing 345-kV line within the presently managed portion of the ROW between Sherman Road Switching Station and West Farnum Substation.

1.1.2 Summary of State Siting Jurisdictions

CL&P would construct, own, and operate the Project facilities to be located in Connecticut. Facilities in Connecticut are subject to the review and approval of the Council. The proposed facilities in Rhode Island, which would be owned and operated by The Narragansett Electric Company, are subject to review and approval by Rhode Island's Energy Facility Siting Board. Similarly, the proposed facilities in Massachusetts would be owned and operated by New England Power Company and would be subject to review and approval by the Massachusetts Energy Facilities Siting Board.

1.2 CONNECTICUT PORTION OF THE INTERSTATE RELIABILITY PROJECT

The Connecticut facilities proposed as part of the Interstate Reliability Project represent the culmination of a multi-year planning and alternatives analysis process. During this process, CL&P, in partnership with the Independent System Operator – New England (ISO-NE) and National Grid, initially investigated and evaluated five major systems options.

After these studies led to the selection of a preferred system solution for the new 345-kV transmission lines and related facilities in the three-state area, CL&P then identified and analyzed potential route alternatives and transmission line configurations before selecting a Proposed Route and overhead transmission line configurations for the Connecticut portion of the Project. The primary objectives of the route selection process were to identify a location for the new 345-kV transmission lines that would:

- Comply with state and federal statutory requirements, regulations and siting policies
- Minimize adverse effects to natural and human resources

- Achieve a reliable, operable and cost-effective solution

Based on these objectives, the principal factors considered in selecting the Proposed Route and overhead transmission line configurations were:

- Availability of existing ROWs within which the proposed facilities could be developed without the need for extensive additional easements
- Avoidance or minimization of effects on environmental resources
- Constructability/engineering considerations
- Minimization of conflicts with developed areas
- Consideration of visual effects
- Accessibility
- Cost

The Proposed Route and overhead transmission line configurations, consisting of the following facilities, best meet these objectives while representing CL&P's preferred solution for providing reliable, cost-effective, and environmentally sound improvements to the regional electric transmission system (refer to Volume 1A for details regarding the alternatives evaluation process[2]):

[2] Underground and overhead line-route variations to portions of the Proposed Route and design were identified and evaluated, consistent with Connecticut General Statutes § 16-50p(i), which requires consideration of alternatives, including underground options where proposed 345-kV transmission line facilities may be determined by the Council to be located adjacent to specific land uses (e.g., areas of known Statutory Facilities and residential areas) designated by the Council. Such alternative alignments, configurations, and route variations are detailed in Volume 1A, Sections 14 and 15.

- New 345-kV electric transmission lines and associated facilities extending between CL&P's existing Card Street Substation in the Town of Lebanon, existing Lake Road Switching Station in the Town of Killingly, and the Connecticut/Rhode Island border (in the Town of Thompson). The overhead line design along this Proposed Route incorporates CL&P's preferred Best Management Practices (BMPs) designs for reducing magnetic fields.[3]

- Related additions at CL&P's existing Card Street Substation, Lake Road Switching Station, and Killingly Substation.

Figure 1-2 illustrates the locations of these proposed Connecticut facilities, which are described in the following subsections.

1.2.1 Proposed 345-kV Lines from Card Street Substation to Lake Road Switching Station and from Lake Road Switching Station to the Connecticut / Rhode Island Border

The proposed 345-kV transmission lines between Card Street Substation and Lake Road Switching Station (the 3271 Line), and between Lake Road Switching Station and the Connecticut / Rhode Island border (the 341 Line) would traverse approximately 36.8 miles, crossing portions of 11 towns in northeastern Connecticut. The new 345-kV transmission lines would be constructed overhead and aligned adjacent to existing 345-kV overhead transmission lines along existing CL&P ROWs. The existing 345-kV lines along the Proposed Route were constructed in the early 1970s. Segments of the existing ROWs also include other overhead transmission lines (e.g., 69 kV and 115 kV), as well as distribution lines (23 kV).

Approximately 35.4 miles (96%) of the new transmission lines would be installed within CL&P's existing ROWs, requiring no additional easement acquisition. In addition, of the 36.8 miles along the Proposed Route, approximately 5 miles (13.4%) would be aligned across CL&P-owned properties.

[3] CL&Ps preferred BMP transmission line designs are detailed in Section 3 (Appendix 3A) and Section 7 of this volume, as well as in Volume 10, and are consistent with the Council's *Electric and Magnetic Fields Best Management Practices for the Construction of Electric Transmission Lines in Connecticut* - approved on December 14, 2007.

Figure 1-2: Location of Proposed 345-kV Transmission Lines and Substation / Switching Stations to be Modified in Connecticut

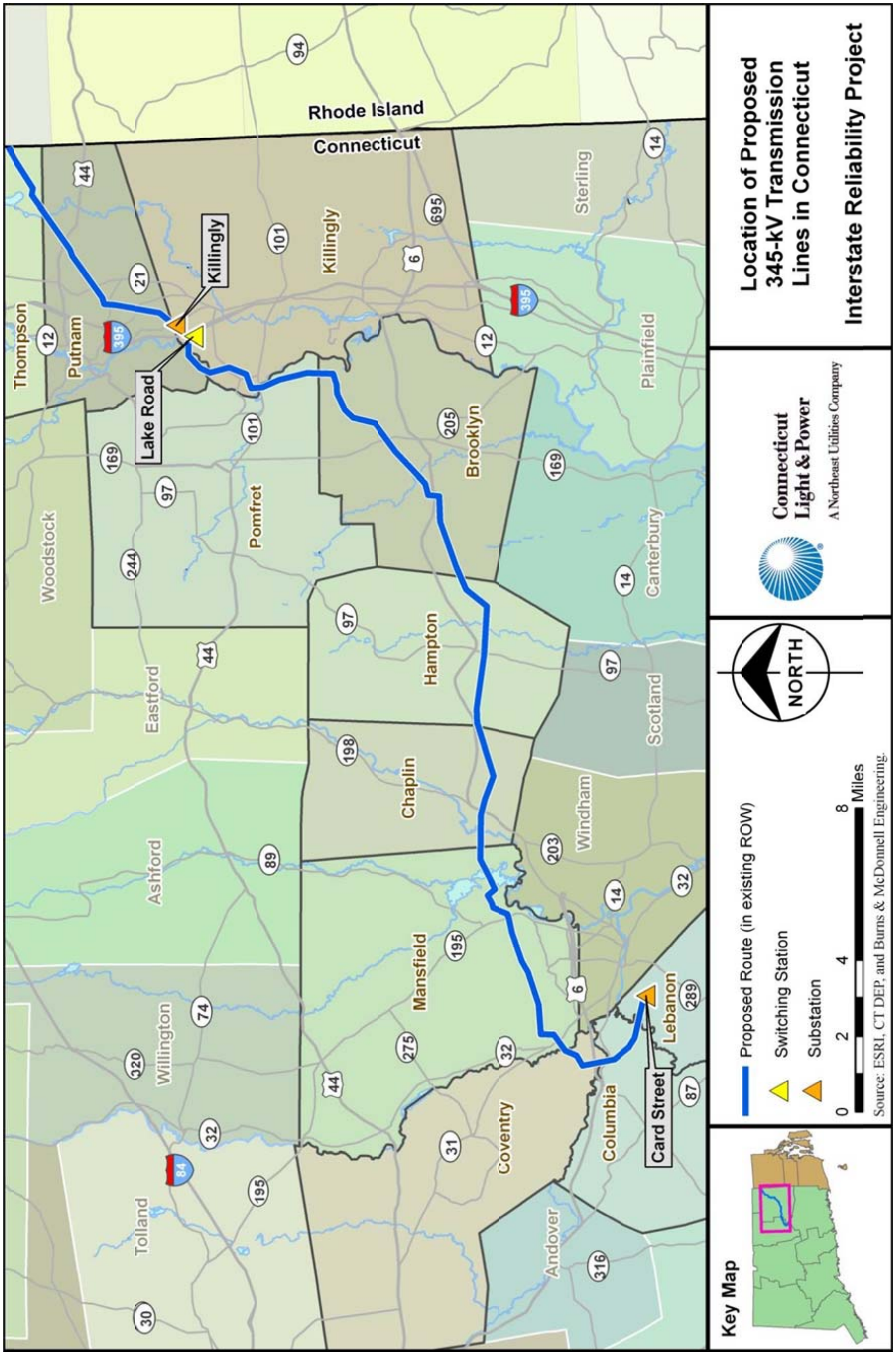


Table 1-2 summarizes the length of the transmission line ROWs in each of the 11 towns along the Proposed Route, as well as the typical width of the existing CL&P ROW along which the proposed 345-kV transmission lines would be aligned. The table also provides a key to the location of the Proposed Route as depicted on the aerial photograph mapsheets in Volumes 9 and 11, and identifies the Cross-Section (XS) drawings in Section 3, Appendix 3A in this Volume and in Volume 10 that illustrate the proposed alignment and configuration of the overhead lines within each of the ROW segments.[4]

Table 1-2: Proposed 345-kV Transmission Line ROW Segments: Miles, Width, Cross-Sections, and Configuration (By Town and Volumes 9 and 11 Aerial Alignment Mapsheet Reference)

Town	ROW		Aerial Alignment Mapsheet Number		Cross-Section (refer to Section 3 of Volume 1, Volume 9, and Volume 10)
	Miles	Width Range (Feet, Typical)	400-Scale (Volume 9)	100-Scale (Volume 11)	
Lebanon	0.6	350	1 of 40	1 – 3 of 133	XS-1
Columbia	1.7	300-350	2 -3 of 40	3 – 9 of 133	XS-1
Coventry	1.2	300	3 – 5 of 40	9 – 14 of 133	XS-1, XS-2 BMP
Mansfield	6.4	150*-300	5 – 10 of 40	13 – 37 of 133	XS-2 BMP, XS-2, XS-3, XS-4
Chaplin	3.3	150*-300	10 – 13 of 40	37 – 49 of 133	XS-4, XS-5, XS-6
Hampton	4.3	300	13 – 17 of 40	48 – 64 of 133	XS-6
Brooklyn	7.2	300-360	17 – 25 of 40	64 – 90 of 133	XS-6, XS-6 BMP, XS-7
Pomfret	1.7	360	25 – 27 of 40	90 – 96 of 133	XS-7
Killingly^	3.0	250-400	27 – 32 of 40	96 – 103 and 105 – 109 of 133	XS-7, XS-8, XS-9, XS-10
Putnam^	5.6	340-400	30 – 36 of 40	109 – 126 of 133	XS-8, XS-10, XS-11, XS-12
Thompson	1.8	300	37 – 40 of 40	126 – 133 of 133	XS-12, XS-12 BMP
Total	**36.8**				

* = CL&P's existing easement is 150 feet wide for approximately 0.9 mile in the Town of Mansfield and 0.5 mile in the Town of Chaplin.

^= Following CL&P's existing ROWs, the Proposed Route extends northeast across Killingly into Putnam, back into Killingly, and then into Putnam.

4 Cross-Section drawings illustrating the proposed overhead line configuration and typical structure type along each segment of the Proposed Route, as well as along each of the route variations, also are included in Volume 9.

1.2.1.1 Line Structure Appearance

Along a majority of the Proposed Route, the new overhead 345-kV transmission lines would be supported on two-pole H-frame structures similar in appearance to the existing H-frame structures that support the 345-kV lines presently occupying the ROWs. Along certain segments of the Proposed Route, CL&P's proposed design incorporates steel-monopole structures.

The new 345-kV line structures would be aligned generally to the north or west (depending on the location of the ROW segment) of and adjacent to the existing 345-kV transmission line structures. The new H-frame structures would be steel or laminated wood, with typical structure heights between 80 and 90 feet above ground. CL&P's preference for structure material would be steel in this instance, due to superior maintenance and constructability benefits. Angle and deadend structures in an H-Frame line would have three poles, either self-supported or guyed, depending on site-specific conditions.[5]

The cross-sections included in Section 3, Appendix 3A, of this Volume and in Volumes 9 and 10 illustrate the tangent structure types, heights, and typical configurations along each of the ROW segments.

1.2.1.2 ROW Width and Potential Easement Acquisition

As summarized in Table 1-2, with the exception of 1.4 miles in the towns of Mansfield and Chaplin (representing approximately 4% of the 36.8-mile Proposed Route), the existing CL&P ROWs along which the proposed 345-kV lines would be aligned are approximately 300 feet wide (or more), and have sufficient unused width to accommodate a new 345-kV transmission line without having to acquire additional easements or to rebuild and reconfigure the existing line. However, for 0.9 mile in the Town of Mansfield and 0.5 mile in the Town of Chaplin (referred to collectively as the "Mansfield Hollow area"), the existing CL&P ROW is 150 feet wide and traverses property owned by the federal government under the auspices of the U.S. Army Corps of Engineers (USACE).

[5] Section 3, Appendix 3B, includes illustrations of the typical structures associated with a 345-kV H-frame line.

The Mansfield Hollow area property was acquired by the federal government approximately 60 years ago in conjunction with federal projects designed to control flooding on the Thames River, such as the creation of Mansfield Hollow Dam and Lake. The USACE currently leases the property to the Connecticut Department of Energy and Environmental Protection (CT DEEP), which manages it as Mansfield Hollow State Park and the Mansfield Hollow Wildlife Management Area (WMA).

CL&P's existing 345-kV transmission line is centered within the 150-foot-wide ROW across the 1.4 miles of federally-owned properties, leaving insufficient width to install and properly separate the new 345-kV line adjacent to the existing line within the current easement. CL&P is presently engaged in consultations with the USACE regarding the alignment of the proposed 345-kV transmission line across the federally-owned lands.

After investigating various alternative routes and transmission line designs for the 1.4-mile ROW in the Mansfield Hollow area, CL&P determined that the acquisition of additional easement width from the USACE to allow the new 345-kV line to be installed adjacent to the existing 345-kV line, using structures of similar height and appearance, would be best. Accordingly, in this Application, the Proposed Route reflects CL&P's proposed acquisition from the USACE of approximately 11[6] additional acres of easement to expand the ROW to the north and allow the development of the new 345-kV line, adjacent to the existing 345-kV line, through the 1.4-miles of federal property.

However, as discussed in detail in Section 10, CL&P also has identified two other feasible design configurations for aligning the new 345-kV line across the USACE-owned properties: one involving less additional ROW expansion (approximately 5 acres) but taller line structures, and one involving no ROW expansion but requiring both the reconstruction of the existing 345-kV line and the use of taller line structures for both the new and the reconstructed 345-kV lines. As presented in the no-ROW-expansion

6 This additional easement acreage calculation is estimated based on preliminary survey data and takes into consideration the configuration of the existing CL&P easement. Final easement acreages would be determined based on final legal surveys and agreements with the USACE.

option, in the event that obtaining a grant of additional easement from the USACE is not possible or practical, CL&P could develop the new 345-kV transmission line within the existing 150-foot-wide ROW. However, in order to provide space for the new 345-kV line, this design configuration option would require relocating and reconstructing the existing 345-kV transmission line in a vertical configuration within the two ROW segments. Compared to the proposed easement acquisition (11 acres) or the minimal-easement-acquisition option (approximately 5 acres), the no-ROW-expansion option would be more expensive, would require taller transmission line structures (for both the new and rebuilt 345-kV lines), and would require more complicated construction (including outages of the existing 345-kV line) within the existing ROW.

CL&P is prepared to develop the new 345-kV line across the federally-owned properties using either the proposed (11-acre easement expansion) configuration or one of the other design configuration options.[7] As a result, although in this Application, the Proposed Route incorporates the proposed 11-acre easement expansion across the federally-owned properties, CL&P has included in Section 10 of this volume a complete analysis of the other design configuration options for aligning the new 345-kV line through the 1.4-mile Mansfield Hollow area.[8] During the Council's siting process, CL&P expects to continue to consult with the USACE, the CT DEEP, and other interested groups regarding the most appropriate configuration for new 345-kV line across the Mansfield Hollow area.

1.2.2 Substations and Switching Stations

In order to interconnect the new 345-kV transmission lines between Card Street Substation and the Connecticut / Rhode Island border to the existing transmission system, CL&P proposes to modify three existing stations: Card Street Substation, Lake Road Switching Station, and Killingly Substation. The

7 CL&P also could potentially develop the new 345-kV line across the USACE properties using a combination of these design configurations (e.g., one configuration in Mansfield and another in Chaplin).

8 Volume 1A, Section 15.5 describes two less-preferred route variations that CL&P considered for aligning the new 345-kV line to the south of and avoiding the federally-owned properties. Maps of these route variations also are included in Volume 9.

facility modifications proposed for each of these stations are described in the following subsections and illustrated on the drawings in Volume 7.

1.2.2.1 Card Street Substation

The Card Street Substation is located in the northeastern portion of the Town of Lebanon. The developed portion of the existing substation occupies approximately 10 acres of CL&P's 150-acre owned property.

Card Street Substation was initially developed in 1960 as a 115- to 69-kV substation. Shortly thereafter, the station was modified to include distribution facilities. The substation was expanded to include 345-kV facilities in 1969, interconnecting to the 368 and 383 transmission lines to Manchester Substation and Millstone Switching Station, respectively. The 330 Line[9] (345 kV) was interconnected to the substation in the early 1970s.

To interconnect the new 345-kV line to Card Street Substation, CL&P proposes the following modifications to the substation, all within the existing fenced area: a new 345-kV transmission line terminal structure, three new 345-kV circuit breakers, lightning masts, four disconnect switches, bus work and cable trench, three surge arresters, three capacitively coupled voltage transformers (CCVTs), and one wave trap.[10] New protection and control equipment would be installed within the existing relay / control enclosure. (Note: Initial Project plans included the expansion of Card Street Substation to accommodate the terminal structures for a proposed "loop" of the 345-kV 310 Line into and out of the substation from Village Hill Road Junction. Because that loop is no longer proposed as part of the Project, expansion beyond the existing fenced area of the substation will not be necessary.)

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9 Prior to the development of the Lake Road Switching Station and Killingly Substation, this 345-kV transmission line was the 347 Line. Since then, only the line section from Killingly Substation to Sherman Road Switching Station retains the 347 circuit number.

10 Typical drawings of the equipment proposed for the Card Street Substation, Lake Road Switching Station, and Killingly Substation are included in Volume 7.

1.2.2.2 Lake Road Switching Station

CL&P's Lake Road Switching Station is located in the northwestern portion of the Town of Killingly, on an easement consisting of approximately 3.5 acres. The existing switching station, which was developed and interconnected in 2001, occupies approximately 3 acres of the total site.

The proposed new construction would include the addition of three 345-kV circuit breakers, six 345-kV disconnect switches, bus work, six surge arresters, 10 CCVTs, four potential transformers (PTs), two wave traps, and new protection and control equipment within the existing control house. These modifications would be accommodated within the existing developed (fenced) portion of the switching station.

1.2.2.3 Killingly Substation

Killingly Substation also is located in the northwestern portion of the Town of Killingly on approximately 29.4 acres of CL&P-owned property. The existing substation, which was developed in 2006, occupies approximately 5.6 acres of the total site.

For the Project, the new construction at Killingly Substation would entail the installation of two 345-kV transmission line terminal structures to support new 345-kV line conductors passing through the substation. These additions would be accomplished within the existing substation's fenced area. The new 345-kV transmission line extending between Lake Road Switching Station and the Connecticut / Rhode Island border would traverse Killingly Substation using these new structures, but would not electrically connect to the substation.

SECTION 2

PROJECT BACKGROUND AND NEED

2. PROJECT BACKGROUND AND NEED

This section explains how the Interstate Reliability Project was developed as part of the NEEWS projects so that the electric supply system in Southern New England (SNE)[1], particularly in Connecticut, Rhode Island, and south-central Massachusetts, would comply with national and regional reliability standards and criteria. The section first identifies the applicable reliability standards and reviews how they evolved as the North American electric supply system was developed, then summarizes the initial development of this project and the overall NEEWS projects, and finally describes the need for the Interstate Reliability Project and how that need has evolved while the project has been in the development stage.

2.1 THE SYSTEM PLANNING PROCESS AND RELIABILITY CRITERIA

Maintaining continuity of service to customers has been a primary objective of electric utilities in North America since their very beginning. As electric supply systems have grown and become more complex, more interconnected, and increasingly critical to human welfare and a healthy economy, standards for assuring continuity of service have become mandatory and more stringent, requiring the use of increasingly sophisticated analytical tools. Today engineers using detailed and highly sophisticated and accurate computer models are able to evaluate the reliability of the existing interconnected transmission system and to plan modifications or additions needed to comply with those standards by simulating the performance of the system, as well as with proposed potential improvements to it. The following sections review the development of reliability planning standards and their current application.

2.1.1 A Brief History of Electric Reliability Planning

During the first half of the 20th Century, individual power systems each developed and applied their own planning criteria. By mid-century, however, with the dramatic growth of synchronous interconnections

[1] For electric transmission purposes, SNE encompasses Connecticut, Massachusetts, and Rhode Island.

and the increasing use of the electric transmission system to move power over longer distances, utilities began to coordinate their planning activities.

When the Northeast Blackout of 1965 occurred, it was obvious that a more closely coordinated strategy was necessary. Shortly after the blackout, the electric utilities involved formed the Northeast Power Coordinating Council (NPCC) to promote and improve the reliability of the interconnected bulk power system in northeastern North American, including the six New England states, New York State, and the Canadian provinces of Ontario, Québec, New Brunswick, and Nova Scotia. The U.S. systems of the NPCC also formed two new power pools: the New England Power Pool, which eventually became the Independent System Operator – New England (ISO-NE), and the New York Power Pool, which evolved into the New York Independent System Operator (NYISO). Other utilities across North America also formed similar regional reliability councils, which together eventually encompassed most of the continent.

Each regional reliability council established its own reliability criteria. Each also developed procedures for assessing conformance. With time, individual electric utilities and power pools often developed their own more detailed and stringent planning and operating procedures to ensure the reliability of their portions of the interconnected bulk-power electric system; however, those procedures had to continue to be compliant with the broader regional criteria requirements.

In 1968, the U.S. regional reliability councils formed the National Electric Reliability Council (NERC) to coordinate their activities nationally and developed voluntary reliability guidelines for their collective systems. NERC has evolved over the years. In 1981, its name was changed to the North American Electric Reliability Council, to reflect the addition of Canadian members. But the most dramatic changes occurred in the wake of the August 14, 2003 Midwest/Middle Atlantic blackout. The Energy Policy Act of 2005 (EPAct) directed the Federal Energy Regulatory Commission (FERC) to establish an Electric

Reliability Organization (ERO), whose major role would be to develop and enforce mandatory reliability standards for planning and operations. After a period of study, FERC designated NERC as the ERO, and its name was changed to the North American Electric Reliability Corporation, Inc.

2.1.2 Modern Reliability Standards and Criteria

The NERC standards today are subject to approval by FERC and are much more specific than they were in the past, and compliance is mandatory under federal law. Violations are punishable by fines as high as $1 million per day per violation. Regional reliability councils may have their own criteria,[2] but these must conform to all NERC requirements – planning, system design and operations. Similarly, an Independent System Operator (ISO) and individual electric systems may also have their own criteria and procedures, but they all must conform to both NERC standards and the regional criteria. Thus, in conducting planning studies, all transmission owners in New England are required to comply with NERC standards, NPCC criteria, and ISO-NE planning procedures. Copies of these standards and criteria, and procedures, as well as the *Northeast Utilities Transmission Planning Guideline*, are included in Volume 5.

2.1.3 Simulating Contingencies

A key element of the reliability standards is the consideration of “contingency” events wherein generation and/or transmission facilities are assumed to suddenly and unexpectedly trip out of service. Such contingency events could be caused by weather; by generator, transmission line, or substation equipment failures; by contingencies on other transmission systems connected to the New England transmission system; or by some combination of these factors.

NERC, NPCC, and ISO-NE standards, criteria and procedures specify the contingencies that must be considered in planning studies. The NPCC criteria and ISO-NE procedures must be consistent with all

[2] Although “standards” and “criteria” may be synonymous in many cases, in electric reliability planning, “standards” are correctly used to refer to the mandatory NERC standards, and “criteria” to the rules adopted by subordinate reliability organizations, which must be consistent with the NERC standards.

NERC standards. This means that NPCC criteria may be more stringent, but must as a minimum conform to the NERC standards. Likewise, ISO-NE procedures may be even more stringent, but must as a minimum conform to the NPCC criteria and NERC standards. In general, contingencies (i.e. outages of system elements) are studied to insure that, should one of the specified contingency events occur, the remainder of the system would survive without a transmission element overload, an unacceptably low voltage condition, instability, cascading outages, system separation, or loss of firm customer load.

When a generating unit or a transmission line suddenly and unexpectedly trips out of service, power flows increase instantaneously on the transmission lines that remain in-service. (This is in accordance with the laws of physics as applied to electric power systems.) Thus, an area's transmission system must be designed not only to transmit and/or import power required to offset anticipated generation deficits with all transmission facilities in service, but also must be capable of transmitting or importing power reliably following specific contingencies as required by the mandatory national standards and regional criteria. Otherwise, post-contingency power flows could exceed emergency transmission element ratings and/or result in low voltage conditions on portions of the electric system below prescribed limits.

Because each transmission line must be able to carry the additional current that would instantaneously flow in the event of the sudden loss of a generating unit, transmission line, or other system element, normal power flows on transmission lines will typically be well below the thermal ratings of the line.

Contingencies, as specified by NERC, NPCC, and ISO-NE standards and criteria, are usually characterized as loss of a single system element – that is, a generator, transmission line, bus section, etc. Sometimes, however, a single contingency can result in the loss of two transmission elements, such as where two electric circuits share a common set of towers, forming a "double-circuit tower" (DCT) transmission line. Both of these types of events are referred to as "N-1" contingency events. Another type of contingency involves the occurrence of two separate and unrelated outages within a short period of time (30 minutes per NPCC criteria and ISO-NE procedures). These are referred to as "N-1-1" events. When such a contingency event is simulated, reliability standards and criteria require an assumption that there will be sufficient time between contingency events for the system operator to implement specific "manual system adjustments" to the system before the second contingency event occurs.

Thus, the applicable standards and criteria require that in a planning study, after performing each of the required N-1 contingency analyses with all transmission facilities assumed to be initially in service, planning engineers test the ability of the system to be operated reliably with a key facility out of service. To do this, they apply a contingency; measure and document system performance prior to readjusting or reconfiguring the system (with "manual system adjustments"); then apply a second (unrelated) contingency; and then study the electric system's response. The criteria governing planning studies for the New England control area provide that, to make the system ready for the next contingency, only those manual adjustments that can be implemented within 30 minutes may be considered. These include adjusting the output of generation units, activating "quick start" generating reserves, and changing phase angle regulator taps.

To evaluate compliance with applicable reliability standards, the specified contingencies are simulated on computer models developed to represent the power grid with expected future modifications and additions, operating with projected future loads. If the simulations show that currents on a transmission element will exceed its thermal ratings (a thermal overload), or that system voltages cannot be maintained within acceptable limits following one or more of the contingencies (a voltage violation), appropriate solutions must be developed and implemented in order to maintain the reliability of the electric grid.

The specific contingencies prescribed by the NERC standards for power-flow analyses do more than demonstrate how the power grid would perform should the specific events being modeled occur. These simulations also represent stresses that could result from multiple other potential events, some of which may not even be foreseeable at present. That is, the objective of the simulations is not just to assure that the system will withstand the specific contingencies defined by the standards, under the specific conditions modeled, but to document that the system will be strong and robust enough to survive a wide range of potential events that could impose comparable stresses.

2.1.4 Generation Dispatches in Power-Flow Simulations

In accordance with the reliability criteria and procedures of NPCC and ISO-NE, the regional transmission power grid must be designed for reliable operation during stressed system conditions. Stressed conditions are simulated, in part, by developing generation dispatches. First, a base case that reflects the planners' expectation of likely resource availability in the study period is constructed. Resources may be assumed to be unavailable in the base case based on operating experience, announced retirement, or other reasons. Then, to simulate critical system conditions, at least the largest and most critical generating unit or station in an area is assumed to be unavailable. The planners may also determine that, in light of the size of the area under study or other considerations, additional units should be assumed to be unavailable. Such considerations include reducing dependence on specific local generation, and recognizing that units may be out of service for any one of a number of reasons, such as economics, equipment failure, loss of fuel supply or maintenance. Further, heightened environmental restrictions on fossil-fueled generating stations could affect continuous operation of generating units or result in the closure of one or more units at a generating station.

Thus, in a September 15, 2010 decision, the Connecticut Department of Public Utility Control (DPUC) [3] estimated that due to a combination of likely new emission rate limits and market conditions, 2,446 megawatts (MW) of oil-fired steam generation, including 1,504 MW in Connecticut, could be forced to

[3] Effective July 1, 2011, the DPUC was consolidated with the former CTDEP as the Connecticut Department of Energy and Environmental Protection (CT DEEP). The agency is now referred to as the Public Utilities Regulatory Authority, within CT DEEP. In this document, references to the DPUC pertain to materials published by that agency prior to the July 1, 2011 consolidation.

retire by 2017.[4] Moreover, the DPUC noted that there is substantial uncertainty around these estimates, and that under certain foreseeable market conditions, retirements could exceed 4,000 MW. Recently, the owners of the 745-MW Salem Harbor Station in Salem, Massachusetts confirmed that all of the plant's units would be retired in 2014, notwithstanding requests from ISO-NE that two of the units continue to be operated for reliability reasons. ISO-NE determined that the probability that the 620-MW Vermont Yankee nuclear power station will be retired as early as 2012 is so significant that it was assumed to be retired in the "base case" power-flow simulations in ISO-NE's recent studies for the Interstate Reliability Project.

Unplanned outages of generating units are common in the electric industry. For example, in 1996 three nuclear-powered generators at Millstone Station (in Waterford, Connecticut) were shut down by order of the Nuclear Regulatory Commission, a loss of more than 2,600 MW of generating resources in Connecticut. These units remained out of service through 1997, 1998, and into 1999, and only two of the three Millstone units eventually returned to service. When ISO-NE set a record for peak winter load on January 21, 2003, eight generating units in Southwest Connecticut (SWCT), with a total capacity of approximately 1,038 MW, were unavailable due to problems associated with the extremely cold weather. Similarly, on June 30, 2008, Milford Power Units 1 and 2 tripped off line during a three-day-long forced outage of Millstone Unit 2, making about 1,470 MW of Connecticut-based generation unavailable for over 12 hours on a summer day. The Millstone Unit 2 (882 MW) was lost from service from July 3 to July 27, 2010 – nearly an entire summer month. And on four separate occasions in the last two years, two generators in the Boston area, with an aggregate capacity of 1,368 MW, were simultaneously lost from service. Most recently, on July 22, 2011, when the second highest New England historic peak load was reached, more than 1,400 MW of generation was unexpectedly unavailable due to forced outages and reductions.

[4] DPUC Docket 10-02-07, DPUC Review of the Integrated Resource Plan, Sept. 15, 2010, at 4.

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. This technique also tests 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, as described earlier. The former is a base case assumption – the system as represented before any contingency is applied. The latter is one of the many contingencies specified by the NERC, NPCC, and ISO-NE standards, criteria and procedures, which the pre-contingency system must be able to withstand without experiencing a transmission line or substation element overload, a low voltage condition, instability, cascading outages, system separation, or loss of firm customer load.

2.2 THE NEW ENGLAND BULK-POWER SUPPLY SYSTEM

The North American power systems are divided into four large synchronous interconnections or "grids." The largest of these, the Eastern Interconnection, stretches from the Canadian Maritimes to Florida, and from the Atlantic Ocean roughly to eastern Montana, Wyoming, Colorado, and New Mexico.

The New England bulk-power electric system is part of the Eastern Interconnection, and serves 14 million people living in a 68,000 square-mile area. There are more than 300 New England electric generating units, which are capable of producing a total of approximately 32,000 MW of electricity; most of these generating units are connected to approximately 8,000 miles of high-voltage transmission lines. Thirteen transmission tie lines interconnect New England with neighboring electric systems in New York and the Canadian provinces of New Brunswick and Québec. In addition to these power-supply resources and transmission interconnections, New England depends upon significant demand-reducing resources. As of the summer 2011, approximately 2,035 MW of demand-reducing resources, including "behind the meter" generators, were registered as part of the ISO-NE Forward Capacity Market. Customers in these programs agree to reduce load quickly to enhance system reliability.

FERC has designated all of New England as a single operating control area, and has designated ISO-NE as the independent system operator for the region. As such, ISO-NE is responsible for operating New England's bulk-power generation and transmission system, overseeing and administering the region's wholesale electricity markets, and managing the regional bulk-power system planning process.

In 1971, the New England Power Pool was formed to coordinate planning and operation of the New England power grid. The New England power grid now integrates resources with the transmission system to serve all regional load, regardless of state boundaries. Most of the transmission lines are relatively short and networked as a tightly integrated grid. Therefore, the electrical performance of one part of the system may affect other areas of the system.

The New England region reached a new record summer peak load of 28,130 MW on August 2, 2006, due to the extreme temperatures and humidity throughout the region. In accordance with ISO-NE operating procedures, demand-response programs were activated, and this action reduced the peak demand for electric power by approximately 640 MW. In the absence of these programs, the peak load would have been 28,770 MW. Although this peak load level has not been exceeded since 2006, it has been approached. Notwithstanding the current economic downturn, the 2010 summer peak load, reached on July 6, 2010, was 27,100 MW. On July 22, 2011, load peaked at 27,702 MW – the second highest peak ever recorded in New England. This load was net of 643 MW of real time demand resources that were dispatched by ISO-NE.

Normal dispatch, considering economics, generation availability, and transactions with neighboring systems, can result in multiple intra-New England power transfers of varying direction, magnitude, and duration. The development of about 9,500 MW of new generation in New England since 1999, without commensurate transmission system upgrades, has resulted in situations where surplus generation in one subarea may not be deliverable to other subareas and may not be operable with other generation in the sub-area or region.

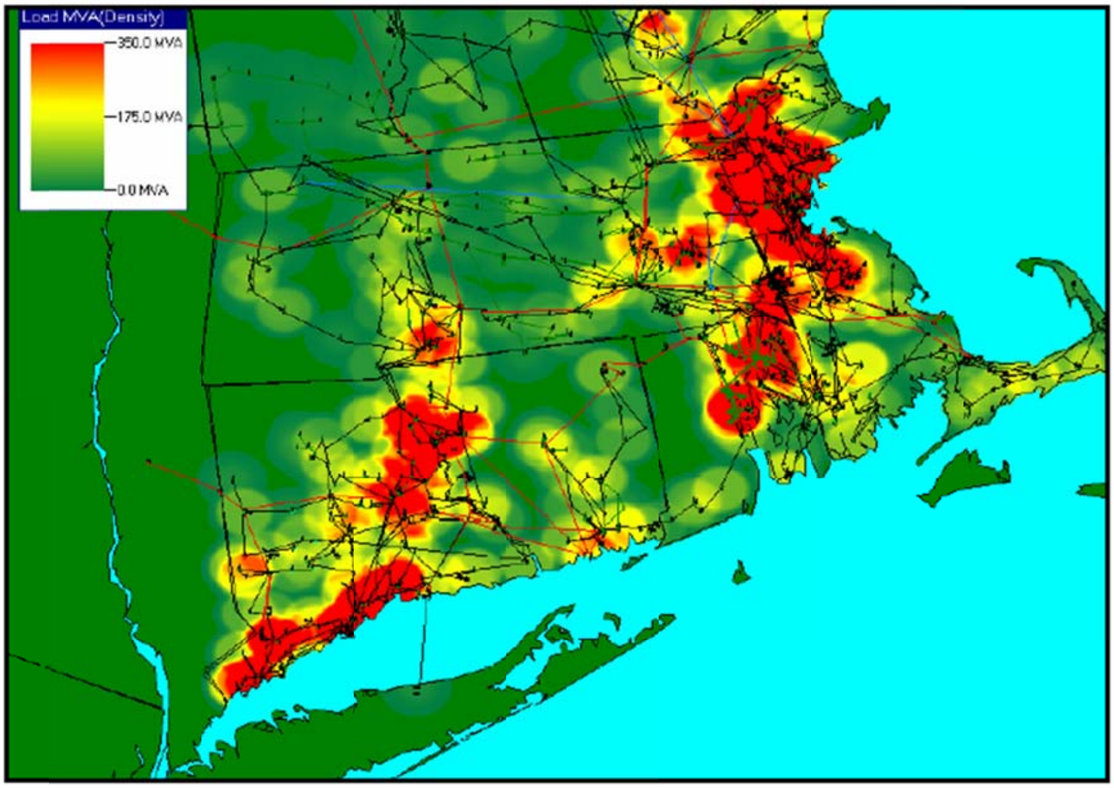
Generation in New England is not dispatched based on utility service areas or political jurisdictions. Rather, New England in its entirety is dispatched on a “single-system” basis. Transmission constraints can however constrain the optimal generation dispatch. Such constraints on the dispatch of generation can result in higher overall costs under normal conditions, and in reliability problems under contingent conditions.

2.3 BULK-POWER SUPPLY IN SOUTHERN NEW ENGLAND

The SNE area accounts for approximately 80% of the total New England load. Customer load in SNE exceeds available local generation capacity. Accordingly, power is routinely transmitted to SNE from generators in Northern New England and Canada.

As shown in Figure 2-1, the SNE load is concentrated in Boston and its suburbs, central Massachusetts, and Springfield, Massachusetts; Rhode Island; Hartford, Connecticut, and Southwest Connecticut. Such areas of load concentration are called “load pockets” if some portion of customer load demand must be met by local generation resources because the transmission system is not adequate to reliably import all the power needed to meet customer load requirements from other parts of the transmission system. Connecticut as a whole is a “load pocket.”

Figure 2-1: Southern New England Load Concentrations

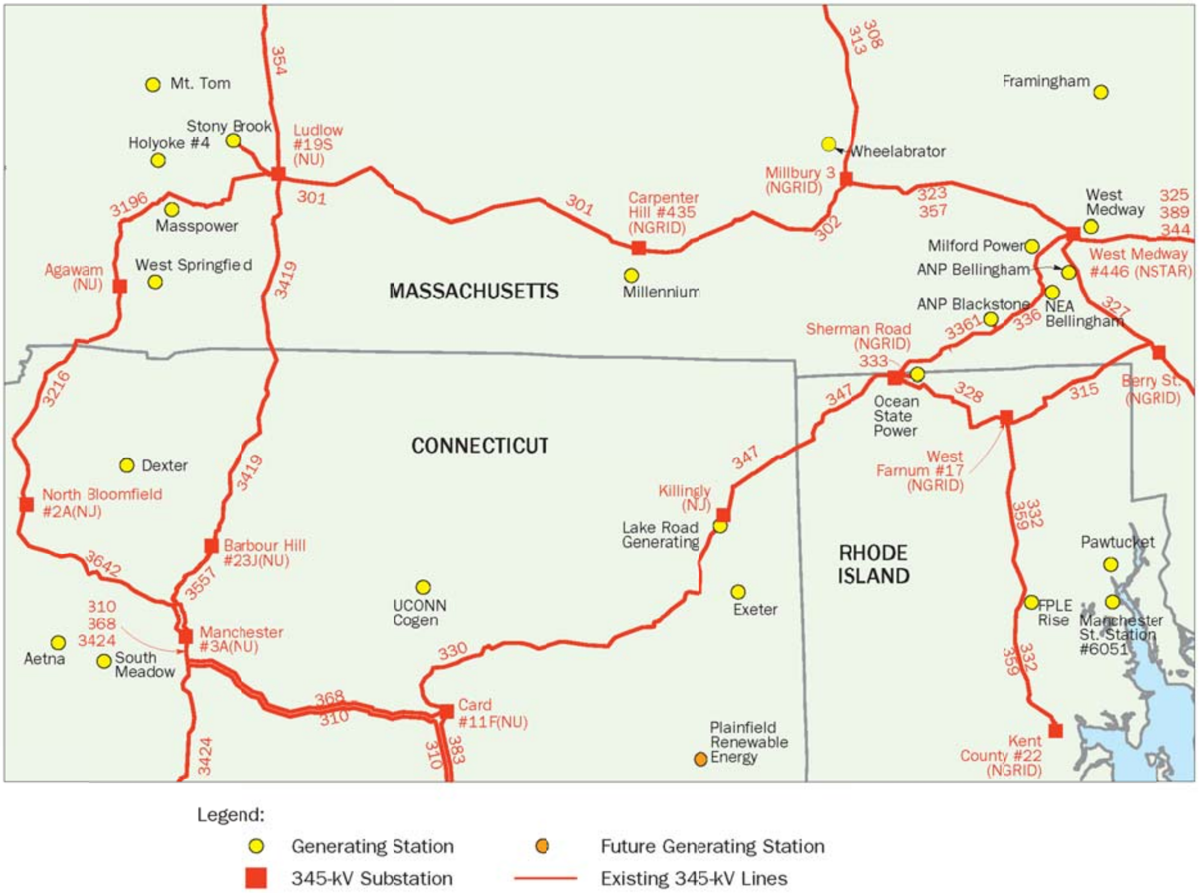


Source: ISO 2008 Needs Report.

The 345-kV transmission network in SNE is the area of particular interest for this Application. Figure 2-2 illustrates this 345-kV transmission network, as it will be constituted with the completion of two of the NEEWS projects that are now under construction (i.e., the Greater Springfield Reliability Project [GSRP][5] and the Rhode Island Reliability Project [RIRP]).

[5] GSRP was reviewed and approved by the Council under Docket No. 370.

Figure 2-2: Southern New England 345-kV System, Geographic Overview



Notes:
1. 345-kV lines, substations, and switching stations are shown in red.
2. Generating stations are shown in yellow.

2.3.1 Transmission Interfaces

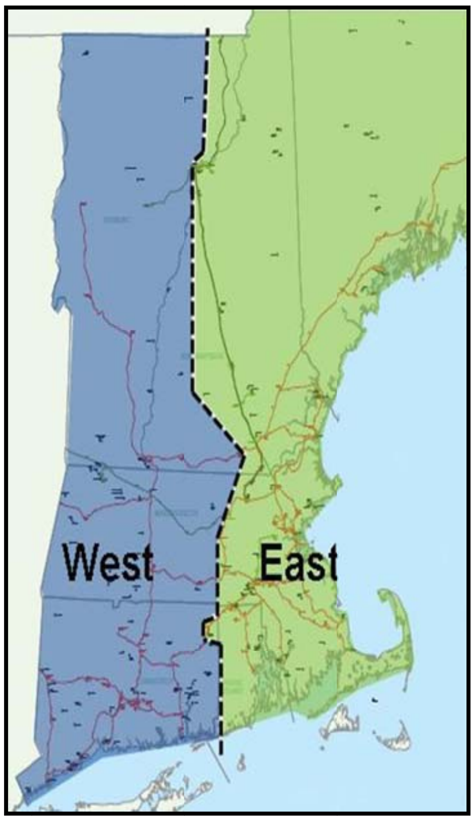
"Interfaces" are sets of designated transmission facilities that can be used to reliably transfer power, within defined limits, from one area to another. They can be visualized as "boundaries" between areas of the system – all transmission lines that cross such a boundary are by definition part of that interface. The transfer capability across an interface depends on the power flows that all of the transmission elements crossing the interface can carry without violating prescribed limits of system stability, current carrying capability, or permissible ranges of voltage. Transfer capabilities are expressed in terms of the power flow that the transmission elements can safely carry under normal conditions, and that which they can carry under defined contingency conditions. Since system conditions, such as load and the amount and location of available generation, can vary significantly from day-to-day and sometimes from hour-to-hour, transfer capabilities across an interface are properly expressed as a range of values. These transfer limit values will always be much lower than the sum of the individual current carrying capacities of each of the transmission elements that make up the interface. This is because the system must be planned to withstand the potential contingent loss of any of the elements of the interface, and for the overlapping loss of a second element within 30 minutes of the first contingency event. When such contingent events occur, the power flowing on the element lost from service automatically redistributes onto the remaining elements of the system.

Interface transfer limits are important tools for transmission planning studies. ISO-NE establishes transfer limit levels for each New England interface for use in planning studies. The limits are expressed as a range, since they will vary with system conditions. Transfer limits are published annually in FERC Form 715, and are considered the "applicable" limits for use in planning studies. However, when the object of the studies is to define and, if necessary, improve interface transfer capability, a different approach is used. Rather, the actual transfer capabilities that result from modeled system conditions are determined, and if the existing transfer capability is insufficient to comply with reliability requirements, then system improvements are designed to increase transfer capability.

2.3.2 The New England East – West Interface

Electrically, New England consists of two large operating areas, divided by the New England East –West Interface. In its traditional configuration, this interface roughly corresponds to the boundaries of the service areas of major electric utilities, and divides New England approximately in half, separating the load centers of the Southeast Massachusetts Area (SEMA)/Boston area and Connecticut. The interface follows the Connecticut – Rhode Island border (except for a jog around the Lake Road Generating Station in northeast Connecticut), then passes through Massachusetts, just west of the Millbury, Massachusetts hub, proceeds northeast into New Hampshire, west of the major generating facilities in southern New Hampshire, and then extends north through New Hampshire and Vermont, westerly of the high-voltage direct current (HVDC) line from Québec and its terminal facilities. The location of this interface is illustrated in Figure 2-3.

Figure 2-3: Approximate Boundary of New England East – West Interface



Three 345-kV transmission lines currently cross this interface. In addition, there are two 230-kV transmission lines, and a few underlying 115-kV facilities. Most of the 230-kV and 115-kV facilities extend for long distances, have relatively low thermal capacity, and do not add significantly to the transfer capability of the interface.

In the mid-1980s and early 1990s, monitoring the New England East-West Interface was important in day-to-day operations because of constraints in moving significant amounts of power from generating stations located in the west (including four nuclear generating units in Connecticut) to Boston and its suburbs in the east. At that time, Connecticut was a net exporter of power.

However, in the late 1990s, following the influx of new generation in the east and the long-term loss of four Connecticut nuclear generating units, this interface became severely constrained in the opposite direction, from east to west, as Connecticut became a large net importer of power. Following this period, only two of the Millstone generating units (units 2 and 3) returned to service in the late 1990s. Both Connecticut Yankee and Millstone Unit 1 were retired. Since then, approximately 2,000 MW of new generating capacity has been built or committed pursuant to ISO-NE's Forward Capacity Auction process in locations to the west of the interface, mostly in Connecticut. However, the addition of these new resources will not eliminate the constraints of the interface. To the contrary, as recent studies by ISO-NE (discussed later in this section) have demonstrated, under existing and anticipated future conditions, power flows across the interface may be constrained in both directions, so that power generated to the west of the interface and needed in the east – or vice versa – cannot be delivered under conditions for which the system must be planned.

As explained in Section 2.5.2, the New England East-West Interface is constrained under some system conditions. The Lake Road Switching Station (Connecticut) to Sherman Road Switching Station (Rhode Island) to West Medway Substation (Massachusetts) 345-kV lines are required to do the double duty of serving as a transportation corridor between eastern and Western New England (and between Connecticut and Rhode Island and Rhode Island and southeast Massachusetts), while simultaneously moving the power from four generating stations with an aggregate summer capacity of approximately 2,000 MW. These generators were constructed in recent years, following the restructuring of the electric power industry. As a result, system operators today protect against contingent overloads on the New England

East-West, Connecticut-Rhode Island and Rhode Island-SEMA interfaces by shifting the point along the Lake Road – Sherman Road – West Medway corridor where power flow is monitored, depending on whether power is flowing toward Connecticut or toward Massachusetts. Thus, the interface boundary shifts according to power-flow direction.

2.4 DEVELOPMENT OF THE INTERSTATE RELIABILITY PROJECT

The Project proposed in this Application is the product of more than six years of planning studies. The phases of these studies, and the results of each of them, are explained in the following sections.

2.4.1 The Southern New England Transmission Reliability Studies and the NEEWS Plan (2004-2008)

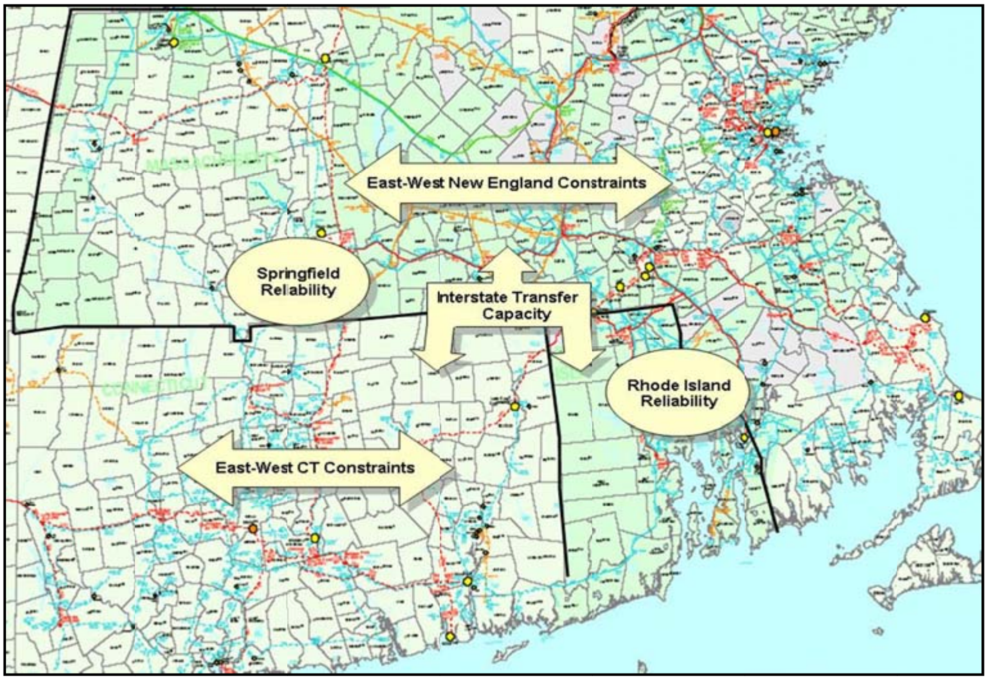
The existing 345-kV transmission line on the ROWs between CL&P's Card Street Substation in Lebanon, Connecticut and the Rhode Island border was constructed in the early 1970s and was looped into the Lake Road Switching Station and Killingly Substation when those facilities were constructed in 2002 and 2006, respectively. Prior to constructing that line, CL&P had acquired a ROW that was generally 300 feet wide because it then anticipated a future need to accommodate additional lines. In 2004, Northeast Utilities Service Company (NUSCO)[6] began planning and routing studies for a possible second 345-kV line from the Card Street Substation to National Grid's Millbury Switching Station in Millbury, Massachusetts, with a potential connection to National Grid's Sherman Road Switching Station in Burrillville, Rhode Island, and with a connection to the Lake Road Switching Station in Killingly, Connecticut. Also in 2004, ISO-NE, in conjunction with NUSCO and National Grid planners (collectively, the "Working Group") together with outside consultants, embarked on a coordinated series of studies of the deficiencies in the SNE electric supply system. These studies were collectively called the Southern New England Transmission Reliability (SNETR) study.

[6] CL&P is a wholly-owned subsidiary of NU, as is NUSCO. NUSCO provides services to CL&P, including transmission planning, design, and permitting work.

When the SNETR study was undertaken, the Southwest Connecticut and National Grid transmission system improvements previously described were planned or under construction, and were expected to be in-service by 2009. The SNETR study therefore assumed the completion of these projects, and sought to identify additional improvements that would be required to assure compliance with mandatory reliability standards by addressing problems expected to arise at least through 2016. Initially, these studies considered limitations on east-west power transfers across SNE, and transfers between Connecticut and southeast Massachusetts and Rhode Island – limitations that are addressed in large part by the proposed Project. These limitations were first identified as interdependent (that is, as affecting one another) in ISO-NE's 2003 Regional Transmission Expansion Plan (RTEP03).

In the course of these studies, the SNETR Working Group determined that other, previously identified reliability problems in Greater Springfield and Rhode Island were not simply local issues, but were also affected by interstate transfer capabilities. In addition, the planners discovered constraints in transferring power generated in (or imported into) eastern Connecticut across central Connecticut to the concentrated load in Southwest Connecticut. The cluster of reliability problems identified by the SNETR study is illustrated in Figure 2-4.

Figure 2-4: Southern New England Subareas and Constraints



As finally developed, the SNETR study addressed all of these interrelated problems and recommended transmission solutions. The transmission projects that emerged from this planning process were collectively referred to as the NEEWS Plan.

The four principal projects that comprise the NEEWS Plan are described below:

- The **Interstate Reliability Project**, which is the subject of this Application.
- The **Greater Springfield Reliability Project** (GSRP) includes the construction of new 345-kV 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 lines along approximately 27 miles of overhead line ROW in Massachusetts; and related substation and switching station improvements in Massachusetts and Connecticut. This project was approved by the Council and by the Massachusetts Energy Facilities Siting Board in 2010, is currently under construction, and is planned to be in service in December 2013. In the proceeding in which it approved the GSRP, the Council also approved a separate but related **Manchester to Meekville Junction Project**, which strengthens the Connecticut 345-kV system by constructing transmission improvements along 2.7 miles of ROW in Manchester, Connecticut.

- The **Rhode Island Reliability Project** (RIRP), as proposed by National Grid, includes the construction of a new 345-kV line along 21 miles of existing overhead line ROW, extending from its West Farnum Substation in North Smithfield, Rhode Island to its Kent County Substation in Warwick, Rhode Island. It also includes a number of related improvements to existing 115-kV and 345-kV facilities. This project was approved by the Rhode Island Energy Facility Siting Board in 2010, and is expected to be in service in the fourth quarter of 2012.

- The **Central Connecticut Reliability Project** (CCRP), would have included the construction of a new 345-kV line along 38 miles of existing overhead line ROW, extending from CL&P's North Bloomfield Substation in the Town of Bloomfield to its Frost Bridge Substation in the Town of Watertown, together with related improvements to existing 345-kV and 115-kV facilities are also included. This project is currently under review by ISO-NE as part of the Greater Hartford / Central Connecticut (GHCC) study, which is examining both the problems that would be addressed by CCRP and other potential problems.

The following summarizes the electric transmission system deficiencies identified by the SNETR studies, and how they were addressed by the original NEEWS Plan:

- **Rhode Island Reliability**. Transmission system reliability and dependence on local generation were the major concerns for the Rhode Island system. System modeling demonstrated that a number of overload and voltage violations could occur on the Rhode Island transmission facilities following contingency conditions. These problems were caused by several contributing factors, both independently and in combination, including: high load growth (especially in southwestern Rhode Island and its coastal communities), generating unit unavailability, and transmission outages (planned or unplanned). It was determined that the addition of the new 345-kV line from West Farnum Substation to Kent County Substation and other associated improvements would both greatly improve the reliability of the state's transmission system and reduce dependence on local generation. New 345-kV lines from Millbury Switching Station to West Farnum Substation, and from West Farnum Substation to Lake Road Switching Station, would serve a dual role of both improving Rhode Island reliability and providing an essential component of the new 345-kV Interstate Reliability Project, as discussed herein.

- **Greater Springfield Reliability.** The GSRP addresses overloads and voltage violations on the existing Greater Springfield 115-kV system by improvements to that system and the construction of a new 345-kV line, substation modifications, and new switching stations. Together with the existing 345-kV line between the North Bloomfield, Barbour Hill, Ludlow and Manchester Substations, the new North Bloomfield – Agawam – Ludlow 345-kV line will complete a 345-kV "loop" through north-central Connecticut and western Massachusetts. This new high-capacity loop will relieve congestion on the 115-kV system that currently serves the Springfield area and will support interstate power transfers between the North Bloomfield, Barbour Hill and Ludlow Substations. At the same time, the new line will increase the power-transfer capability between Connecticut and western Massachusetts. The completed high-capacity electrical loop will serve a function analogous to that of a multi-lane circumferential highway constructed around an urban area where previously all highways had terminated at the edges of the city, requiring that traffic traverse congested city streets to gain access to the next section of highway.

- **Regional East–West Power Flows.** Regional power flows across New England were found to be limited due to the potential overloading of existing 345-kV lines that traverse Connecticut, Massachusetts and Rhode Island from east to west, and by potential voltage violations at substations served by those lines.

- **Connecticut Import Limitations.** Power transfers into Connecticut were found to be limited, such that they could 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 and criteria. The Working Group determined that construction of additional 345-kV ties to Rhode Island and Massachusetts would greatly improve the system's ability to serve the load by providing additional paths on which power may flow in the event of a planned or unplanned loss of a system element, such as a transmission line or generating unit, and thus significantly increase power transfer capabilities into Connecticut.

- **Connecticut East-West Transfers.** Load in Connecticut is heavily concentrated in SWCT, whereas Connecticut's generation resources are concentrated in the eastern part of the state. The SNETR studies recognized that completion of a 345-kV loop serving SWCT in 2008 would enable power to move freely through SWCT, and that the construction of the Interstate Reliability Project and the GSRP would enable the import of sufficient power to provide reliable service to the entire state, including SWCT. However, the increased power flows across central Connecticut to serve the growing load were projected to result in overloads on existing transmission lines under contingency conditions. This "bottleneck" between eastern Connecticut and western Connecticut would be eliminated by the addition of another 345-kV connection between these areas. The 345-kV connection provides a less constricted path for power generated in eastern Connecticut and/or imported from generation resources central/eastern Massachusetts and Rhode Island to flow into western Connecticut thus reducing the amount of power that must presently flow through the lower capacity Hartford/Springfield 115-kV transmission system.

The Working Group's analysis and conclusions are summarized in two reports. The first of these reports is entitled *Southern New England Transmission Reliability Report – Needs Analysis* (the *2008 Needs Analysis*). That report was first published in draft form for stakeholder comment on the ISO-NE website in 2006, and was issued in final form in January 2008. The *2008 Needs Analysis* describes the related problems in SNE, which the NEEWS projects have been planned to address. The second report is entitled *New England East-West Solutions (Formerly Southern New England Transmission Reliability) Report 2, Options Analysis* (*Options Analysis*). The *Options Analysis* was issued in its final form in April 2008. It describes five sets of transmission "Options" that the Working Group had determined could provide a solution for the problems identified in the *2008 Needs Analysis*. Copies of each of these reports were provided with CL&P's 2008 Municipal Consultation Filing for the Project, and additional copies are provided in Volume 5.[7]

Each set of Options related to a transmission system component that would address at least one of the identified system deficiencies by itself, and would work together with other components to provide a coordinated resolution of region-wide issues. ISO-NE tasked NU and National Grid, as transmission owners (TOs), to develop a set of compatible preferred Options for each component of the NEEWS Plan by further analyzing the technical advantages and disadvantages of the options identified in the *Options Analysis*, and their comparative cost, constructability, and routing aspects, so that selections could be made on the basis of all pertinent information. That further analysis, as it pertains to the Project, is described in a third report, *"Solution Report for the Interstate Reliability Project"* dated August, 2008, a copy of which is also provided in Volume 5.

[7] The version of each report that is provided has been redacted by ISO-NE, in accordance with federal Homeland Security regulations, to avoid the disclosure of information determined to be Confidential Energy Infrastructure Information (CEII). Unredacted reports will be provided to the Council and to qualified participants in the proceedings on this Application, pursuant to the Council's rules that preserve the confidentiality of CEII.

2.4.2 Re-Evaluation of the NEEWS Projects, 2008-2010

ISO-NE is obliged by Section 4.2(a) of Attachment K to its FERC-approved Open Access Transmission Tariff to update its needs assessments as new resources materialize through the Forward Capacity Auction process. In accordance with this requirement, ISO-NE undertook needs reassessments for all four of the NEEWS components in 2008. The reassessment was undertaken before the start of siting hearings for the RIRP, which was the first component of the four NEEWS projects to proceed to siting. The needs reassessments for the RIRP and the GSRP were completed, presented to the ISO-NE Planning Advisory Committee (PAC)[8], and provided in support of the applications in both the RIRP and the GSRP state siting proceedings. As previously noted, both of these projects have received their siting approvals in 2010 and are now under construction.

The re-evaluations of the Interstate Reliability Project and the Central Connecticut Reliability Project were complex and required more time. The Interstate Reliability Project re-evaluation was not substantially completed until the summer of 2010, and was presented to the PAC in August and November of 2010. The CCRP re-evaluation is underway and has expanded into a more regional review including the greater Hartford area.

Since the original (2008) SNETR *Needs Analysis* was finalized in 2008, there have been significant developments affecting electric system supply and demand that could be expected to affect the need for the Interstate Reliability Project, and therefore required a reevaluation of that need. Approximately 2,000 MW of new generation resources have been built, or committed to be built, through ISO-NE's Forward Capacity Auction process, in Connecticut and other areas west of the New England East-West Interface. (Refer to Figure 2-5).

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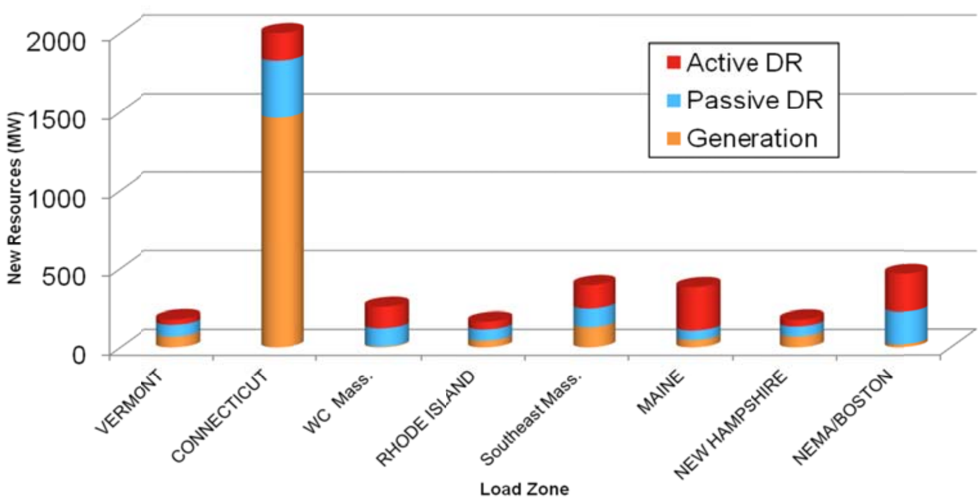
8 The ISO-NE PAC is an advisory committee open to all parties interested in regional system planning activities in New England. ISO-NE is required by its FERC-approved tariff to conduct an open and transparent planning process. Pursuant to this requirement, ISO-NE presents to the PAC the scope of work, 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.

Figure 2-5: Resource Additions by Load Zone Since 2008 Needs Analysis[9]

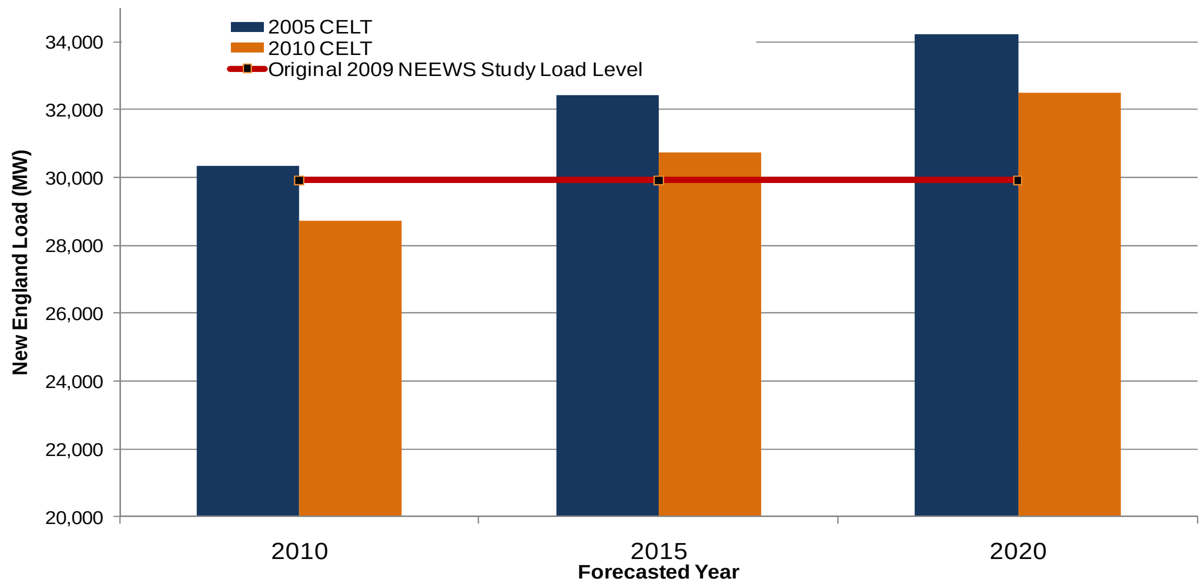


Further, the *2008 Needs Analysis* had been based on 2005 vintage CELT[10] load forecasts and, largely because of the subsequent economic downturn, more recent load forecasts have been lower. However, the original Needs Assessment considered a load projected by ISO-NE's 2005 CELT forecast to occur in 2009, whereas the re-evaluation considered system conditions beginning in 2015 – as a practical matter the first full year in which the Interstate Reliability Project could be in-service in light of its deferral for further study. The 2010 load forecast for 2015 was actually higher than the 2005 vintage forecast for 2009 (30,000 MW) that initially showed the criteria violations identified in the *2008 Needs Analysis*. This relationship is shown in Figure 2-6.

9 DR stands for Demand Response, which is a temporary change in electricity consumption by a demand resource in response to market or reliability conditions. Passive Demand Resources (Passive DR) save energy (MWh) when on during peak hours and are not dispatchable. Active Demand Resources (Active DR) are designed to reduce peak loads (MW) and can reduce load based on real-time system conditions or ISO instructions. Generation is any electric generating or storage facility using any fuel, including nuclear materials, that furnishes electricity (but not including an emergency generating device). Figure 2-5 is extracted from the *2011 Needs Reanalysis.*

10 ISO-NE publishes annually its Forecast Report of Capacity, Energy, Loads, and Transmission, known as the CELT Report.

Figure 2-6: Comparison of Original NEEWS Load Level to 2005 & 2010 CELT Forecasts



2.5 THE 2011 NEEDS RE-ANALYSIS

The detailed assumptions, analyses, and results of ISO-NE's re-study of the need for the Interstate Reliability Project are set forth in a report entitled: *New England East-West Solution (NEEWS): Interstate Reliability Project Component Updated Needs Assessment*, April 2011 (the *2011 Needs Re-analysis*). A copy of that report, redacted to avoid disclosure of CEII, is provided in Volume 5 of this Application. An unredacted copy will be provided to qualified parties and intervenors in the Council proceeding, pursuant to the Council's rules protecting the confidentiality of CEII.

The *2011 Needs Re-analysis* re-confirmed the existence of serious thermal and voltage violations in Connecticut, Massachusetts and Rhode Island starting as early as 2015. It also confirmed specifically a need for increased transfer capability into Connecticut.[11] However, the most striking results of the re-analysis concerned transfer capability across the New England East-West Interface. In addition to

[11] As previously noted, the original need for the Interstate Reliability Project component of NEEWS was based, in large part, on a deficiency in the system's capability to move power from Eastern New England to Western New England and into Connecticut. While Connecticut's need for increased import capability has since been mitigated by the commitment of new local generation resources and load growth lower than expected, the *2011 Needs Re-analysis* concludes that a Connecticut load serving problem would still exist under N-1-1 conditions in 2015.

confirming the previously documented deficiency in the system's capability to move power across that interface from resources in the east to load in the west, it documented a new problem of insufficient transmission capability to move power from newly constructed generation resources in the west to load centers in the east.

2.5.1 Summary of Re-Analysis Testing

ISO-NE performed various power-flow simulations to model system conditions projected to exist in 2015 and 2020. The results of these studies showed that the Project is needed to maintain system reliability.

2.5.1.1 Power-Flow Modeling Assumptions

The assumptions built into the power-flow modeling are set forth in detail in the *2011 Needs Re-analysis*. In summary, all transmission projects with ISO-NE Proposed Plan Application approvals as of the June 2010 Regional System Plan Project listing were included in the base case. These projects included two NEEWS projects - the GSRP and the RIRP. They did not include the CCRP, which is being re-evaluated, or the Interstate Reliability Project, which was the subject of the study.

Both existing generation plants and new projects expected to be in-service during the study years, because they have accepted a Forward Capacity Market (FCM) Capacity Supply Obligation, were included in the study base case. However, the Vermont Yankee nuclear power station was not included because of the significant uncertainty concerning its continued operation after 2012. On the other hand, the 745-MW Salem Harbor Station, located on the north shore area of Massachusetts, was included in the base case, and modeled as out-of-service only in a sensitivity analysis. More recently, the owners of Salem Harbor have confirmed that it will be retired in 2014, and ISO-NE has directed the New England transmission owners not to include Salem Harbor in any reliability studies for any year after 2014. Active Demand Resources that have cleared the FCM were also modeled as capacity resources.

In accordance with ISO-NE planning procedures, the modeled load was based on the 90/10 weather forecast in ISO's 2010 CELT load forecast. These values were 31,810 MW for all of New England in 2015 and 33,555 MW in 2020, allocated among the New England states as shown in Table 2-1 below:

Table 2-1: 2010 90/10 CELT Load

State	2015 Load (MW)	2020 Load (MW)
Maine	2,275	2,400
New Hampshire	2,750	2,957
Vermont	1,138	1,205
Massachusetts	14,160	14,952
Rhode Island	2,098	2,208
Connecticut	8,112	8,486
Total*	**31,810**	**33,555**

*after adjustment for transmission losses

The modeled loads[12] were based on the 2010 CELT forecasted loads, but were adjusted downwards to reflect the effect of passive and active demand response measures. Finally, generator dispatch scenarios in each sub-area under study were constructed. In this set of studies, ISO-NE assumed the two largest generation resources in the study area to be out-of-service as part of the base case.

2.5.1.2 Power-Flow Modeling Results – Thermal Criteria and Voltage Violations

Numerous thermal criteria violations were found in New England for N-1 and N-1-1 contingency events. These violations occurred when the system attempted to deliver power from western New England to serve load in eastern New England, and when it attempted to move power from eastern New England to serve load in western New England. Overloads also occurred within Connecticut and Rhode Island. The detailed results are provided in the *2011 Needs Re-analysis*.

[12] Since the *2011 Needs Re-analysis* was begun, the 2011 CELT report was published. The forecasted 2015 and 2020 loads in this report are higher than those predicted in the 2010 CELT report that were used in the analysis. Accordingly, the need for the Project is likely even more acute than the 2011 analysis recognized.

The power-flow modeling also showed voltage violations following N-1-1 contingency events in Eastern New England, Western New England, and Connecticut.

2.5.1.3 Delta P Testing

Delta P testing analyzes the torsional impact on the shafts of generating machines from contingencies. Higher stresses as a result of transmission line switching events may cause serious damage to generator shafts and machine equipment, which could result in a prolonged outage.[13] Delta P testing of the Lake Road Generator (Killingly, Connecticut) showed both delta P in excess of 0.5 per unit when the Connecticut import level was only 1,700 MW. These violations were exacerbated as the Connecticut import level was increased.

2.5.1.4 Transmission Transfer Capability Analysis

ISO-NE performed a transmission transfer capability analysis of each of the subareas in order to estimate when the transfer capability into each subarea is likely to become inadequate and the extent of such inadequacy. This analysis sums up the total resources available to an area (local generation plus demand response minus generation outages) and then subtracts 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. In order to perform this analysis, it is first necessary to establish an import limit for the subarea under study. This is done by using a computer program to model transfers across an interface, in both all-lines-in and line out conditions, until an element becomes overloaded.

As explained in detail in the *2011 Needs Re-analysis*, the results of the transfer capability analysis showed:

[13] A delta P below 0.5 per unit of machine megavolt ampere (MVA) is considered acceptable.

- Transfer capability from western to eastern New England is already deficient in 2011 by 446 to 546 MW and this deficiency would grow to between 1,762 to 1,862 MW in 2020 without transmission improvements. With generation retirements (including Salem Harbor Station retirements) the need for additional eastern New England import capability would be even greater. A New Brunswick import of 1,000 MW could defer the need for additional west-to-east transfer capability, but only to between 2015 and 2016.

- 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 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 generation resources in Connecticut retire.

2.5.2 Discussion of Transmission Deficiencies

New England has adequate quantities of generation and load-reducing resources to meet its electric needs under normal system conditions, and this situation can be expected to continue into the indefinite future, even with some retirements of existing generation. However, in many circumstances, the available generation would not be deliverable to all resource-deficient load centers. In particular, ISO-NE's analyses have shown that, in the modeled system conditions, there is surplus generation on one side of the New England East-West Interface that cannot be delivered to the other side of the Interface when it is needed following certain contingency events. Such undeliverable generation is said to be "locked-in."

ISO-NE presently disqualifies proposed new generators from participating in the FCM if they are to be interconnected to the electric grid in a location that would constrain delivery of their output. However, much of the existing New England fleet of generation was not sited to assure regional deliverability. Even when central station generation is optimally sited, transmission is needed to integrate it with load, and to balance generation and demand resources with customer load demand. This is particularly true because, under ISO-NE's FCM rules, it will procure only such new capacity as it determines to be necessary to meet New England-wide capacity needs. The transmission system will therefore need to be capable of delivering generation to all New England loads in order to avoid load-serving problems.

Many of the problems documented by the ISO-NE analysis relate to the constrained transmission path along the Card Street – Lake Road – Sherman Road – West Medway corridor (CT-RI-MA), which crosses the New England East-West Interface, providing the only direct 345-kV tie between Connecticut and Rhode Island[14], and one of two 345-kV ties between Rhode Island and Massachusetts. This corridor extends from CL&P's Card Street Substation in Lebanon to the Lake Road Switching Station and Killingly Substation (both in Killingly), across the Connecticut/Rhode Island border to National Grid's Sherman Road Switching Station in Burrillville, Rhode Island, and from there to NSTAR's West Medway Substation in southeast Massachusetts.

Figure 2-2 (refer to page 2-12) illustrates the location of the Card Street – Lake Road – Sherman Road to West Medway corridor within the SNE 345-kV transmission system. Several modern and efficient gas-fired generators, most constructed since electric restructuring, are located along this corridor. These generators are listed in Table 2-2.

Table 2-2: Generation Resources Located along Card Street Substation to West Medway Substation Corridor

Generating Station	Aggregate Summer Capacity (MW)	Location	Year Placed in Service
Lake Road	745	Killingly, CT	2002
ANP Blackstone	444	Blackstone, MA	2001
NEA Bellingham	278	Bellingham, MA	1991
Ocean State	541	Burillville, RI	1990-1991
ANP Bellingham	473	Bellingham, MA	2002
Total	2481		

The generating stations listed in Table 2-2 may not all be dispatched at the same time because of a potential for overloading one or more of the lines making up the New England East-West Interface in the

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

event of a contingency. For the same reason, ISO-NE has refused requests from generators to site an additional 430 MW of capacity along this corridor.

Transmission lines that cross an interface typically terminate at load-serving substations on each side of the interface and do not also interconnect multiple large generating stations in between those terminals. The Card Street – Lake Road – Sherman Road - West Medway 345-kV transmission line corridor is unusual in that it performs these dual purposes. It serves as a "super highway" transporting power from Connecticut resources to serve load in southeast Massachusetts (including the Boston area) and also transports power from southeast Massachusetts resources to Connecticut load centers. In addition, this "super highway" has several large "on ramps" between Card Street and West Medway Substations – the four large, highly efficient base load generating stations that connect to the 345-kV transmission network at various locations along the transmission corridor.

As a result, the New England East-West Interface must shift according to whether power is flowing on this transmission corridor into Connecticut or into southeastern Massachusetts. The aggregate flows on the New England East-West Interface must be maintained at levels where overloads will not result following the contingent loss of any of its elements.

System operators therefore must measure, in real time, the remaining capacity of each line that will be available in the event of a contingency. In order to maintain the margin necessary to accommodate the largest potential contingency, system operators must consider the generators along the Lake Road to West Medway corridor as being on the side of the interface from which power is being exported.

Thus, if power is flowing toward eastern Massachusetts, the flow will be measured just west of the West Medway Substation. On the other hand, if power is flowing into Connecticut, the power flow will be measured just west of the Lake Road Switching Station.

The power flow on the Lake Road – Sherman Road – West Medway 345-kV transmission line corridor is thus treated as part of the "transfer" across the Interface, and power flows on the remaining elements of the Interface are maintained at levels such that overloads will not result in the event the Lake Road – Sherman Road – West Medway transmission lines or any of the other elements that make up the Interface are suddenly lost. This practice has the effect of including greater Rhode Island resources with those on the west side of the New England East-West Interface when power flows toward eastern Massachusetts or greater Boston, and with those on the east side of the Interface when power flows toward Connecticut.

The concentration of resources along the Lake Road – Sherman Road – West Medway corridor also results in shifts of the Connecticut – Rhode Island and Rhode Island – Massachusetts interfaces. When the Lake Road plant was placed in-service in 2002, Connecticut was typically a net importer of power. Because imports into Connecticut are monitored just west of the Lake Road Switching Station, the Lake Road Generating Station is treated as electrically in Rhode Island. However, when Connecticut is exporting power to or through Rhode Island, the Lake Road Generating Station capacity is treated as being within Connecticut, so as to avoid overloading the Connecticut - Rhode Island interface. Similarly, when power is being exported to southeastern Massachusetts, the flow on the line between Sherman Road (in Rhode Island) and West Medway (in Massachusetts) is monitored just west of the West Medway Substation to avoid overloading this element of the New England East-West Interface the reliability of the entire Interface.

The shifting New England East-West Interface is illustrated in Figure 2-7 and Figure 2-8.

Figure 2-7: East – West Interface and Greater Rhode Island Corridor Limit Flows From the West and Greater Rhode Island to the East

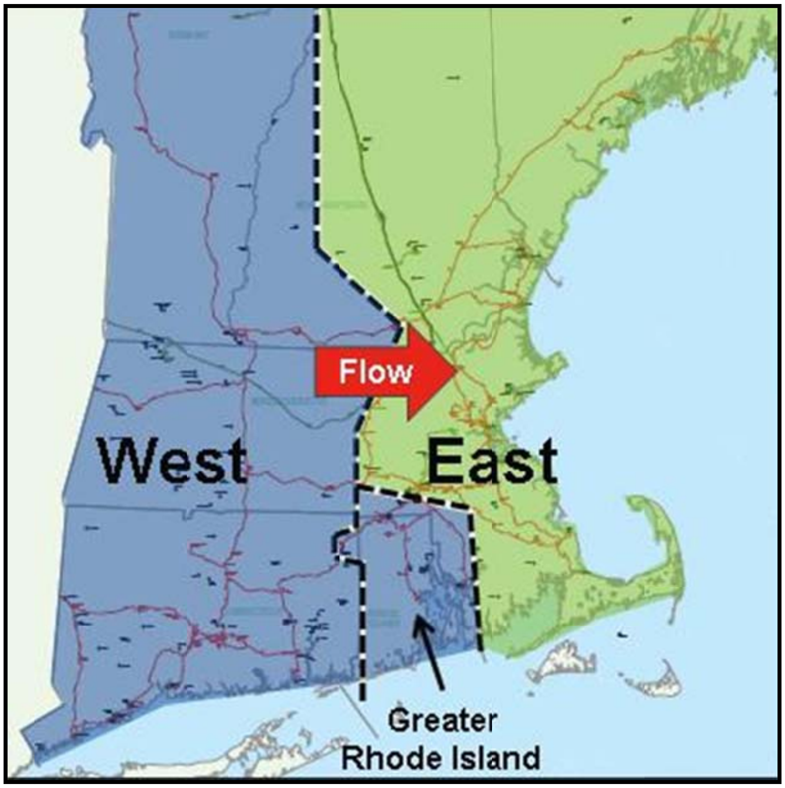
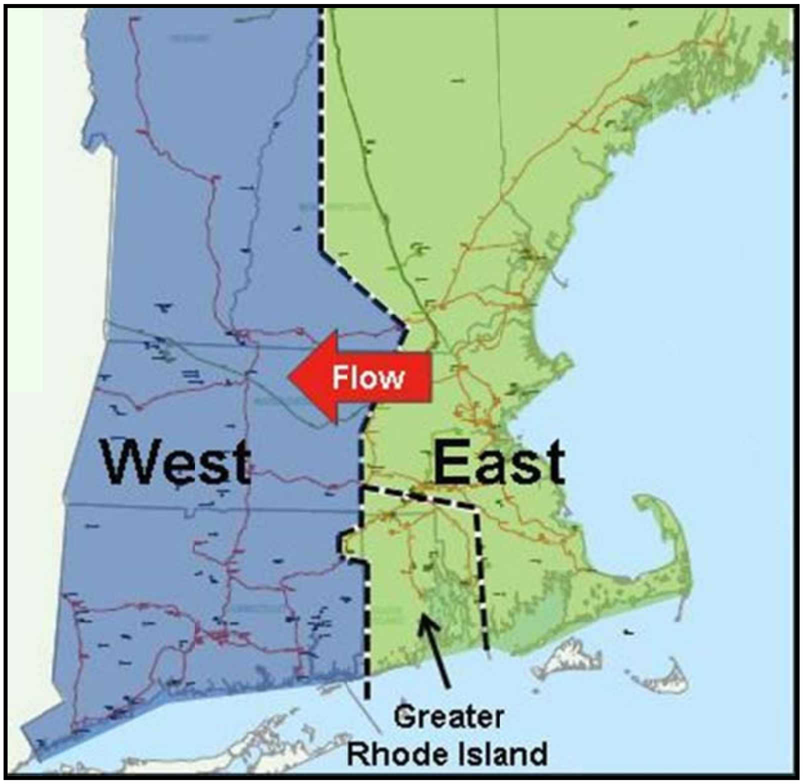


Figure 2-8: East – West Interface Limits Flows to the West From the East and Greater Rhode Island



The studies undertaken for the *2011 Needs Re-analysis* simulated these complex power flows and performance of the projected future New England bulk power network under contingency conditions, in accordance with NERC, NPCC and ISO-NE planning standards, criteria and procedures. The results or this modeling are summarized in Section 2.5.1 and are set forth in detail in the *2011 Needs Re-analysis*.

The *2011 Needs Re-analysis* demonstrated that, although the Interstate Reliability Project, as originally designed, would resolve most of the modeled criteria violations, it would not resolve the constraints of moving power from the west to the east across the New England East–West Interface. These constraints became apparent when the extensive new generation constructed or committed for construction on the west side of the interface was modeled in the course of the re-analysis.

2.6 THE UPDATED SOLUTION STUDY

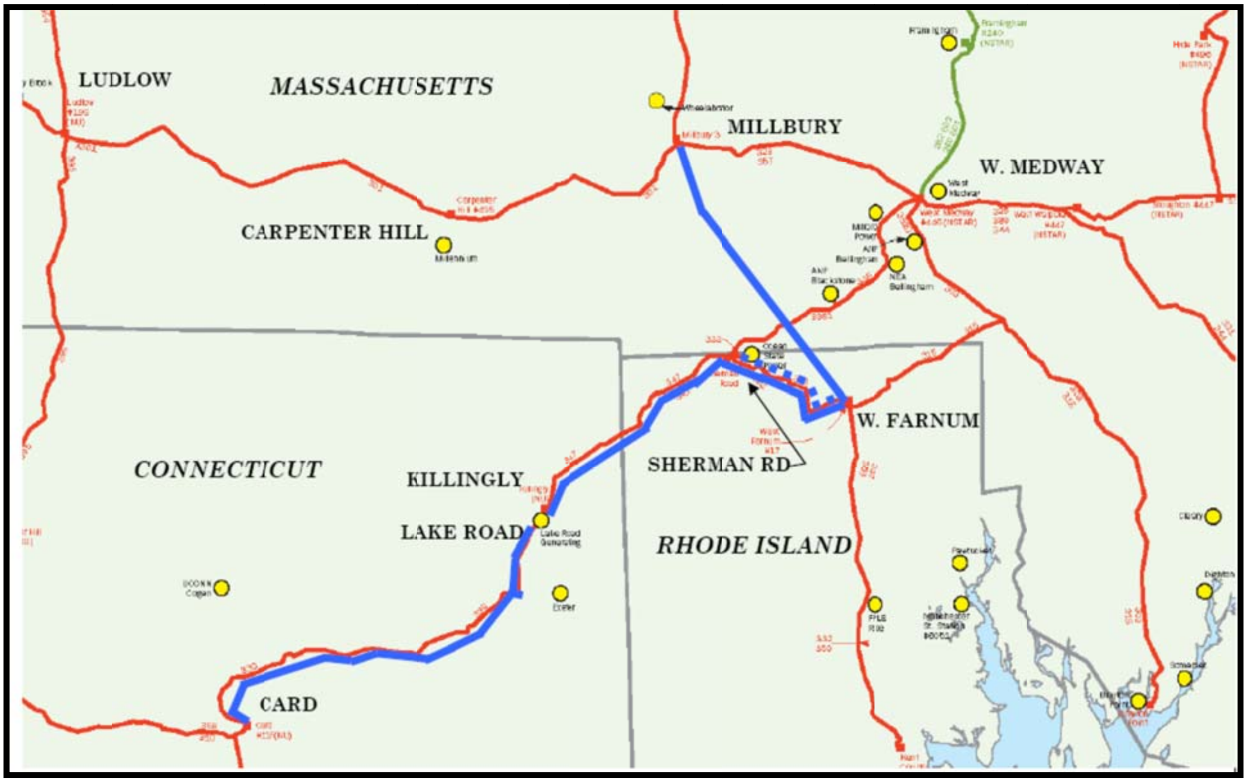
After determining that the need for the Project had evolved to include new reliability problems of insufficient capability to use resources in the west to serve load in the east, ISO-NE undertook a further study to determine if any changes to the Project were necessary to serve this enhanced need; and to identify the optimal and most cost effective design for any such required changes. ISO-NE assigned responsibility for these studies to the previously formed Working Group of planners from ISO-NE, NUSCO, and National Grid. For the purpose of this study, the group was expanded to include representatives of NSTAR.

The expanded Working Group determined that changes and additions to the Project facilities in Rhode Island were required. No additions to the Connecticut portion of the Project were needed. In fact, a planned looping of the 345-kV Millstone to Manchester 310 Line to Card Street Substation over a 1-mile-long ROW segment in the Town of Lebanon, Connecticut and an associated expansion of the footprint of Card Street Substation were removed from the Interstate Reliability Project scope.[15]

The redesigned Interstate Reliability Project differs from the original Project mainly in that the Sherman Road Switching Station will be rebuilt and a reconductoring of the Rhode Island portion of the Killingly to Sherman Road 347 Line is replaced by a rebuild of the Sherman Road to West Farnum 328 Line. The revise proposed Project is illustrated in Figure 2-9.

[15] This potential improvement is now being evaluated as part of the Greater Hartford / Central Connecticut study, and could be proposed again as an outcome of that study.

Figure 2-9: Proposed Interstate Reliability Project as Identified by Results of Updated Solution Study



Existing 345-kV Lines
New 345-kV line Millbury-West Farnum-Lake Road-Card Street
Reconductor and rebuild 345-kV line from Sherman Road to West Farnum

Note: For readability, Figure 2-9 shows the proposed new lines slightly offset from existing lines. The new 345-kV lines would actually be aligned along and within existing CL&P and National Grid ROWs.

This supplemental analysis is described in Volume 1A, Section 13 of this Application. The results of the analysis were presented to the PAC on November 30, 2010, and are set forth in detail in an ISO-NE report entitled New England East-West Solution (NEEWS): *Interstate Reliability Project Component Updated Transmission Analysis Solution Study Report*, a redacted copy of which is provided as part of Volume 5 of this Application.

2.7 CONNECTICUT-SPECIFIC BENEFITS OF THE INTERSTATE RELIABILITY PROJECT

While the principal purpose of the Interstate Reliability Project is to better integrate the electric supply systems of the three Southern New England states for the benefit of the entire New England control area, it will also yield significant benefits specifically to Connecticut electric customers.

2.7.1 Improving Connecticut's Import Capability: Reliability Benefits

Of all the New England states, Connecticut is the least able to import power to supplement its internal supply resources. New Hampshire, Vermont, and Rhode Island have enough import capability to serve 100% of their peak load under N-1 contingency events. Massachusetts and Maine can import slightly less than 50% of their peak load. Connecticut, however, will only be able to import approximately 33% of its peak load even following the improvement in its import capability from completion of the GSRP.

Transfer capability limits are properly expressed as a range, because they will vary depending on system conditions such as load level, generation dispatch, system topology, and other regional transfer levels. The existing upper limit of the Connecticut Import interface transfer capability is approximately 2,500 MW. Following the completion of the GSRP, the upper limit of the Connecticut Import interface transfer capability is expected to increase by at least 100 MW, to 2,600 MW. The more significant impact of GSRP on the Connecticut Import Interface will be to significantly increase the lower end of the range, which is presently set at 300 MW, and to make transfers in the upper portion of the range more regularly available. CL&P expects that the Interstate Reliability Project will increase the upper limit of the Connecticut Import interface transfer capability by at least an additional 800 MW, to approximately 3,400 MW. The new transfer capability levels will be determined by ISO-NE with detailed and comprehensive studies.

As previously described, power-flow simulation studies show that Connecticut will require power imports to maintain reliability for N-1-1 contingencies in accordance with mandatory reliability standards and criteria. Moreover, this increased import capability will provide desirable flexibility to maintain reliability in light of potential changes in system conditions that could occur in short notice.

2.7.2 Environmental Benefits

In its 2010 review of the *Integrated Resource Plan*, submitted by the Connecticut Energy Advisory Board, the Department of Public Utility Control (DPUC)[16] observed that, because of potential changes in federal and state clean air regulations, it is plausible that 1,504 MW of Connecticut oil-fired steam capacity will retire, unless it can be exempted from the new regulations. Other capacity may remain, but will need to be upgraded. While industry participants expect most of these retirements to occur between 2013 and 2020 due to the anticipated timing of changes in the environmental regulations, the DPUC determined that the amount and timing of these retirements are uncertain. What is clear is that the implementation of the Interstate Reliability Project by 2015 will provide a capacity margin that will allow older, high emission plants that have become uneconomic to retire; it will also allow, if economic to do so, some of those retired generating units to be re-powered with cleaner burning fuels.

Similarly, recent government policy initiatives require access to low-emission and/or renewable energy sources. These include the Renewable Portfolio Standards (RPS) adopted by all of the New England states except Vermont. The Connecticut RPS require that, starting in 2007, escalating annual percentages of retail load must be served by each of three classes of renewable generation including, for instance, wind and solar energy. In its review of the 2010 *Integrated Resource Plan*, the DPUC concluded that "there is considerable uncertainly" as to whether Connecticut can meet renewable resource adequacy requirements after 2013.[17] If state policy continues to require that significant in-state energy needs be met with renewable resources, they will have to be imported from outside the state, likely from northern New England and Canada. While the Interstate Reliability Project will not by itself provide Connecticut with

16 As the result of 2011 legislation, the DPUC is now the Public Utilities Regulatory Authority (PURA)
17 Docket No.10-02-07 DPUC Review of the 2010 Integrated Resource Plan, Sept. 15, 2010, p. 66.

direct access to such sources, it will serve as an essential link to the new regional transmission network necessary to do so.

2.7.3 Increasing Connecticut's Generation Resources

In addition to increasing Connecticut's Import Interface capability, the Project will increase the state's defined local generation. For import-constrained areas such as Connecticut, ISO-NE sets a Local Sourcing Requirement (LSR). The LSR is the minimum amount of generating capacity that must be electrically located within an import-constrained load zone to meet system-wide resource adequacy requirements.

The Lake Road Generating Station is physically located in Killingly, Connecticut, but because of the limitations of the existing transmission system, it presently cannot be counted toward the Connecticut local sourcing requirement. Construction of the Interstate Reliability Project, which will provide a second 345-kV path in and out of the Lake Road Switching Station, is expected to make the Lake Road Generating Station's three units eligible for consideration as local Connecticut resources.

2.8 CONCLUSION

The Interstate Reliability Project has been under study by regional planners for more than six years, during which time the evolving analyses have taken into account multiple changes in system conditions. The Project is needed to fully integrate generation with load throughout SNE by eliminating transmission constraints on the transfer of power from east to west and from west to east.

At the same time, the Project will resolve multiple remaining reliability issues within SNE and provide needed N-1-1 import capability to Connecticut. It will ensure that the approximately 2,000 MW of generation along the Card Street – Lake Road – Sherman Road – West Medway corridor, most of which is relatively new and efficient, can be called upon to reliably serve load in both western and eastern New England, as needed, over the long-term planning horizon. The bulk-power transmission system will be capable of carrying sufficient power to meet peak customer demands in the event one of the 345-kV transmission lines across the New England East-West Interface is lost suddenly, or other design contingencies occur.

The future in which the Project must be operated continues to hold many uncertainties. Significant generation retirements are highly probable, but their extent and timing is uncertain. Some generators that are not retired may be taken out of service for lengthy periods in order to be repowered to allow the use of more efficient and/or cleaner fuels. Power imports beyond those required for reliability are likely to be needed in order to meet renewable portfolio standards. The need to move greater amounts of power across the New England East-West Interface may continue to be predominantly from east to west, or it may change to be more from west to east. In either case, there will be system conditions requiring significant transfers in the opposite direction. All of these reliability concerns will be addressed by the Interstate Reliability Project. Accordingly, while recognizing these uncertainties, the DPUC included the Interstate Reliability Project in its 2010 Integrated Resource Plan[18]. Pursuant to Section 16a-13b(a) of the Connecticut General Statutes, CL&P is required to pursue siting approval for transmission upgrades specified in the plan.

[18] Docket No.10-02-07 DPUC Review of the 2010 *Integrated Resource Plan*, Sept. 15, 2010, p. 18.

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SECTION 3

TECHNICAL PROJECT SPECIFICATIONS

3. TECHNICAL PROJECT SPECIFICATIONS

This section describes the technical specifications for the Project, including:

(1) The proposed new 345-kV overhead transmission lines along the Proposed Route between Card Street Substation, Lake Road Switching Station, and the Connecticut / Rhode Island border.

(2) The related improvements to CL&P's existing transmission lines, substations, and switching station, which are required to support the new 345-kV transmission lines.

The technical information provided for the Project includes:

- Conductor size and specifications
- Overhead structure design, appearance, and height
- Route length, by municipality, and terminal points
- Initial and design voltages and capacities
- ROWs and access roads, including estimated areas of new easement acquisition
- Proposed structure location envelopes[1]
- Substation and switching station connections and proposed modifications
- Estimated capital (construction) and life-cycle costs

[1] "Structure location envelope" refers to a 100-foot distance along the line's centerline, on either side of the proposed location of a new transmission line structure. As the Project design is finalized, proposed new structure locations may change slightly. However, final structure locations typically would be within 100 feet of the proposed locations shown (i.e., within the "structure location envelope"). Refer to Section 3.1.4 for further discussion. Note that the "structure location envelope" does not represent a proposed construction area.

3.1 PROPOSED TRANSMISSION LINE FACILITIES: CARD STREET SUBSTATION TO LAKE ROAD SWITCHING STATION TO CONNECTICUT / RHODE ISLAND BORDER

The proposed 345-kV transmission lines are summarized in Table 3-1 and described in the following subsections. The new transmission lines would extend, in overhead configurations, for approximately 36.8 miles, adjacent to an existing CL&P 345-kV transmission line (i.e., the 330, 3348, or 347 Line) and in some locations, adjacent to existing overhead 69-kV and 115-kV transmission lines as well as distribution lines.

Table 3-1: Existing Transmission Lines Sharing ROWs with the Proposed 345-kV Transmission Lines

CL&P Line Number	Line Description	Line Voltage
330	Card Street Substation to Lake Road Switching Station	345 kV
3348	Lake Road Switching Station to Killingly Substation	345 kV
347	Killingly Substation to Connecticut / Rhode Island Border	345 kV
800 / 900	Card Street Substation to Babcock Hill Junction	69 kV
1505 and 1607	Day Street Junction to Killingly Substation	115 kV

The proposed 345-kV transmission lines would be aligned adjacent to the 330 Line from Card Street Substation east-northeast to the Lake Road Switching Station, and then would follow the 3348 Line north-northeast from Lake Road Switching Station to Killingly Substation and the 347 Line north-northeast from Killingly Substation to the Connecticut / Rhode Island border and the interconnection with National Grid's portion of the 347 Line. Between Card Street Substation and Lake Road Switching Station, the new 345-kV line would be designated as the 3271 Line. Between Lake Road Switching Station and the Connecticut / Rhode Island border and on to the West Farnum Substation, the new 345-kV line would be designated as the 341 Line.

Approximately 96% (35.4 miles) of the Proposed Route for the new transmission lines would be located entirely within existing CL&P ROWs that range in width from approximately 250 to 400 feet. Of the 35.4 miles of the Proposed Route in CL&P's existing ROWs, approximately 5 miles would extend across property that CL&P owns.

3.1.1 345-kV Conductor Size and Specifications

The new overhead 345-kV transmission lines would consist of three sets of conductors. Each set is comprised of a bundle of two 1,590,000 circular mil (1,590-kcmil) aluminum conductors with a steel core support (ACSS). This conductor is CL&P's standard for new 345-kV line construction.

The new lines would be protected by overhead lightning shield wires. The 3271 Line between Card Street Substation and Lake Road Switching Station would be protected by two shield wires that would also contain optical glass fibers for communication purposes (also referred to as Optical Ground Wire or "OPGW"). Between Lake Road Switching Station and the Connecticut / Rhode Island border, the new 341 Line would be shielded from lightning strikes by one 19 No. 10 Alumoweld shield wire and one OPGW.

3.1.2 Proposed Lines Overhead Design, Appearance, and Heights

All existing CL&P ROWs along which the new 345-kV lines would be located are occupied by an existing 345-kV transmission line (i.e., the 330, 3348, or the 347 Line), as summarized in Table 3-1. The existing 345-kV lines are supported mostly on wood-pole H-frame structures with a typical height of 80 feet, with some shorter wood-pole H-frame structures and some taller steel monopole structures in limited areas. H-frame tangent structures, which are the predominant type of structure along the existing 345-kV lines, have two poles. However, within the H-frame "family" of structures, three-pole structures are used at angles (turns in the ROW).

New transmission line structure placement along the ROW would typically be adjacent to existing line structure locations. In general, proposed tangent structures for the new 345-kV lines would be steel or [laminated] wood H-frames, with a typical height of 85 feet. Cross-sections drawings (XSs) depicting the proposed structure types and general location in relation to the existing structures on each ROW segment are included in Appendix 3A, located at the end of this section.[2]

Three-pole structures, which would be used for the proposed lines at ROW angles, would be either guyed or self-supported steel structures with a typical height of 85 feet. Structures are typically guyed in areas that are not residential yards, cultivated farmland, or wetlands. Additionally, structures located closer than usual to existing lines are not guyed when clearances from guy wires to existing lines would be insufficient. (The Volume 11 maps illustrate potential guy locations.)

In certain areas along the route, taller steel poles with a delta conductor configuration are proposed. One of these areas is in the Town of Mansfield, on the 0.9-mile segment of the Proposed Route across federally owned properties (i.e., Mansfield Hollow State Park, WMA, and Mansfield Hollow Lake). In this area, the proposed delta steel-pole design would match the structure type of the existing 345-kV transmission line and would require 55 feet of ROW expansion (refer to XS-3 in Appendix 3A or Volumes 9 and 10).

In addition, CL&P evaluated electric and magnetic field best management practice ("EMF BMP") line-design alternatives for potential use in several focus areas along the Proposed Route (refer to Section 7, Appendix 7B, for details). As a result, in three locations, CL&P proposes to use taller steel poles with a delta conductor configuration, instead of an H-Frame line design (refer to XS-2 BMP in the towns of Coventry and Mansfield, to XS-6 BMP in the Town of Brooklyn, and to XS-12 BMP in the Town of

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2 These cross-sections are also included with the maps in Volume 9 and are presented in oversize format in Volume 10.

Putnam; refer to Appendix 3A and Appendix 7B in this volume and to Volumes 9 and 10 for illustrations of these cross-sections).

Appendix 3B (located at the end of this section) provides illustrations of the family of structure types that CL&P uses in H-frame lines and in steel-pole lines with delta or vertical conductor configurations.

Modifications to Existing Facilities: 69-kV Line Structure

As explained in Section 3.1, the proposed 345-kV transmission lines would be constructed adjacent to existing transmission lines in CL&P's ROWs. The new 345-kV lines would be located such that sufficient space exists between the proposed and existing lines for safe and reliable line operations.

There is one location (near the crossing of State Route 66 and the Hop River in the Town of Columbia) where a modification must be made to CL&P's existing 69-kV double-circuit 800/900 Line in order to achieve clearance standards (refer to mapsheet 3 of 40 in Volume 9 and to XS-1). In this area, the proposed 345-kV line would be constructed between the existing 69-kV line and the existing 345-kV line. One span of the 69-kV line, between existing structure Nos. 6538 and 6539, is almost 900 feet long. Under some high wind conditions, there would be insufficient clearance from the new 345-kV conductors to the 69-kV line. In order to achieve the necessary clearances, CL&P proposes to install one new steel-pole (double-circuit) structure in the existing 69-kV line (800/900 Line). A preliminary pole location (Structure 6538A, located south of the Hop River in the Town of Columbia) is illustrated on mapsheet 3 in Volume 9, on mapsheet 9 in Volume 11, and on the Volume 10 sheet titled "Interstate Reliability Project, Card Street S/S – Babcock Hill Junction, Plan & Profile Sheet 3 of 3, Line 3271."

The addition of this structure in the 800/900 Line resolves clearance violations that would otherwise be created by the addition of the new 345-kV line adjacent to the 800/900 Line. The additional structure would prevent the nearest 69-kV conductor from swinging into the proposed 345-kV line under high wind conditions. Temporary line sections and short-term outages of each 69-kV circuit will be required to safely install the additional 69-kV line structure.

Modifications to Existing Facilities: Guy Wires

Based on preliminary design data, CL&P estimates that existing guy wires on approximately 34 transmission line structures would need to be relocated to facilitate construction of the proposed 345-kV transmission lines. These guyed structures are on CL&P's existing 345-kV lines (330 and 3348 Lines) and are currently in locations that would cause conflicts with construction activities or with proposed structure locations. The relocation of these existing guy wires would not require the relocation of any existing structures.

The exact locations of the relocated guy wires on the existing structures would not be defined until detailed design is complete. However, all guy locations would remain within the limits of the existing ROWs.

Structures Near Airports

Two airports are located in northeast Connecticut in the vicinity of the Project: Windham Airport in the City of Willimantic and Danielson Airport in the Town of Killingly. At the nearest points, the Proposed Route would be approximately 3,700 feet northwest of Windham Airport, and approximately 2,800 feet west of Danielson Airport.

Given the proximity of the ROW to both of these airports and/or their runway approach flight paths, CL&P consulted with and filed proposed preliminary and existing structure height and location information with the Federal Aviation Administration (FAA). The information provided to the FAA concerning the proposed 345-kV transmission lines was based on preliminary structure design data. The FAA studied this information and in 2009 issued a Determination of No Hazard to Air Navigation for the majority of structures (proposed and existing). However, five existing and seven proposed structures near

Windham Airport and seven existing and 10 proposed structures near Danielson Airport were issued a Notice of Presumed Hazard (NPH) based on this data. A NPH determination means that the structures could potentially interfere with flight safety in the area and would require some mitigating measure to improve safety. The FAA's preliminary determinations for issuing the NPHs were based on the proximity of the existing and proposed line structures to aircraft flight paths and runways associated with the two airports, taking into consideration topography and structure height.

Near Windham Airport, the FAA issued NPHs for structures located east of Mansfield City Road and west of Storrs Road (State Route 195) in the Town of Mansfield. These structures, all located northwest of the airport, are existing structure Nos. 9066 to 9070 and proposed structure Nos. 59, 60, and 67 to 71 (refer to Volume 9, mapsheets 7 and 8). The structures receiving the NPH near the Danielson Airport are located along the ROW segment extending from just west of Church Street to the east and then northeast to a point south of Killingly Road (State Route 101) in the towns of Brooklyn and Pomfret. These are existing structure Nos. 9214, 9215, and 9224 through 9228 and proposed structure Nos. 215, 217, and 222 through 229 (refer to Volume 9, mapsheets 24, 25, and 26).

Although NPHs were issued for both the existing and proposed line structures in the vicinity of the Windham and Danielson airports, CL&P's intent is to mitigate the potential hazards associated with existing line structures through modifications to adjacent structures in the new line. This could be accomplished by making height adjustments and/or by other mitigation methods, such as installing warning lights or markers on the proposed structures or markers on the proposed shield wires.

The specific mitigation options that would be applied to comply with the FAA requirements for the NPH-designated structures along the ROW segments near Windham Airport and Danielson Airport have yet to be determined. As Project design progresses, CL&P will continue to coordinate with the FAA and the Windham and Danielson airport managers. Finalization of any mitigation on transmission line structures would not be complete until the Project's final design (based on the Council's decision) has been submitted to and reviewed by the FAA.

3.1.3 Design Voltage and Capacity

The bundled 1,590-kcmil ACSS conductors would provide approximately 2,408 MVA of summer normal line capacity and a summer long-term emergency (LTE) capacity of 3,149 MVA at 345 kV. This conductor design choice would minimize conductor corona, as compared to corona levels on the existing adjacent 345-kV line, thereby limiting the new line's audible noise and radio-frequency noise production in wet weather to lower levels. For 345-kV transmission lines, using two conductors per phase with larger diameters reduces electric fields, and therefore corona, on conductor surfaces.

3.1.4 Proposed Structure Locations

Along the overhead line route, the preliminary location of each of the proposed transmission line structures was determined using transmission line design software (Power Line System's "PLS-CADD"™). The proposed structure locations are shown on the Plan and Profile Drawings (Volume 10), as well as on the Volume 9 and Volume 11 maps.

As a starting point in the Project design process, all proposed new 345-kV line structures were initially aligned adjacent to existing 345-kV line structures. This design approach was based on the assumptions that alignment of the new structures adjacent to the existing structures would maximize the use of existing on-ROW access roads (which are already situated to reach existing structures), minimize changes to the visual environment, and mimic existing span lengths to minimize potential clearance violations under certain high-wind conditions.

Following this preliminary structure siting, each proposed structure site was further evaluated to account for other factors, such as potential environmental effects. Based on these additional analyses, CL&P determined that 57 of the new 345-kV structure locations, as determined by the initial structure siting (i.e., placement adjacent to existing structures) would be in wetlands. As constructability evaluations and transmission line design progressed, structure locations were shifted, where practical, to reduce potential effects on environmental resources (e.g., wetlands, streams) and to improve line constructability. As a result of this process, 33 of the 57 structures initially sited in wetlands were shifted to uplands. The remaining 24 proposed structure locations in wetland areas could not practicably be adjusted to avoid the wetlands.[3]

Structure locations may further change as the Project design process continues. Future changes could occur based on information obtained from more detailed field studies (e.g., subsurface investigations, final engineering and environmental surveys, constructability reviews), input from municipalities and regulatory agencies, and the conditions of the Council's approval. After this additional information has been analyzed, final detailed line engineering would be performed to determine the exact locations of the new structures.

Typically, the final structure locations are expected to be within 100 feet (longitudinally) of the proposed structure locations along the structure centerline. Such structure location envelopes are shown at each proposed structure site, as depicted on the Volume 11 maps.

3.1.5 ROW and Access Road Requirements

ROW Requirements and Easement Acquisition

CL&P proposes to construct and operate the new 345-kV transmission lines along its existing ROWs, the vast majority of which have sufficient width to accommodate the new transmission facilities without the need for any additional easement acquisition. The typical ROW widths along different segments of the existing transmission line ROWs are summarized in Table 3-2 (located at the end of Section 3.1) and

[3] In addition, along a 0.6-mile segment in the Town of Putnam where six existing structures will be removed and replaced per XS-12 BMP, two structures will be in wetlands. These two structures also are presently in wetlands.

shown on the cross-section drawings (refer to Appendix 3A at the end of this section and to the Volume 9 and Volume 10 maps).

As part of the Project design process, CL&P reviewed the existing easement rights and restrictions for its existing ROWs along the entire Proposed Route. In general, CL&P has sufficient rights within existing easement agreements to construct the Project. Additional or updated easement rights are required on fewer than 10 properties. The only locations where new easements for additional ROW width would be required to accommodate the Project, as proposed, are within the federally-owned properties in the Mansfield Hollow area (towns of Mansfield and Chaplin) where, for two segments totaling 1.4 linear miles, the existing ROW is only 150 feet wide.

To develop a new 345-kV line adjacent to the existing 345-kV transmission line through the two segments of federally-owned lands, CL&P is requesting additional easements from the USACE, amounting to an expansion of the existing ROW by 55 feet for the 0.9-mile segment through the Mansfield Hollow State Park and Mansfield Hollow WMA (including a span over Mansfield Hollow Lake) in the Town of Mansfield, and by 85 feet for the 0.5-mile segment through the Mansfield Hollow WMA in the Town of Chaplin (including a span over the Natchaug River). This proposed easement expansion is illustrated on XS-3 and XS-5 in Appendix 3A, on the Volume 9 maps, and in Volume 10.

Based on CL&P's proposed ROW expansions in the Mansfield Hollow area, approximately 11 additional acres of new easement area would be acquired. With the acquisition of this additional ROW, the width of the transmission line easement would be 205 feet across the federally-owned lands in the Town of Mansfield and 235 feet across the federally-owned lands in the Town of Chaplin.

<u>Access Road Requirements</u>

To construct, operate, and maintain the new overhead 345-kV transmission lines along the Proposed Route, contiguous access along the ROW is not required. However, access would be required to each transmission structure location. Additional temporary access along the ROW may be required to facilitate vegetation removal during construction. Refer to Section 4.1.4.2 for further information regarding temporary access for vegetation removal.

For most of the Proposed Route, access roads are already established along the CL&P ROWs, where existing transmission lines have been operated and maintained for approximately 40 years. However, to provide access to the new transmission lines, additional temporary and permanent access roads must be established, and most of the existing access roads would require improvements to allow the safe passage of the heavy construction equipment needed to install the new 345-kV lines.

The locations and type of new access roads and access road improvements would depend on the terrain, presence / absence of environmental features, and whether the access road would be temporary (used only during construction) or permanent (retained for long-term maintenance of the lines). Access roads must have appropriate grades and sufficient width and capacity to support the large, heavy construction equipment (such as flat-bed tractor-trailers, drilling rigs, cranes, and concrete trucks) required to construct the new 345-kV lines. The need for access by flat-bed trailers and concrete trucks typically determines the scope of access road improvements.

Access roads along the Project ROWs, whether restored, improved, or newly constructed, would be approximately 15 to 20 feet wide, with a minimum travel width of approximately 12 to 16 feet. Access roads may be graveled or may consist of temporary construction mats or equivalent. In general, gravel would most commonly be used in constructing access roads in upland areas. Across wetlands where only temporary (construction) access is required, timber mats would typically be used. These mats would be removed upon the completion of construction. Where permanent access is unavoidably required across wetlands, road construction would be more extensive and would involve the use of gravel. To maintain drainage patterns across the ROW, access road construction would typically incorporate bridges, flumes, or culverts as needed. Refer to Section 4.2.1 for additional information regarding water resource crossings, including permanent access roads in wetlands.

New access roads would have to be constructed to reach certain proposed structure locations where sufficient access does not currently exist. However, permanent access roads would typically not be developed through long expanses of wetlands with deep standing water or unstable soils, or in locations where consecutive line structures are separated by long distances. In such areas, off-ROW access roads that provide ingress and egress to work sites on the ROW may be required to facilitate construction or to avoid crossings of sensitive environmental resources, such as rivers or large wetland complexes.

As part of the Project planning, CL&P completed a review of the existing public roads leading to or intersecting with the transmission line ROWs. Based on that review, an inventory of public roads that could provide access to the ROWs was prepared. Table 4-3 in Section 4 identifies the public roads, or sites, that potentially could be used for access to the transmission line ROWs. The Volume 9 and Volume 11 maps illustrate locations of these roads with respect to the Proposed Route.

CL&P would conduct a detailed evaluation of the access requirements for the Project as part of final design. Access road information would be included in the Project-specific *Development and Management (D&M) Plan*, which would be required as a condition of the Council's approval.

3.1.6 Facilities on ROW Post-Construction (Proposed Line Design)

The configurations of the proposed 345-kV lines are illustrated on the typical cross-sections presented in Appendix 3A, as well as on the maps located in Volumes 9 and10. Table 3-2 (located at the end of Section 3.1) summarizes the information presented in the cross-sections, identifying both the existing and proposed transmission line configurations.

Cross-sections are provided for each of the 15 different segments of the ROWs, beginning at Card Street Substation and proceeding to the Connecticut / Rhode Island border. For each ROW segment, the cross-sections depict the configurations of both the existing (typical) transmission lines and the new 345-kV transmission line that CL&P proposes.

The cross-sections with the suffix "BMP" represent three of the five EMF Best Management Practice focus areas. Along these three ROW segments (i.e., XS-2 BMP in the towns of Coventry and Mansfield, XS-6 BMP in the Town of Brooklyn, and XS-12 BMP in the Town of Putnam), CL&P's proposed overhead transmission line configuration is not H-frame, but rather an EMF BMP line-design preference, as presented in Section 7, Appendix 7B. The EMF BMPs, including the criteria and process for selecting these areas, are explained in Section 7 of this Application.[4]

The following subsections summarize the typical proposed transmission line configurations, by ROW segment. These descriptions correspond to the cross-sections included in Appendix 3A, in Volume 10, and also with the maps in Volume 9.

3.1.6.1 Card Street Substation to Babcock Hill Junction – XS-1

XS-1 illustrates the typical configuration of the proposed 345-kV line from Card Street Substation to Babcock Hill Junction (paralleling existing 330 Line structures 9001 to 9027) in the towns of Lebanon, Columbia, and Coventry. This cross-section illustrates the typical configuration along this 2.8-mile segment of ROW, as viewed to the northwest. As the cross-section shows, along this segment of ROW, the new transmission line (the 3271 Line) would be aligned between the 330 Line and the 800/900 Line and would be installed on H-frame structures.

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[4] As explained in Section 7, five potential EMF BMP focus areas, designated A through E, were identified. EMF BMP design alternatives for three of these (focus areas A, D, and E), as represented by XS-2 BMP, XS-6 BMP, and XS-12 BMP, were incorporated into CL&P's proposed Project design.

3.1.6.2 EMF BMP – Focus Area A (Babcock Hill Junction to vicinity of Highland Road) – XS-2 BMP

XS-2 BMP illustrates the typical proposed transmission line configuration within the western portion of ROW Segment 2. XS-2 BMP encompasses the portion of ROW from Babcock Hill Junction to east of Highland Road (paralleling existing 330 Line structures 9028 to 9048) in the towns of Coventry and Mansfield. This cross-section depicts a view along the ROW to the northeast and is representative of the proposed transmission line configuration, using a delta steel-monopole design, for a distance of 2.3 miles.

3.1.6.3 Vicinity of Highland Road (Mansfield) to Mansfield Hollow State Park – XS-2

XS-2 illustrates the typical proposed transmission line configuration along the 3.3-mile segment of ROW extending from east of Highland Road to Mansfield Hollow State Park (paralleling existing 330 Line structures 9049 to 9080) in the Town of Mansfield. This cross-section illustrates the proposed use of an H-frame configuration for the new 345-kV line, presenting a typical view along the ROW in a northeast direction.

3.1.6.4 Mansfield Hollow State Park to Bassetts Bridge Road – XS-3

XS-3 illustrates the typical proposed transmission line configuration along this 1-mile ROW segment in the Town of Mansfield, including 0.9 mile through federally-owned properties (consisting of Mansfield Hollow State Park, Mansfield Hollow Lake (span), and the Mansfield Hollow WMA), where CL&P's ROW is only 150 feet wide. Along this segment, the proposed 345-kV line would be aligned adjacent to existing 330 Line structures 9081 to 9086 in the Town of Mansfield.

This cross-section provides a view of the ROW to the east and depicts CL&P's proposed use of a delta steel-pole configuration, to match the existing monopole design along this portion of the ROW. As illustrated on XS-3, the existing 150-foot-wide ROW through the 0.9 miles of federally-owned property is not wide enough to accommodate the installation of the proposed 345-kV line, adjacent to the existing 330 Line while adhering to required transmission line separation distances. CL&P therefore proposes to expand the ROW to the east or north by 55 feet and is presently consulting with the USACE to acquire such additional easement rights.

Along the remaining 0.1 mile of this segment (near existing line structure 9081), CL&P's existing ROW is 300 feet wide and extends across privately-owned property. XS-3 does not depict this 0.1-mile segment.

3.1.6.5 Bassetts Bridge Road to Shuba Lane – XS-4

XS-4 illustrates the typical proposed transmission line configuration from Bassetts Bridge Road to Shuba Lane (paralleling existing 330 Line structures 9087 to 9094) in the towns of Mansfield and Chaplin. This cross-section depicts a 0.8-mile segment of the ROW (as viewed toward the east), extending across CL&P-owned land and private easements. In this area, the existing ROW is approximately 300 feet wide. An H-frame configuration is proposed for the new 345-kV line.

3.1.6.6 Vicinity of Shuba Lane though Mansfield Hollow WMA to Vicinity Willimantic Road – XS-5

XS-5 illustrates the typical proposed transmission line configuration through the federally-owned Mansfield Hollow WMA in the Town of Chaplin, including the span crossing of the Natchaug River (paralleling existing 330 Line structures 9095 to 9099). Along this 0.5-mile segment of federally-owned property, the existing ROW is 150 feet wide. Given the location of the existing 330 Line in the center of the easement, the ROW is not wide enough to accommodate the proposed H-frame line addition. Therefore, CL&P proposes to expand the ROW to the north by 85 feet and is presently negotiating with the USACE to acquire such additional easement rights. XS-5 depicts a typical view, looking east, of the 0.5-mile ROW segment, and illustrates the proposed H-frame structures in relation to the existing 330 Line.

3.1.6.7 Willimantic Road (U.S. Route 6) to Vicinity of Day Street Junction – XS-6

XS-6 illustrates the typical transmission line configuration proposed along the 12.6-mile ROW segment extending from Willimantic Road in the Town of Chaplin to near White Brook, west of Church Street, in the Town of Brooklyn (paralleling existing 330 Line structures 9100 to 9209). In addition to the towns of Chaplin and Brooklyn, this ROW segment also extends through the Town of Hampton. This cross-section depicts the ROW segment, as viewed in a northeasterly direction, and illustrates the proposed H-frame line.

3.1.6.8 EMF BMP – Focus Area D (Vicinity of Day Street Junction) – XS-6 BMP

XS-6 BMP illustrates the typical transmission line configuration, as viewed to the east, proposed for the 1-mile ROW segment from west of Church Street to Day Street Junction (paralleling existing 330 Line structures 9210 to 9219) in the Town of Brooklyn. Along this segment of the ROW, CL&P proposes to use a delta steel-pole configuration.

3.1.6.9 Day Street Junction to Hartford Turnpike – XS-7

XS-7 illustrates the typical transmission line configuration proposed from Day Street Junction to Hartford Turnpike (paralleling existing 330 Line structures 9220 to 9240) in the towns of Brooklyn, Pomfret, and Killingly. This cross-section depicts the ROW, as viewed looking north, for a distance of 2.3 miles. As this cross-section illustrates, along this ROW segment, the new 345-kV line (the 3271 Line) would be installed on H-frame structures and would be aligned west of and parallel to the 330 Line and the 1607 and 1505 Lines.

3.1.6.10 Hartford Turnpike to Lake Road Junction – XS-8

XS-8 illustrates the typical transmission line configuration proposed from Hartford Turnpike to Lake Road Junction (paralleling existing 330 Line structures 9241 to 9262) in the towns of Killingly and Putnam. This cross-section illustrates this 2.6-mile segment of ROW, as viewed to the northeast. Along this ROW segment, the new 345-kV line (the 3271 Line) would be installed on H-frame structures and would be aligned west of and parallel to the 330 Line, and east of the 1607 and 1505 Lines.

3.1.6.11 Lake Road Junction to Lake Road Switching Station – XS-9

XS-9 illustrates the typical transmission line configuration proposed along the 0.2-mile ROW segment from Lake Road Junction to Lake Road Switching Station (paralleling existing structures 9263 to 9264 and extending into Lake Road Switching Station) in the Town of Killingly. This cross-section, which illustrates the transmission line configuration along the ROW segment as viewed looking to the south, depicts the proposed locations of the 341 Line and 3271 Line between the existing 330 Line and 3348 Line. Both new 345-kV lines would be installed with vertical conductor configurations on steel monopoles along this ROW segment.

3.1.6.12 Lake Road Junction to Killingly Substation – XS-10

XS-10 illustrates the typical proposed transmission line configuration (341 Line) from Lake Road Junction to Killingly Substation (paralleling existing 3348 Line structures 9265 to 9267) in the Town of Killingly. This cross-section illustrates the ROW configuration, as viewed to the northeast, for a distance of 0.7 mile. Along this segment of ROW, the proposed 345-kV line on H-frame structures would be aligned between the existing 345-kV line and two existing 115-kV lines.

3.1.6.13 Killingly Substation to Heritage Road – XS-11

XS-11 illustrates the typical proposed transmission line configuration from Killingly Substation to Heritage Road (paralleling existing 347 Line structures 9268 to 9285) in the towns of Killingly and Putnam. This cross-section illustrates the proposed transmission line configuration (H-frame structures) along this 1.7-mile segment of ROW, as viewed in a northeasterly direction.

3.1.6.14 Heritage Road to Connecticut / Rhode Island State Border (Excluding Elvira Heights) – XS-12

XS-12 illustrates the typical transmission line configuration proposed along the 4.5-mile segment of ROW from Heritage Road in the Town of Putnam, through the Town of Thompson, to the Rhode Island border (paralleling existing 347 Line structures 9286 to 9304 and 9311 to 9333; refer to XS-12 BMP for the proposed configuration between structures 9305 to 9310). This cross-section illustrates the ROW as viewed in a northeasterly direction and depicts the proposed use of H-frame.

3.1.6.15 EMF BMP – Focus Area E (Elvira Heights) – XS-12 BMP

XS-12 BMP illustrates the typical transmission line configuration proposed along the 0.6-mile segment of ROW from existing 347 Line structures 9305 through 9310 in the vicinity of U.S. Route 44 and Elvira Heights Court in the Town of Putnam. This cross-section illustrates the ROW as viewed in a northeasterly direction and depicts the proposed BMP use of a delta steel-monopole configuration for the new and existing lines. (Note: As XS-12 BMP shows, along this ROW segment, six existing H-frame structures along the 347 Line would be removed and replaced with delta steel monopole structures.)

Table 3-2: Summary of Existing and Proposed 345-kV Transmission Line Configurations

Transmission Line By Cross-Section (Municipality)	Approx. ROW Mileage	Existing Line Configurations and Typical ROW Width		Proposed 345-kV Transmission Line Reference Case Configurations and Typical ROW Width	
		Typical Structure Type and Height (above ground)	ROW Width (feet)	Typical Structure Type and Height (above ground)	Typical ROW Width (feet)
XS-1 (Lebanon, Columbia & Coventry)	2.8	One 345-kV circuit supported on wood- or steel-pole H-frame structures; heights vary, ranging from 66 to 119 feet, with a typical height of 80 feet. Two 69-kV circuits, both on self-supported steel monopoles; heights vary, ranging from 72 to 115 feet, with a typical height of 95 feet.	350	Install, between the existing 345-kV and 69-kV circuits, one 345-kV circuit on steel- or wood-pole H-frame structures; heights vary, ranging from 70 to 135 feet, with a typical height of 85 feet.	350 (No additional ROW required)
XS-2 BMP (Coventry & Mansfield)	2.3	One 345-kV circuit supported on wood H-frame structures; heights vary, ranging from 59 to 90 feet, with a typical height of 80 feet.	300	Install one 345-kV circuit on self-supported steel monopole structures; heights vary, ranging from 85 to 120 feet, with a typical height of 110 feet	300 (No additional ROW required)
XS-2 (Coventry & Mansfield)	3.3	One 345-kV circuit supported on wood-pole H-frame structures; heights vary, ranging from 59 to 90 feet, with a typical height of 80 feet.	300	Install one 345-kV circuit on steel- or wood-pole H-frame structures; heights vary, ranging from 65 to 120 feet, with a typical height of 85 feet.	300 (No additional ROW required)
XS-3 (Mansfield Hollow State Park, Lake & WMA, Mansfield)	1.0	One 345-kV circuit supported on tubular steel monopole structures; heights vary, ranging from 106 to 137 feet, with a typical height of 115 feet.	150 (0.9 mile) 300 (0.1 mile)	Install one 345-kV circuit on self-supported steel monopoles (delta steel pole design); heights vary, from 115 to 145 feet, with a typical height of 125 feet.	205 (55 feet of additional ROW required to the north)
XS-4 (Mansfield & Chaplin)	0.8	One 345-kV circuit supported on wood-pole H-frame structures; heights vary, ranging from 68 to 103 feet, with a typical height of 80 feet.	300	Install one 345-kV circuit on steel- or wood-pole H-frame structures; heights vary, ranging from 65 to 140 feet, with a typical height of 85 feet.	300 (No additional ROW required)
XS-5 (Mansfield Hollow WMA, Chaplin)	0.5	One 345-kV circuit supported on wood-pole H-frame structures; heights vary, ranging from 73 to 81 feet, with a typical height of 80 feet.	150	Install one 345-kV circuit on steel- or wood-pole H-frame structures; heights vary, ranging from 70 to 85 feet, with a typical height of 85 feet.	235 (85 feet of additional ROW required to the north)
XS-6 (Chaplin, Hampton, & Brooklyn)	12.6	One 345-kV circuit supported on wood-pole H-frame structures; heights vary, ranging from 64 to 102 feet, with a typical height of 80 feet.	300	Install one 345-kV circuit on steel- or wood-pole H-frame structures; heights vary, ranging from 70 to 125 feet, with a typical height of 85 feet.	300 (No additional ROW required)
XS-6-BMP (Brooklyn)	1.0	One 345-kV circuit supported on wood-pole H-frame structures; heights vary, ranging from 65 to 86 feet, with a typical height of 80 feet.	300	Install one 345-kV circuit on steel-self supported monopole structures; heights vary, ranging from 85 to 120 feet, with a typical height of 110 feet	300 (No additional ROW required)
XS-7 (Brooklyn, Pomfret & Killingly)	2.3	One 345-kV circuit supported on wood-pole H-frame structures; heights vary, ranging from 66 to 95 feet, with a typical height of 80 feet. Two 115-kV circuits supported on wood-pole H-frame structures, heights vary, ranging from 51 to 86 feet, with a typical height of 65 feet.	360	Install one 345-kV circuit on steel- or wood-pole H-frame structures; heights vary, ranging from 65 to 105 feet, with a typical height of 85 feet.	360 (No additional ROW required)
XS-8 (Killingly & Putnam)	2.6	One 345-kV circuit supported on wood-pole H-frame structures; heights vary, ranging from 74 to 89 feet, with a typical height of 80 feet. Two 115-kV circuits supported on wood-pole H-frame structures, heights vary, ranging from 51 to 86 feet, with a typical height of 65 feet.	360	Install one 345-kV circuit on steel- or wood-pole H-frame structures; heights vary, ranging from 60 to 140 feet, with a typical height of 85 feet.	360 (No additional ROW required)
XS-9 (Killingly)	0.2	Two 345-kV circuits supported on self-supported steel monopoles; heights vary, ranging from 109 to 150 feet, with a typical height of 125 feet.	250	Install two 345-kV circuits on self-supported steel monopoles; heights vary, ranging from 120 to 135 feet, with a typical height of 130 feet.	250 (No additional ROW required)
XS-10 (Killingly)	0.7	One 345-kV circuit supported on wood-pole H-frame structures; heights vary, ranging from 74 to 105 feet, with a typical height of 80 feet. Two 115-kV circuits supported on wood-pole H-frame structures, heights vary, ranging from 51 to 86 feet, with a typical height of 65 feet.	400	Install between the existing 345-kV and 115-kV circuits one 345-kV circuit on steel- or wood-pole H-frame structures; heights vary, ranging from 85 to 115 feet, with a typical height of 85 feet.	400 (No additional ROW required)
XS-11 (Killingly & Putnam)	1.7	One 345-kV circuit supported on wood-pole H-frame structures; heights vary, ranging from 72 to 95 feet, with a typical height of 80 feet. Two distribution circuits supported on single wood-pole structures, with a typical height of 35 feet.	340	Install between the existing 345-kV and distribution circuits one 345-kV circuit on steel- or wood-pole H-frame structures; heights vary, ranging from 75 to 105 feet, with a typical height of 85 feet.	340 (No additional ROW required)
XS-12 (Putnam & Thompson)	4.5	One 345-kV circuit supported on wood-pole H-frame structures; heights vary, ranging from 63 to 93 feet, with a typical height of 80 feet.	300	Install one 345-kV circuit on steel- or wood-pole H-frame structures; heights vary, ranging from 65 to 105 feet, with a typical height of 85 feet.	300 (No additional ROW required)
XS-12 BMP (Putnam)	0.6	One 345-kV circuit supported on wood-pole H-frame structures; heights vary, ranging from 70 to 80 feet, with a typical height of 80 feet (to be removed).	300	Remove existing H-frame structures 9305 to 9310. Install two 345-kV circuits on self-supported steel monopole structures; heights vary, ranging from 70 to 90 feet, with a typical height of 85 feet.	300 (No additional ROW required)

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3.2 SUBSTATION CONNECTIONS AND MODIFICATIONS

In order to interconnect the new 345-kV transmission lines with the existing transmission system, modifications would be required at two existing CL&P substations and one switching station. None of these modifications would require the acquisition of any additional property from private landowners, or expansion of existing developed (fenced) areas. Preliminary design drawings of the proposed station modifications are included in Volume 7. The technical specifications regarding these modifications are detailed for each station, as follows. Detailed designs would be included as part of the D&M Plan.

3.2.1 Card Street Substation

The Card Street Substation is located in the northeastern corner of the Town of Lebanon and occupies approximately 10 acres of a 150-acre parcel of CL&P-owned land. The modifications required to interconnect the Card Street Substation to the new 345-kV transmission line (the 3271 Line) would be accomplished within the developed (fenced) portion of the property. No expansion or modification to the existing fence line would be required. A preliminary plan and section views for the substation modifications are illustrated in Volume 7, Exhibit 1; these preliminary plans will be updated as the substation design process proceeds.

The new facilities proposed at the Card Street Substation include the following:

- Expand the existing three-position 345-kV ring bus to a four-position ring bus with one new 345-kV transmission line-terminal position (for the new 3271 Line), for a total of four 345-kV transmission line terminal positions.

- Install three new 345-kV circuit breakers, one new 345-kV transmission line terminal structure approximately 110 feet in height, and four lightning masts approximately 110 feet in height.

- Install four disconnect switches, 435 linear feet of bus, 500 feet of control-cable trench, six CCVTs, and one wave trap.

- Install new protection and control equipment within the exiting relay/control enclosure.

3.2.2 Lake Road Switching Station

Lake Road Switching Station is located in the northwestern portion of the Town of Killingly and interconnects the 330 and 3348 Lines at the Lake Road Generating Station. The switching station, which is adjacent to the Lake Road Generating Station, is located on an easement.

The proposed Project modifications at Lake Road Switching Station are illustrated in Volume 7, Exhibit 2. The modifications include the addition of two new transmission line positions to support the two new 345-kV lines from Lake Road to Card Street (3271 Line) and Lake Road to West Farnum (341 Line) by completing the existing partial switchyard bay and building a new partial bay. The existing 330 Line to Card Street Substation would be relocated to the new partial bay. The new Card Street line would be installed in the former 330 Line position with new relays.

The facilities proposed at the Lake Road Switching Station would be developed within the existing fenced portion of the site. No expansion or modification to the existing fence line would be required. The new facilities include the installation of:

- Three 345-kV circuit breakers, six 345-kV disconnect switches, 170 feet of bus, six surge arresters, 10 CCVTs, four PTs, and two wave traps.
- Install new protection and control equipment within the existing relay/control enclosure

3.2.3 Killingly Substation

Killingly Substation is located in the northern portion of the Town of Killingly, northeast of the Lake Road Switching Station, and interconnects the 3348 and 347 Lines with an autotransformer that supplies a 115-kV switchyard, and from there, four 115-kV circuits. The substation is situated on CL&P-owned land.

The new 345-kV transmission line (i.e., the 341 Line) from Lake Road Switching Station to the Rhode Island border would traverse through Killingly Substation, but would not electrically connect to it. For the Project, CL&P proposes to install two new 345-kV transmission line terminal structures at the substation. These structures would be approximately 110 feet high, and would be similar in appearance to the two existing line termination structures. The new 345-kV line conductors would span over the substation, between these two new line terminal structures. Volume 7 includes drawings (refer to Exhibit 3) and plans of the proposed substation modifications.

The new facilities at Killingly Substation are planned for location within the existing fenced substation area. No expansion or modification to the existing fence line would be required.

3.3 ESTIMATED PROJECT COSTS

3.3.1 Estimated Capital Cost of all Interstate Reliability Project Facilities

The estimated capital cost for the three-state Interstate Reliability Project (including CL&P and National Grid facilities) is $511 million, with the transmission line construction accounting for $407 million and substation and switching station modifications accounting for $104 million.[5] The $511 million total is split as follows:

- CL&P: $218 million
- National Grid: $293 million

[5] The Interstate Reliability Project cost estimates reflect conformance with the FERC's May 27, 2011 Order authorizing recovery of 100% of transmission construction work in progress (CWIP) costs for the NEEWS projects, including the Interstate Reliability Project. Under this FERC Order, on June 1, 2011, CL&P, Western Massachusetts Electric Company, and the New England Power Company ceased their accrual of Allowances for Funds Used During Construction (AFUDC) associated with expenditures on the NEEWS projects. Accordingly, project cost estimates no longer include AFUDC beyond June 1, 2011.

3.3.2 Estimated Capital Cost of the Connecticut Portion of the Project

The estimated capital cost for the Connecticut portion of the Interstate Reliability Project is $218 million. This consists of $193 million for new transmission line construction and $25 million for substation and switching station modifications.[6]

3.3.3 Life-Cycle Cost

In accordance with the Council's *Life-Cycle Cost Studies for Overhead and Underground Transmission Lines* (2007), CL&P performed a present-value analysis of capital and operating costs over a 35-year economic life of the Project. The following items were considered:

- Annual carrying charges of the capital cost
- Annual operation and maintenance costs
- Cost of energy losses
- Cost of capacity

Applying these factors, the life-cycle cost for the Connecticut portion of the Interstate Reliability Project is $319 million.

6 The transmission line construction cost estimate includes $4.2 million for magnetic field mitigation, or 1.97% of the total Connecticut Project cost without such mitigation. In Section 7, CL&P identifies magnetic field mitigation designs at three locations (i.e., "focus areas") that each appear individually to meet the eligibility criteria of the Council's EMF Best Management Practices. The total additional cost for all three locations is $8.5 million, or 4% of the total Connecticut Project cost without mitigation. Therefore, the total Connecticut Project cost estimate of $217.8 million would increase by $4.3 million ($8.5 million minus $4.2 million) if all three of CL&P's mitigation proposals were adopted by the Council without change.

Appendix 3A – Cross-Sections

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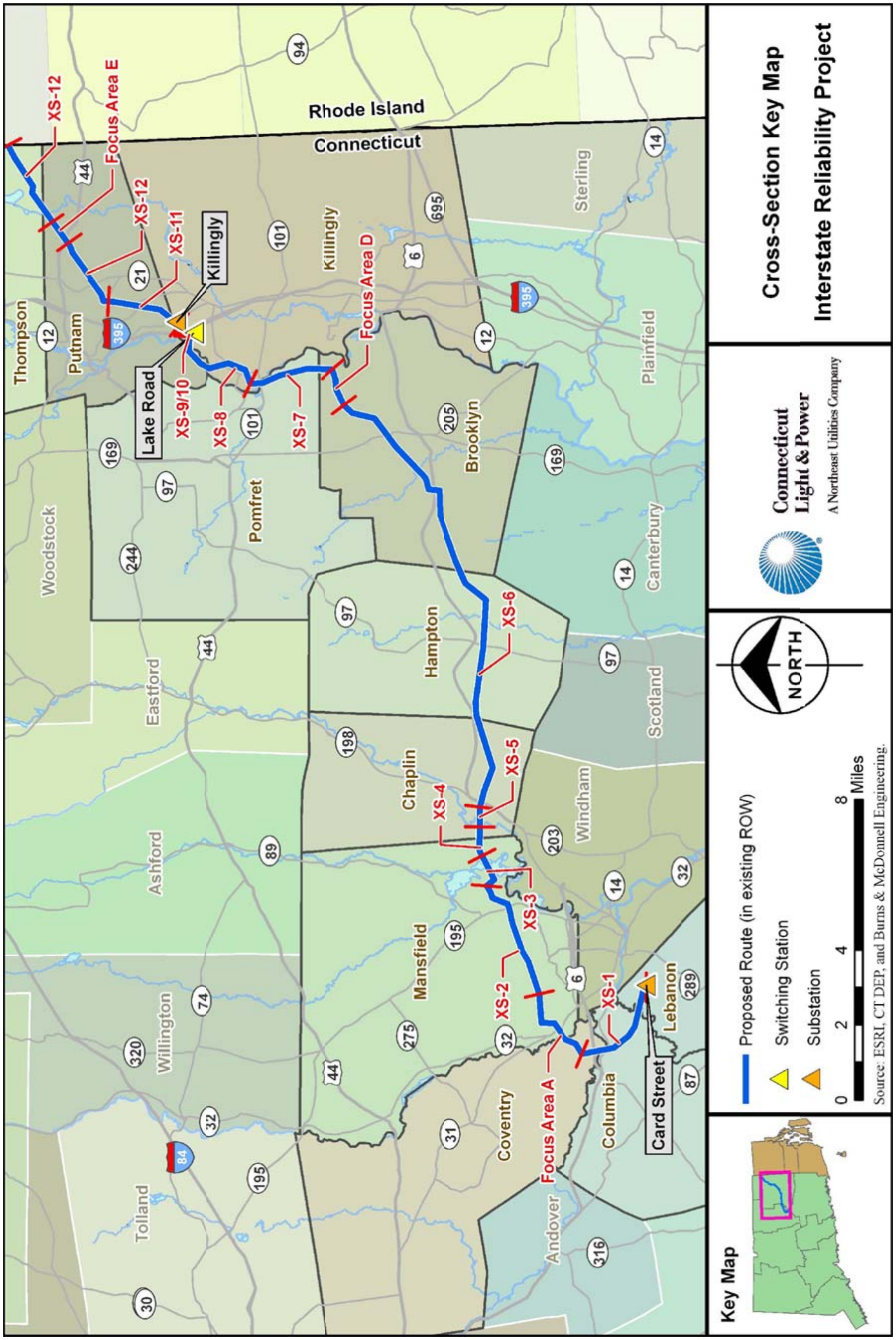
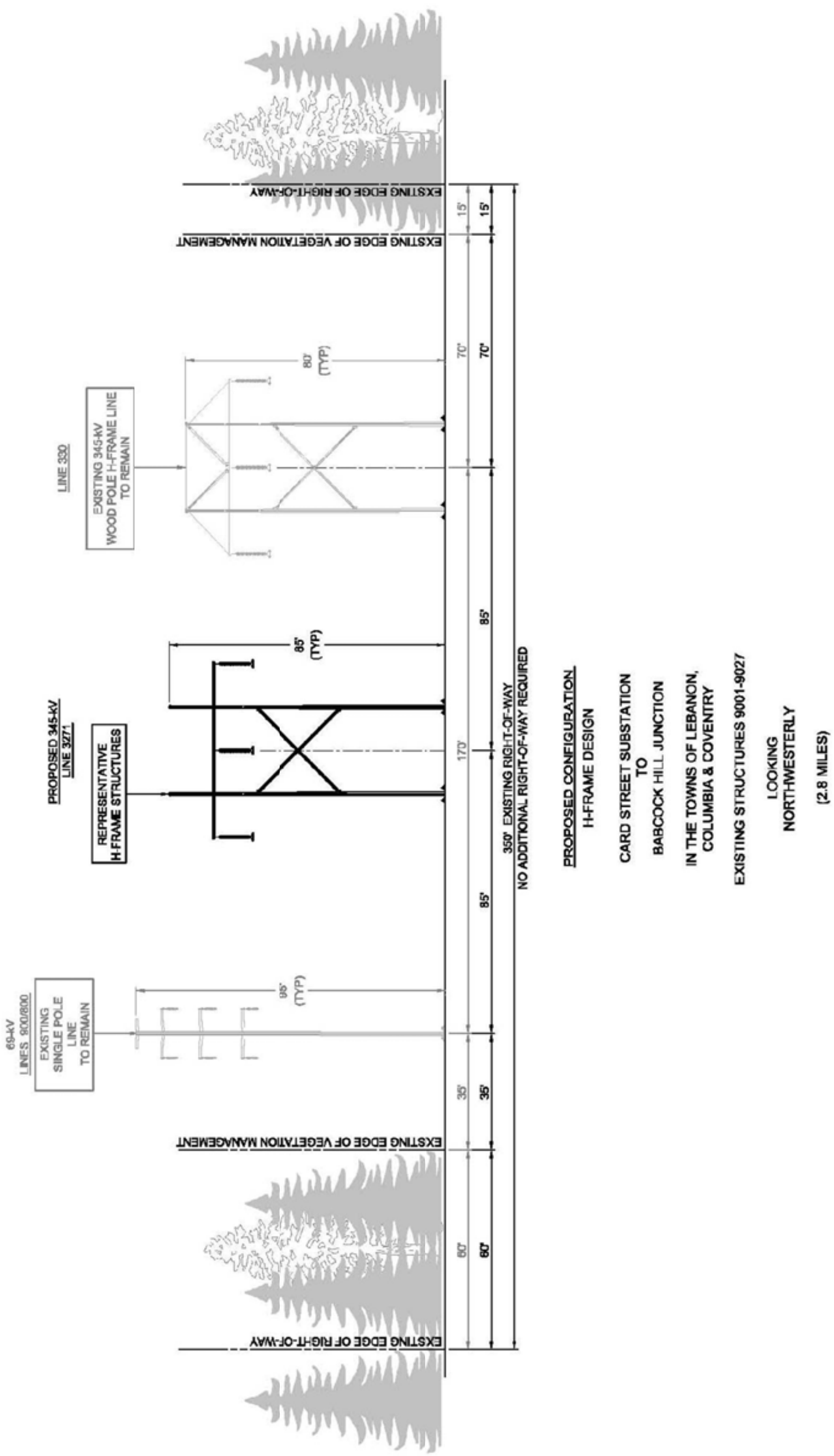
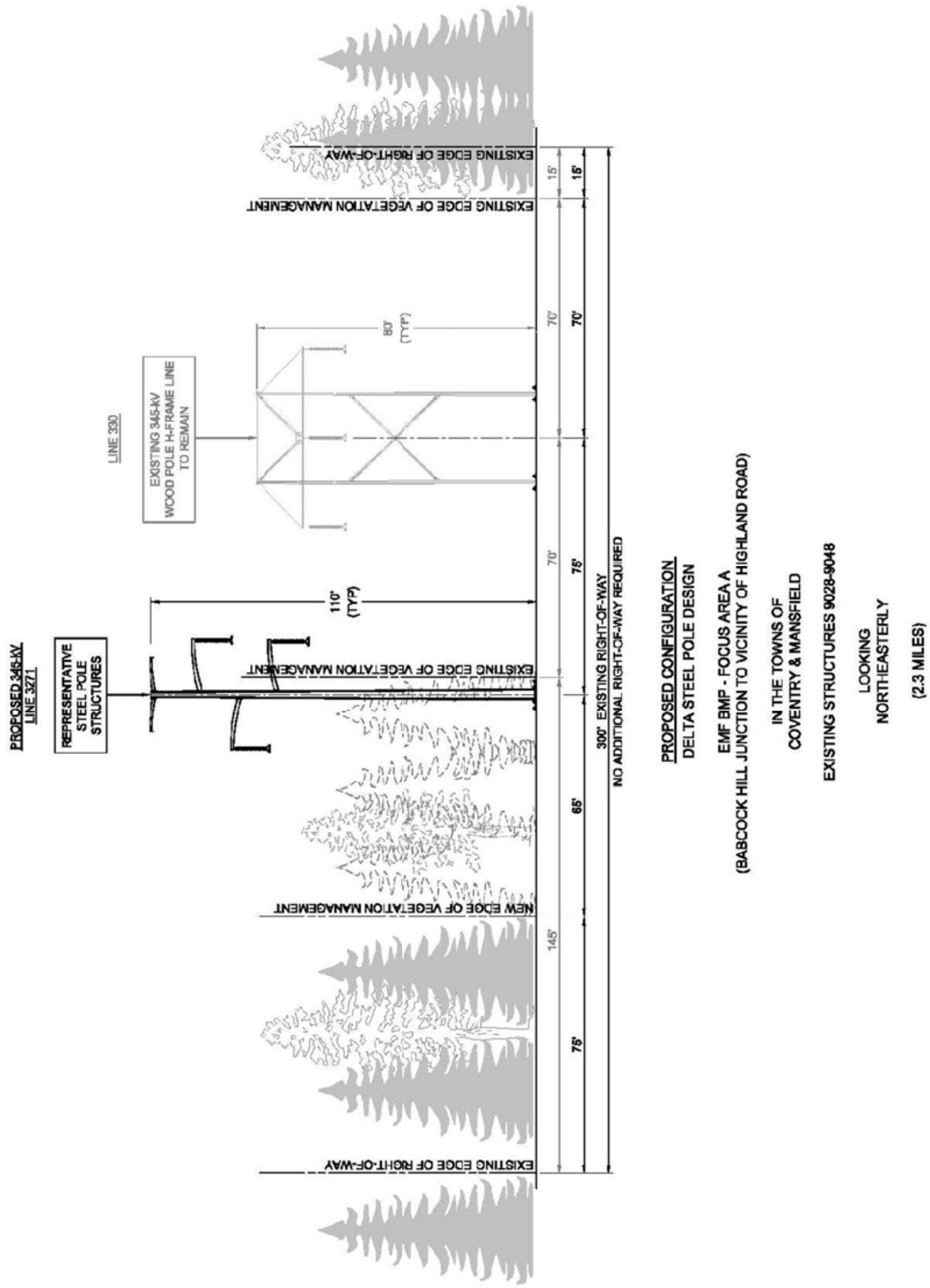

Cross-Section Key Map
Interstate Reliability Project
Connecticut Light & Power
A Northeast Utilities Company
NORTH
Proposed Route (in existing ROW)
Switching Station
Substation
0
2
4
8
Miles
Source: ESRI, CT DEP, and Burns & McDonnell Engineering.
Key Map
Rhode Island
Connecticut
XS-1
XS-2
XS-3
XS-4
XS-5
XS-6
XS-7
XS-8
XS-9/10
XS-11
XS-12
Focus Area A
Focus Area D
Focus Area E
Card Street
Lake Road
Killingly
Thompson
Putnam
Woodstock
Pomfret
Brooklyn
Sterling
Plainfield
Canterbury
Scotland
Hampton
Eastford
Chaplin
Windham
Ashford
Mansfield
Willington
Tolland
Coventry
Columbia
Lebanon
Andover

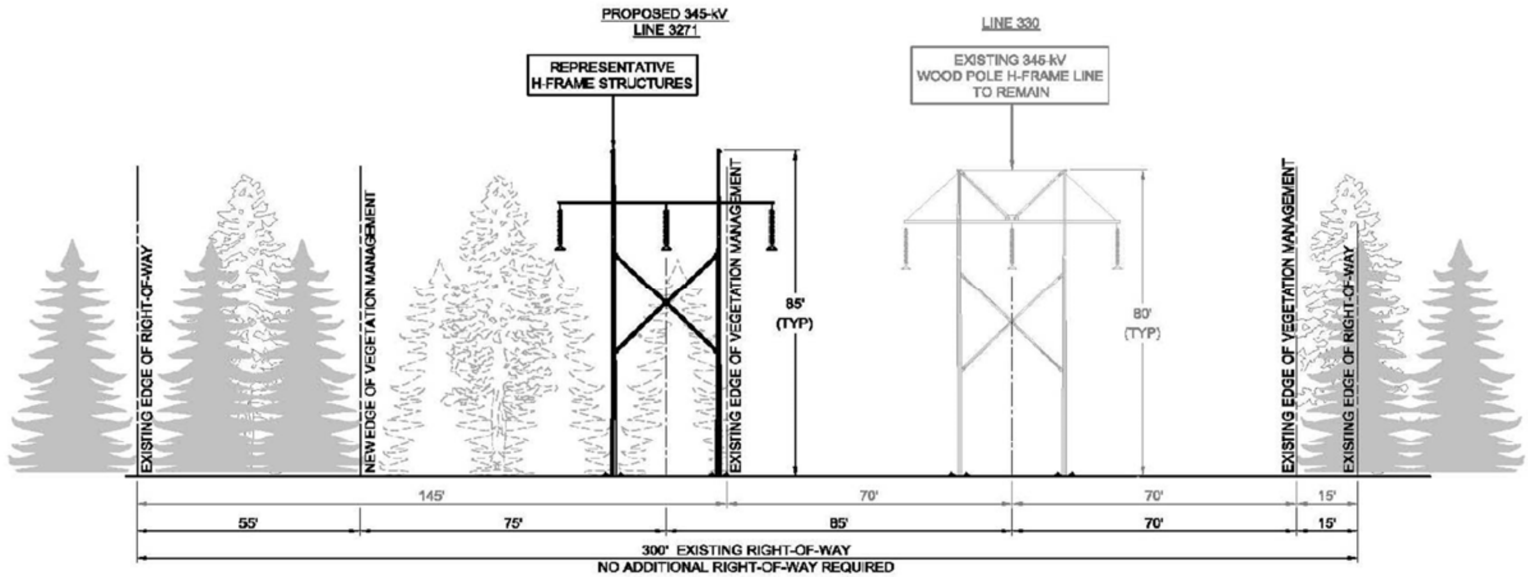
XS-1: Card Street Substation to Babcock Hill Junction



XS-2 BMP: Focus Area A (Babcock Hill Junction to Vicinity of Highland Road)



XS-2: Vicinity of Highland Road (Mansfield) to Mansfield Hollow State Park



PROPOSED CONFIGURATION
H-FRAME DESIGN

VICINITY OF HIGHLAND ROAD (MANSFIELD)
TO
MANSFIELD HOLLOW STATE PARK

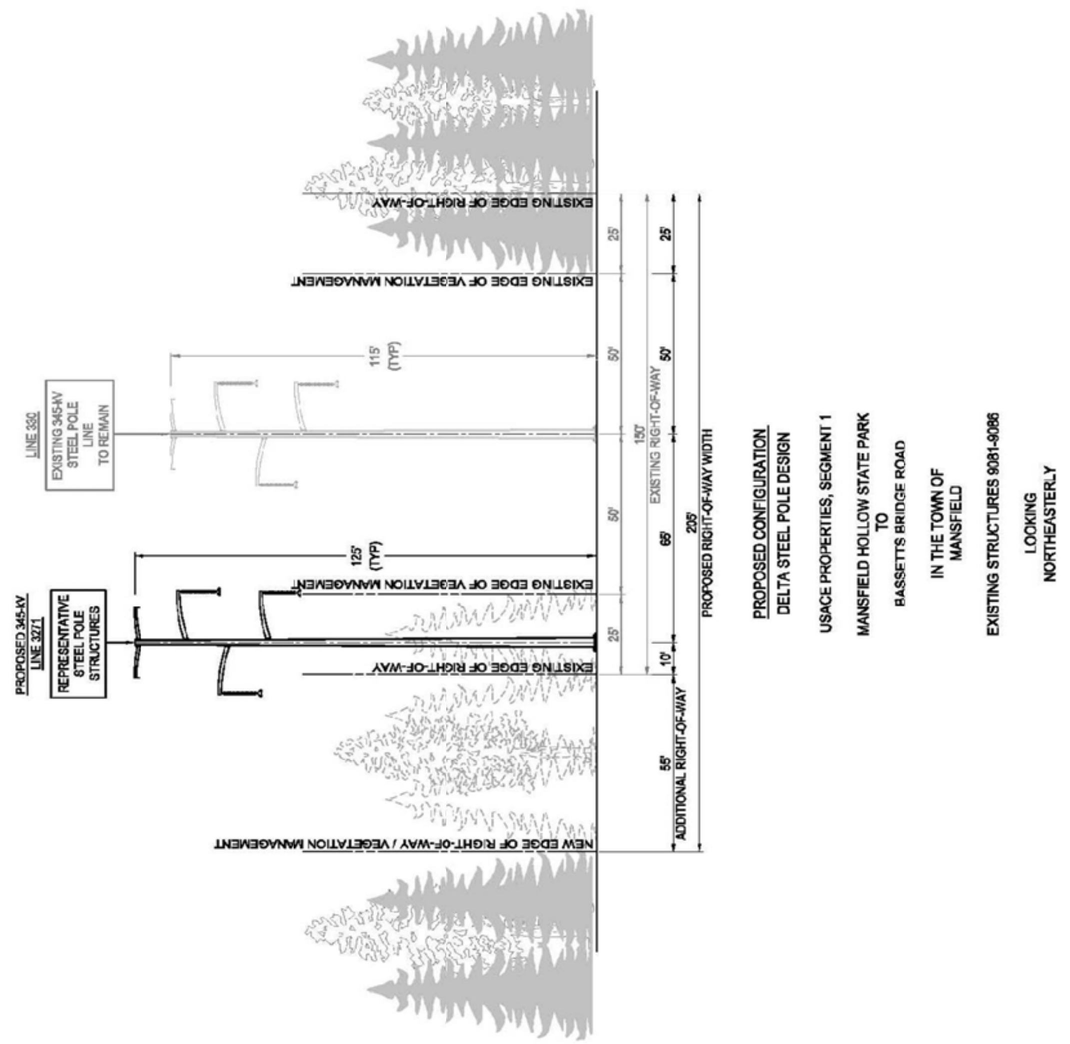
IN THE TOWN OF MANSFIELD

EXISTING STRUCTURES 9049-9080

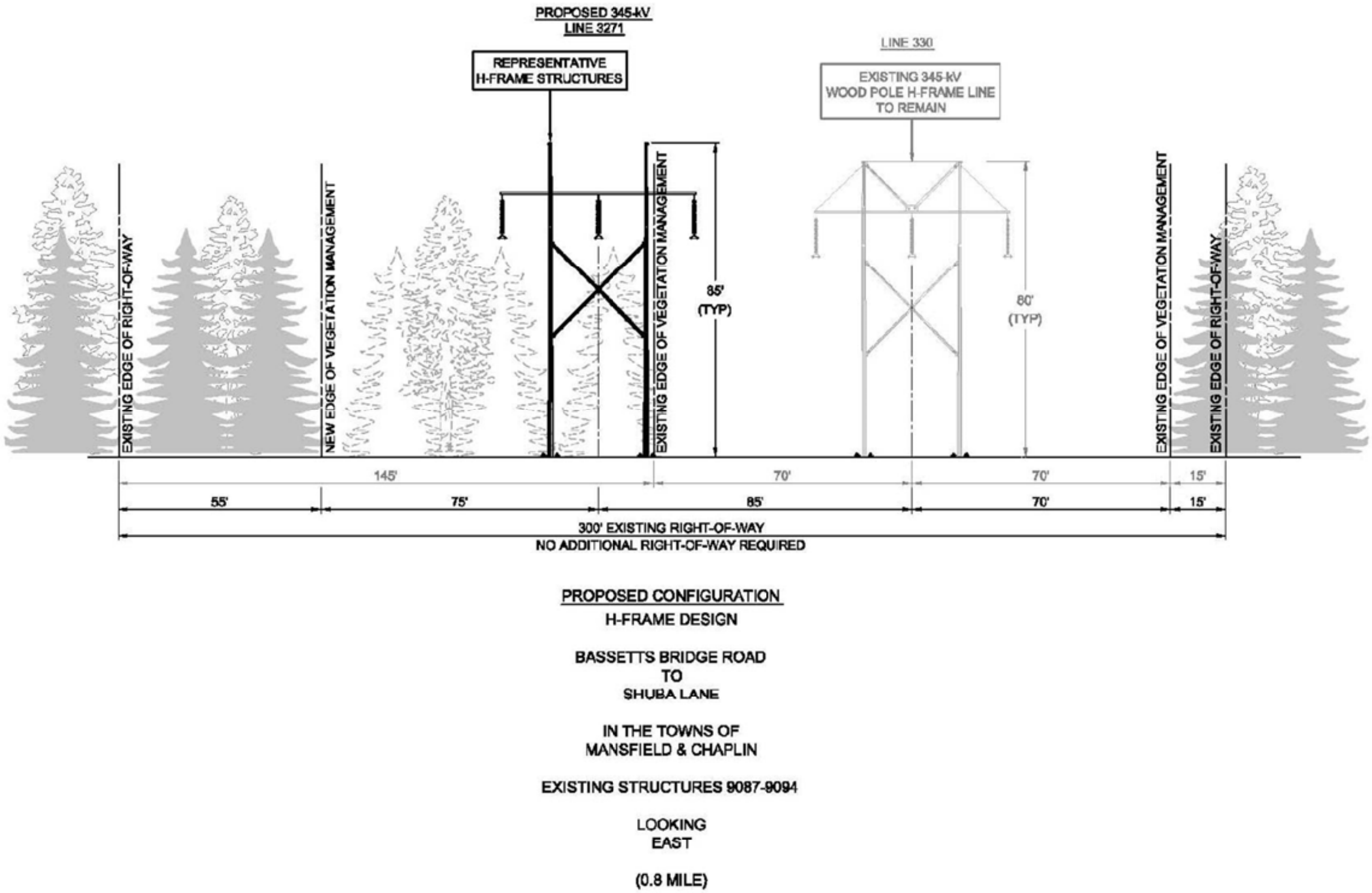
LOOKING
NORTHEASTERLY

(3.3 MILES)

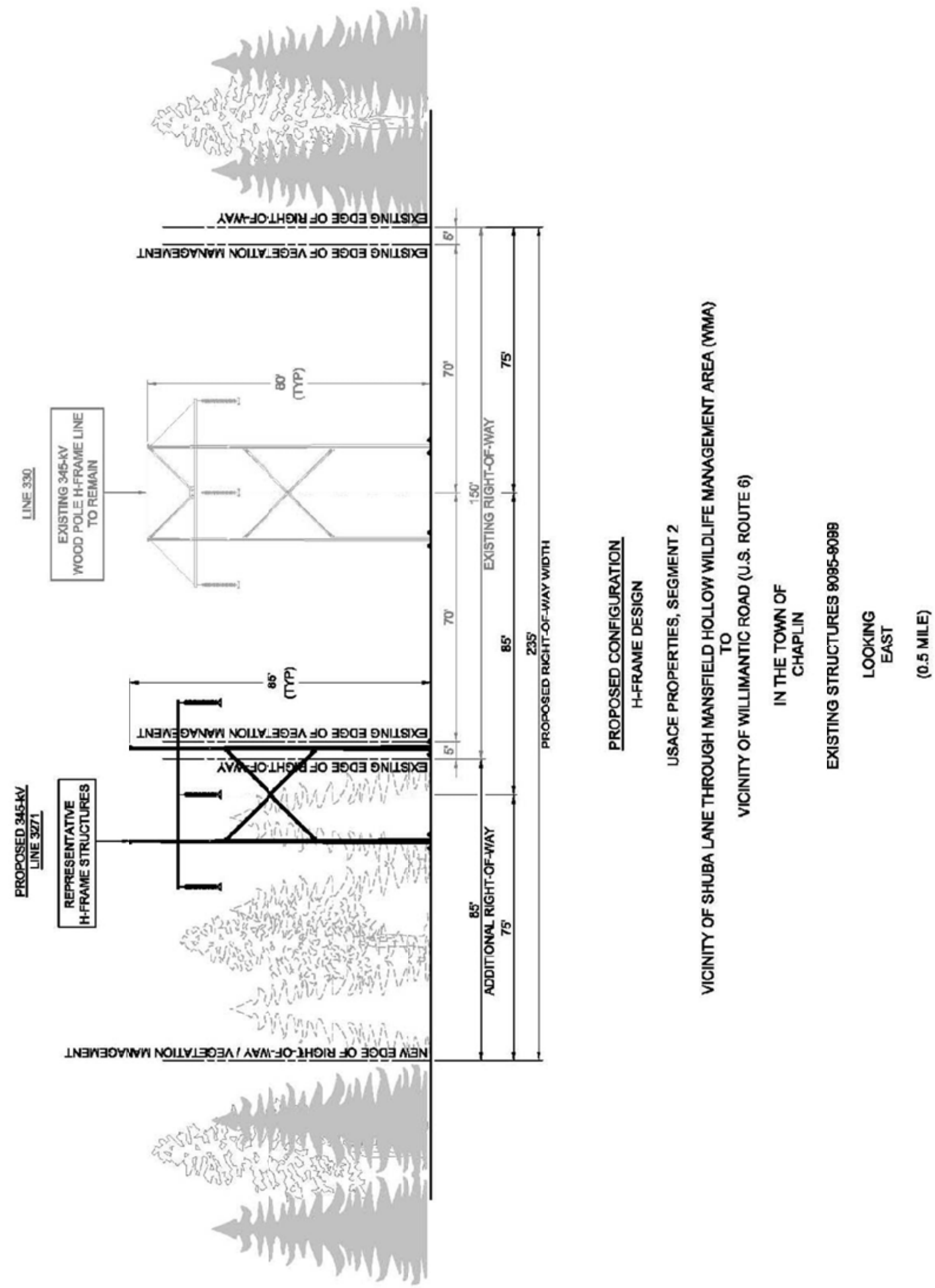
XS-3: Mansfield Hollow State Park to Bassetts Bridge Road



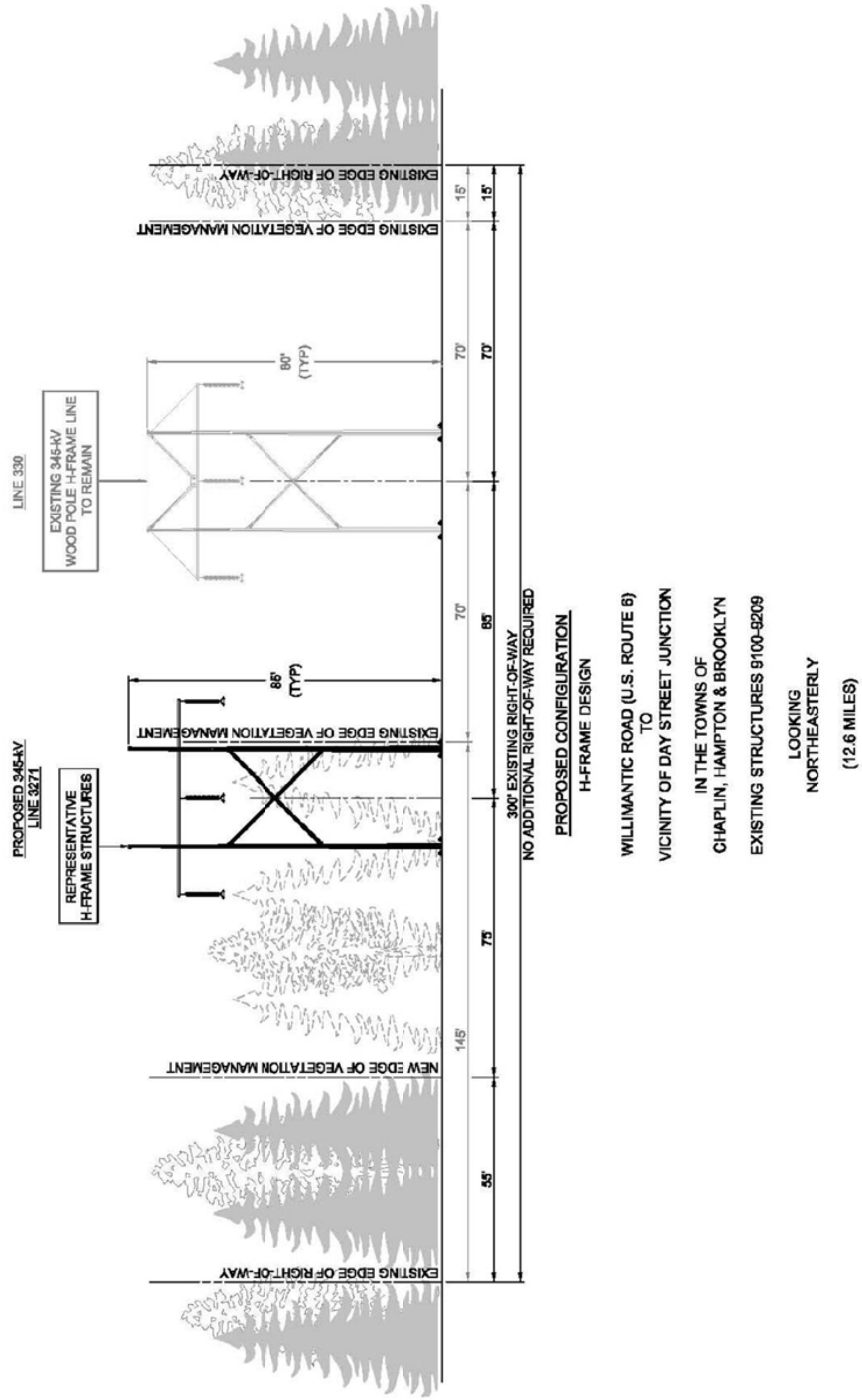
XS-4: Bassetts Bridge Road to Shuba Lane



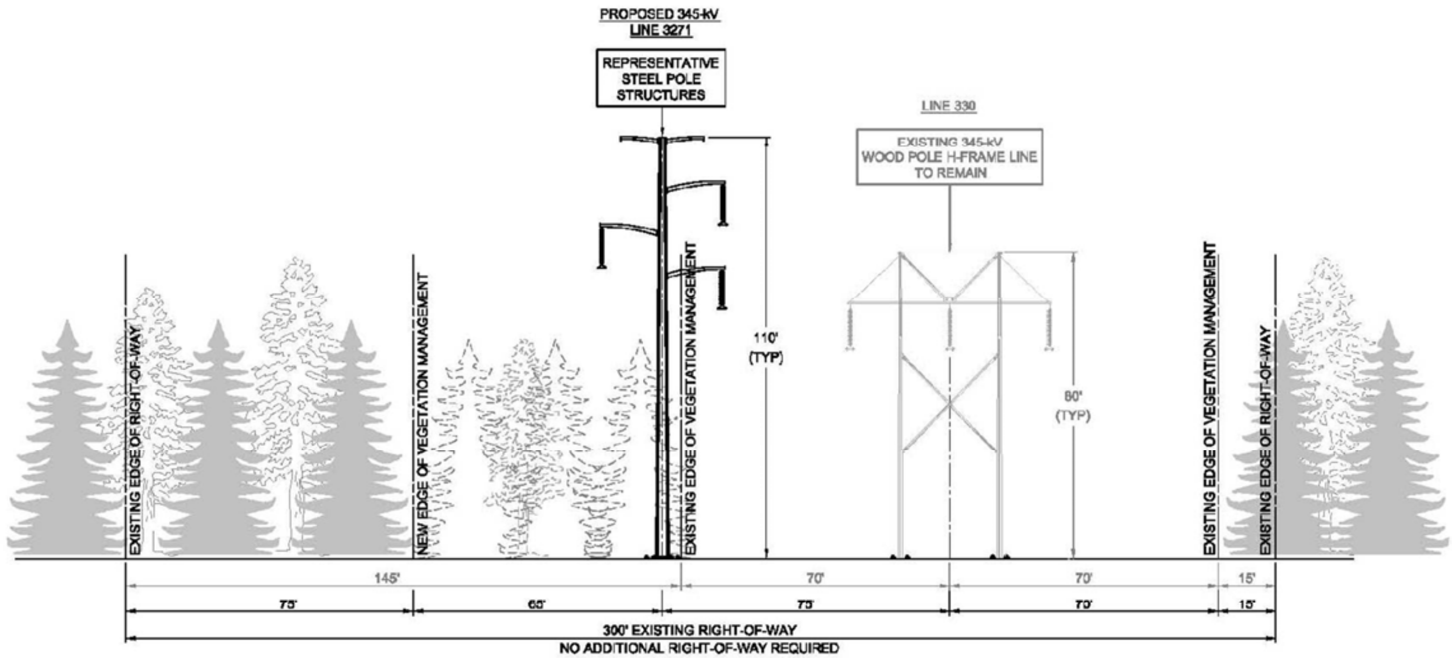
XS-5: Vicinity of Shuba Lane through Mansfield Hollow WMA to Vicinity of Willimantic Road



XS-6: Willimantic Road to Vicinity of Day Street Junction



XS-6 BMP: EMF BMP – Focus Area D (Vicinity of Day Street Junction)



PROPOSED CONFIGURATION
DELTA STEEL POLE DESIGN

EMF BMP - FOCUS AREA D
(VICINITY OF DAY STREET JUNCTION)

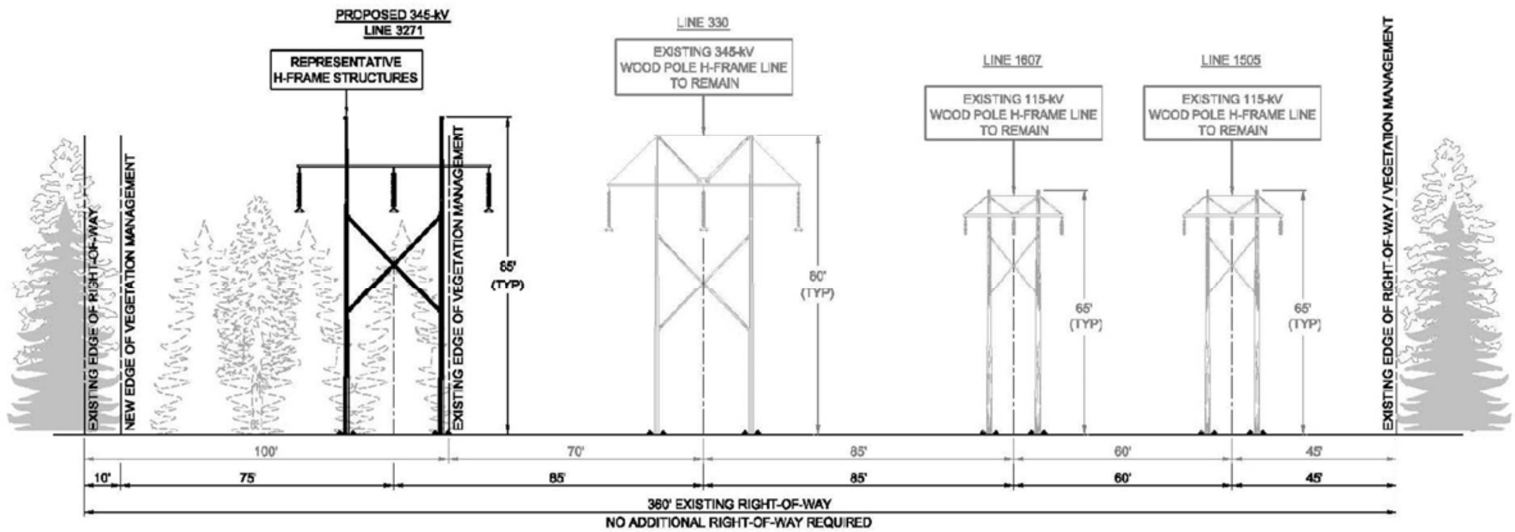
IN THE TOWN OF
BROOKLYN

EXISTING STRUCTURES 9210-9219

LOOKING
NORTHEASTERLY

(1.0 MILE)

XS-7: Day Street Junction to Hartford Turnpike



PROPOSED CONFIGURATION
H-FRAME DESIGN

DAY STREET JUNCTION
TO
HARTFORD TURNPIKE

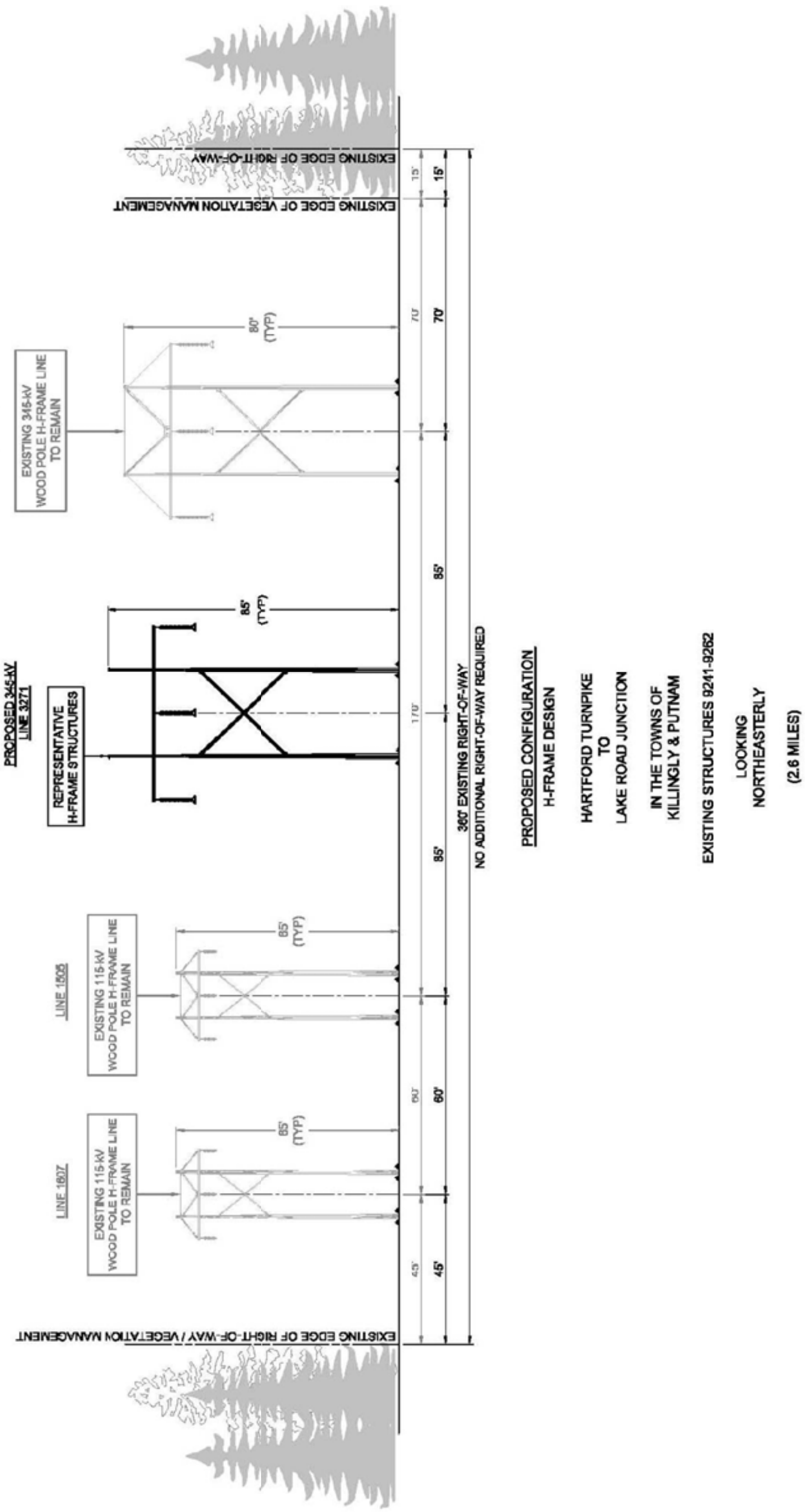
IN THE TOWNS OF BROOKLYN,
POMFRET & KILLINGLY

EXISTING STRUCTURES 9220-9240

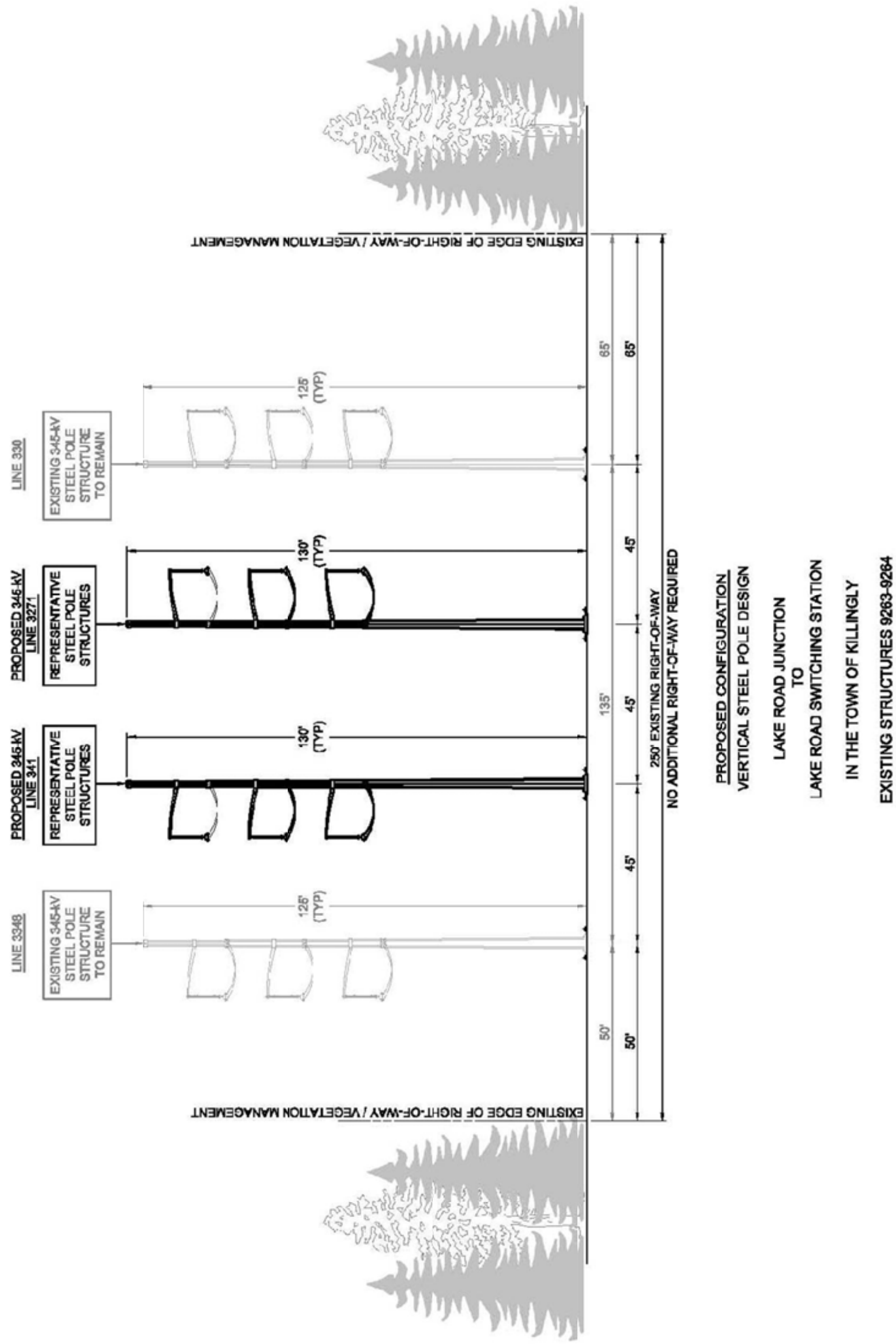
LOOKING
NORTH

(2.3 MILES)

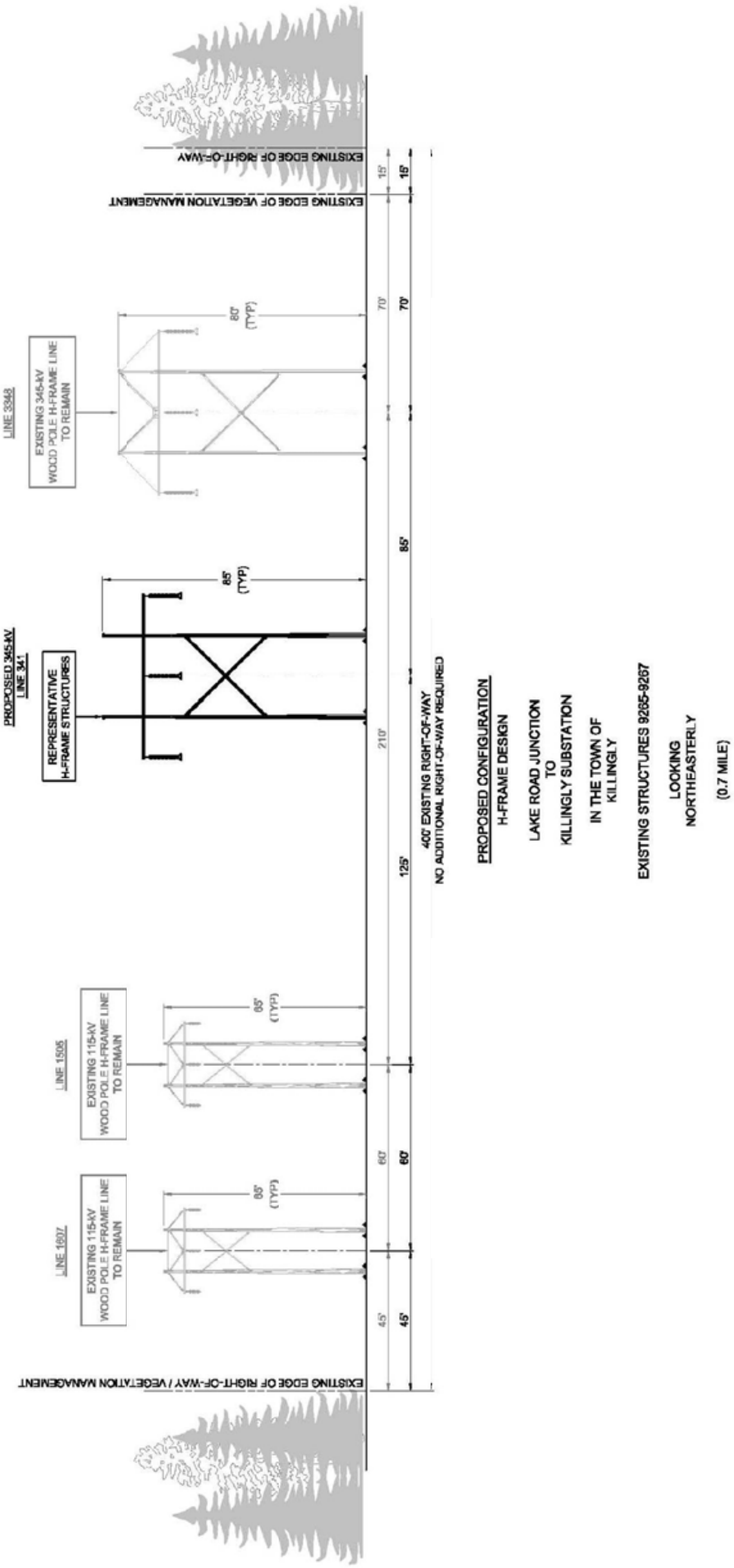
XS-8: Hartford Turnpike to Lake Road Junction



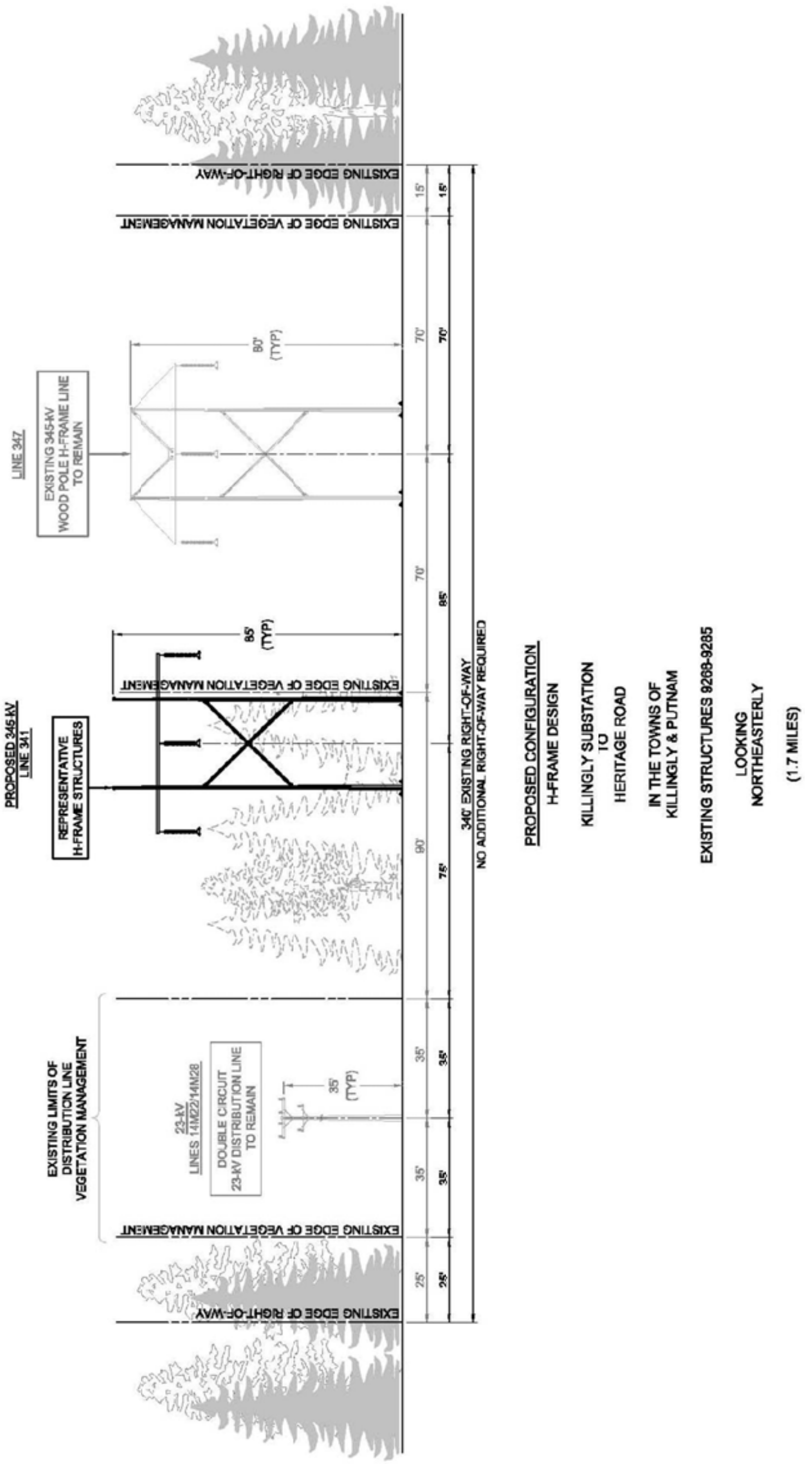
XS-9: Lake Road Junction to Lake Road Switching Station



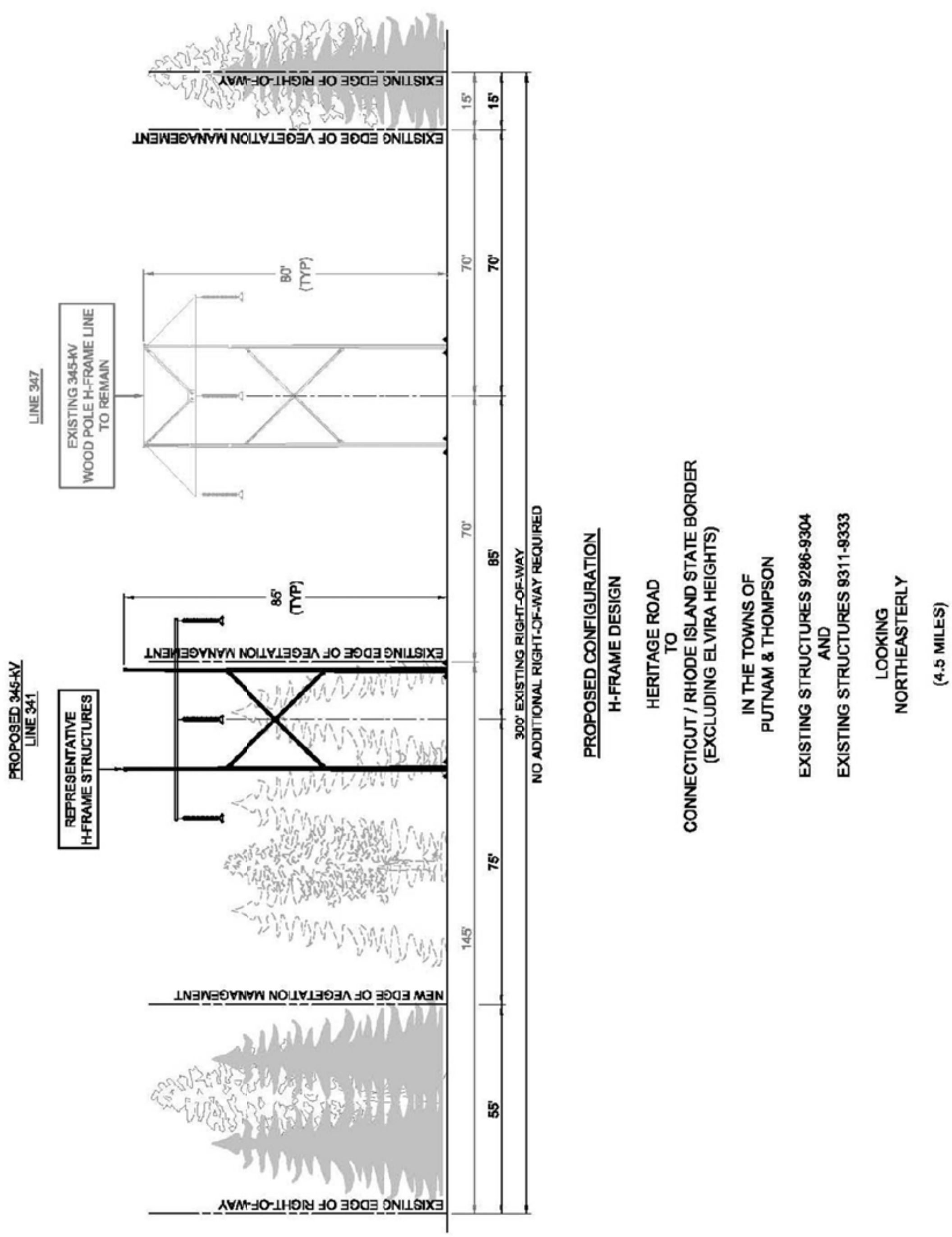
XS-10: Lake Road Junction to Killingly Substation



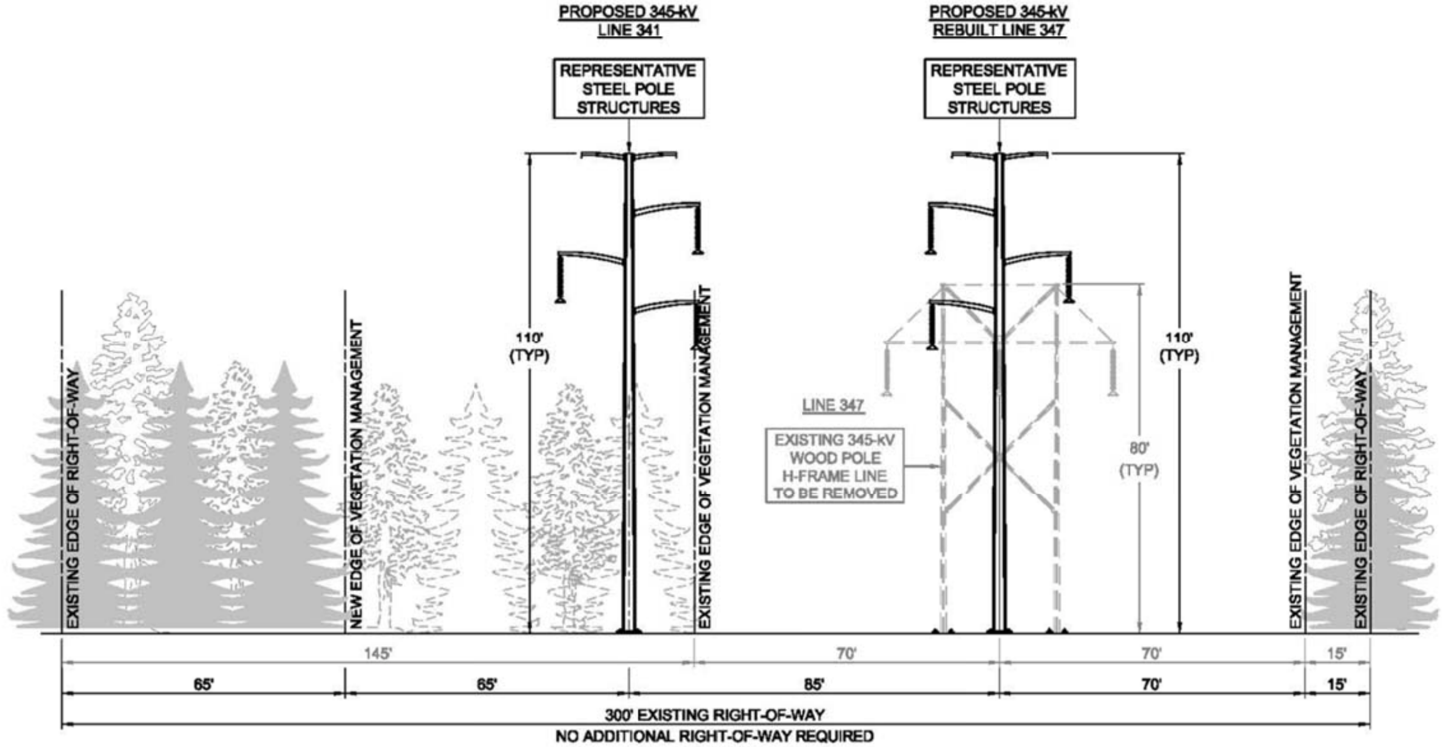
XS-11: Killingly Substation to Heritage Road



XS-12: Heritage Road to Connecticut / Rhode Island State Border



XS-12 BMP: EMF BMP – Focus Area E (Elvira Heights)



PROPOSED CONFIGURATION
DELTA STEEL POLE DESIGN

EMF BMP - FOCUS AREA E

ELVIRA HEIGHTS

IN THE TOWN OF PUTNAM

EXISTING STRUCTURES 9305-9310

LOOKING
NORTHEASTERLY

(0.6 MILE)

Appendix 3B –Illustrations of Transmission Line Structure Types

Note: This page intentionally left blank.

345-kV TRANSMISSION LINE STRUCTURE TYPES

Transmission line structures, which are typically the element of an electric transmission system that are most apparent to the public, support the conductors (wires) that are used to transport electric power from generation sources to customer load centers.[7] Three 345-kV transmission line structure families have been identified for use on the proposed Project or as configuration options to certain segments of the proposed Project:

- H-Frame
- Delta Steel Pole
- Vertical Steel Pole

Each of these structure families includes different functional types of structures. Where and how a particular type of structure is used along a transmission line depends on a variety of factors, such as availability of ROW, load requirements[8], terrain (topography), and magnetic field management preferences. In each structure family, the basic types of structures commonly used along a transmission line are described as follows:

- **Tangent structure**. Tangent structures are the type most commonly used on a transmission line and are used on relatively straight portions of the transmission line. Because the conductors are in a relatively straight line passing through them, tangent structures are designed only to handle small line angles (changes in direction) of 0 to 2 degrees. Tangent structures are usually characterized by suspension (vertical) insulators, which support and insulate the conductors and transfer wind and weight loads to the structure.

---

7 The conductors proposed for the Project are aluminum with a steel core for strength; these conductors are connected to the transmission line structures by insulators (typically made of porcelain) that must be strong enough to support tensile forces and the weight of the conductors while preventing electrical contact between the conductors and the structure. Shield wires, which are connected directly to the structures, are installed above the conductors to protect the conductors from direct lightning strikes.

8 Each structure must be designed for both the loads imposed on it by the weight of the conductors and dynamic loads resulting from factors such as wind and ice accumulation.

- **Angle structure**. Angle structures are used where transmission line conductors change direction. These types of structures are designed to withstand the forces placed on them by the change in direction. Angle structures may be: (1) similar to tangent structures, using suspension insulators to attach the conductors and transfer wind, weight, and line angle loads to the structure; or (2) similar to strain or dead-end structures, using insulators in series with the conductors to bring wind, weight, and line angle loads directly to the structure.

- **Dead-end structure.** A dead-end structure is typically used where transmission line conductors turn at a wide angle or end. Compared to tangent structures, a dead-end structure is designed to be stronger and often is a larger structure. Typically, insulators on a dead-end structure are in series with the conductors (horizontal) to bring wind, weight, and line angle loads directly to the structure. A dead-end structure is designed to resist the full unbalanced tension that would occur if all conductors were removed from one face of the structure.

- **Strain structure**. A strain structure is similar in appearance and design strength to a tangent structure. The difference in appearance is the conductor attachment hardware. The conductor attachment hardware is the same as a deadend or large angle, where the insulator bells are in line with the conductor. Whereas a dead-end structure is designed to withstand the full unbalanced tension that would occur from the loss of all conductors from one face of the structure, a strain structure is designed to withstand only unbalanced tensions associated with the loss of a single phase (bundle of two conductors) on one face of the structure.

As illustrated in this appendix, structures may be self-supported or guyed and may include different insulator configurations (e.g., horizontal, vertical).

H-Frame Family

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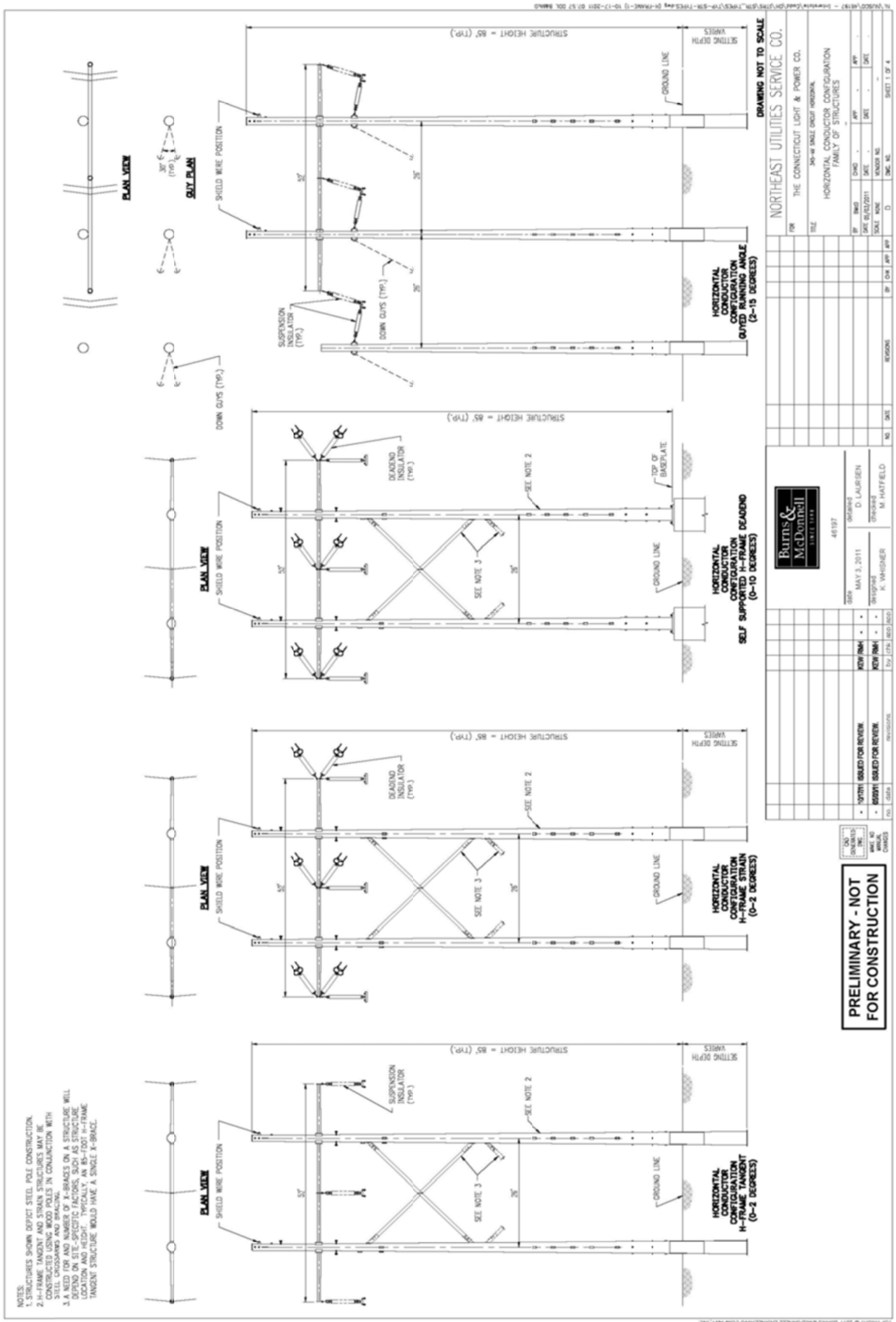
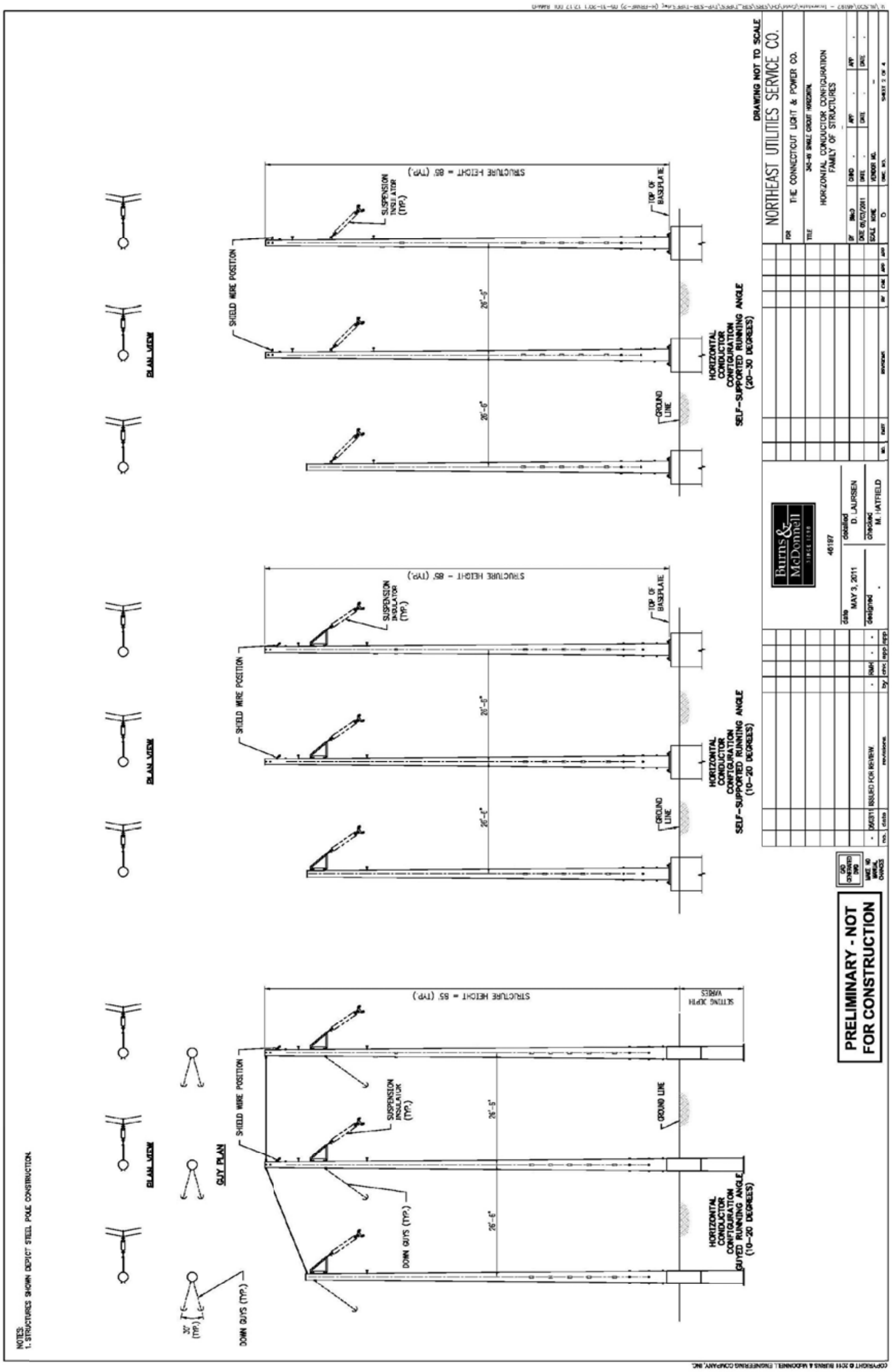
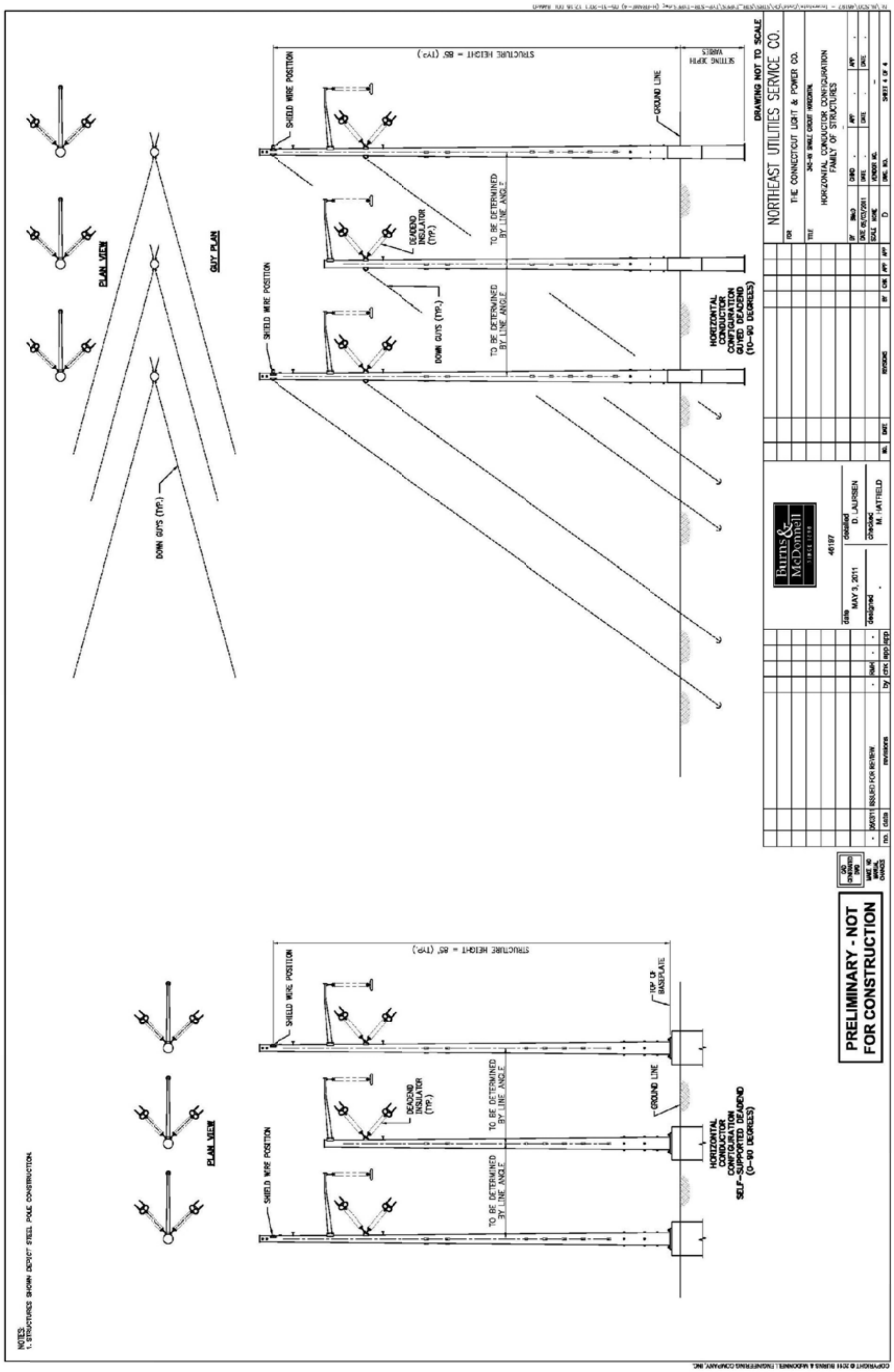

NORTHEAST UTILITIES SERVICE CO.
THE CONNECTICUT LIGHT & POWER CO.
HORIZONTAL CONDUCTOR CONFIGURATION FAMILY OF STRUCTURES
DRAWING NOT TO SCALE
PRELIMINARY - NOT FOR CONSTRUCTION
Burns & McDonnell
HORIZONTAL CONDUCTOR CONFIGURATION GUYED RUNNING ANGLE (2-15 DEGREES)
HORIZONTAL CONDUCTOR CONFIGURATION SELF SUPPORTED H-FRAME DEADEND (0-10 DEGREES)
HORIZONTAL CONDUCTOR CONFIGURATION H-FRAME STRAIN (0-2 DEGREES)
HORIZONTAL CONDUCTOR CONFIGURATION H-FRAME TANGENT (0-2 DEGREES)
PLAN VIEW
GUY PLAN
SHIELD WIRE POSITION
STRUCTURE HEIGHT = 85' (TYP.)
SETTING DEPTH VARIES
GROUND LINE
DOWN GUYS (TYP.)
SUSPENSION INSULATOR (TYP.)
DEADEND INSULATOR (TYP.)
SEE NOTE 2
SEE NOTE 3
TOP OF BASEPLATE
D. LAURSEN
M. HATFIELD
K. WHISNER
MAY 3, 2011
ISSUED FOR REVIEW
NOTES:
1. STRUCTURES SHOWN DEPICT STEEL POLE CONSTRUCTION.
2. H-FRAME TANGENT AND STRAIN STRUCTURES MAY BE CONSTRUCTED USING WOOD POLES IN CONJUNCTION WITH STEEL CROSSARMS AND BRACING.
3. A NEED FOR AND NUMBER OF X-BRACES ON A STRUCTURE WILL DEPEND ON SITE-SPECIFIC FACTORS, SUCH AS STRUCTURE LOCATION AND HEIGHT. TYPICALLY, AN 85-FOOT H-FRAME TANGENT STRUCTURE WOULD HAVE A SINGLE X-BRACE.


DRAWING NOT TO SCALE
NORTHEAST UTILITIES SERVICE CO.
THE CONNECTICUT LIGHT & POWER CO.
HORIZONTAL CONDUCTOR CONFIGURATION FAMILY OF STRUCTURES
PRELIMINARY - NOT FOR CONSTRUCTION
Burns & McDonnell
D. LAURSEN
M. HATFIELD
MAY 3, 2011
46197
ISSUED FOR REVIEW
HORIZONTAL CONDUCTOR CONFIGURATION SELF-SUPPORTED RUNNING ANGLE (20-30 DEGREES)
HORIZONTAL CONDUCTOR CONFIGURATION SELF-SUPPORTED RUNNING ANGLE (10-20 DEGREES)
HORIZONTAL CONDUCTOR CONFIGURATION GUYED RUNNING ANGLE (10-20 DEGREES)
STRUCTURE HEIGHT = 85' (TYP.)
SHIELD WIRE POSITION
SUSPENSION INSULATOR (TYP.)
TOP OF BASEPLATE
GROUND LINE
PLAN VIEW
GUY PLAN
DOWN GUYS (TYP.)
SETTING DEPTH VARIES
26'-6"
NOTES:
1. STRUCTURES SHOWN DEPICT STEEL POLE CONSTRUCTION.


NORTHEAST UTILITIES SERVICE CO.
THE CONNECTICUT LIGHT & POWER CO.
HORIZONTAL CONDUCTOR CONFIGURATION FAMILY OF STRUCTURES
DRAWING NOT TO SCALE
PRELIMINARY - NOT FOR CONSTRUCTION
Burns & McDonnell
MAY 3, 2011
D. LAURSEN
M. HATFIELD
STRUCTURE HEIGHT = 85' (TYP.)
SHIELD WIRE POSITION
GROUND LINE
DEADEND INSULATOR (TYP.)
TO BE DETERMINED BY LINE ANGLE
DOWN GUYS (TYP.)
PLAN VIEW
GUY PLAN
HORIZONTAL CONDUCTOR CONFIGURATION GUYED DEADEND (10-90 DEGREES)
HORIZONTAL CONDUCTOR CONFIGURATION SELF-SUPPORTED DEADEND (0-90 DEGREES)
TOP OF BASEPLATE
NOTES:
1. STRUCTURES SHOWN DEPICT STEEL POLE CONSTRUCTION.

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Delta Steel Pole Family

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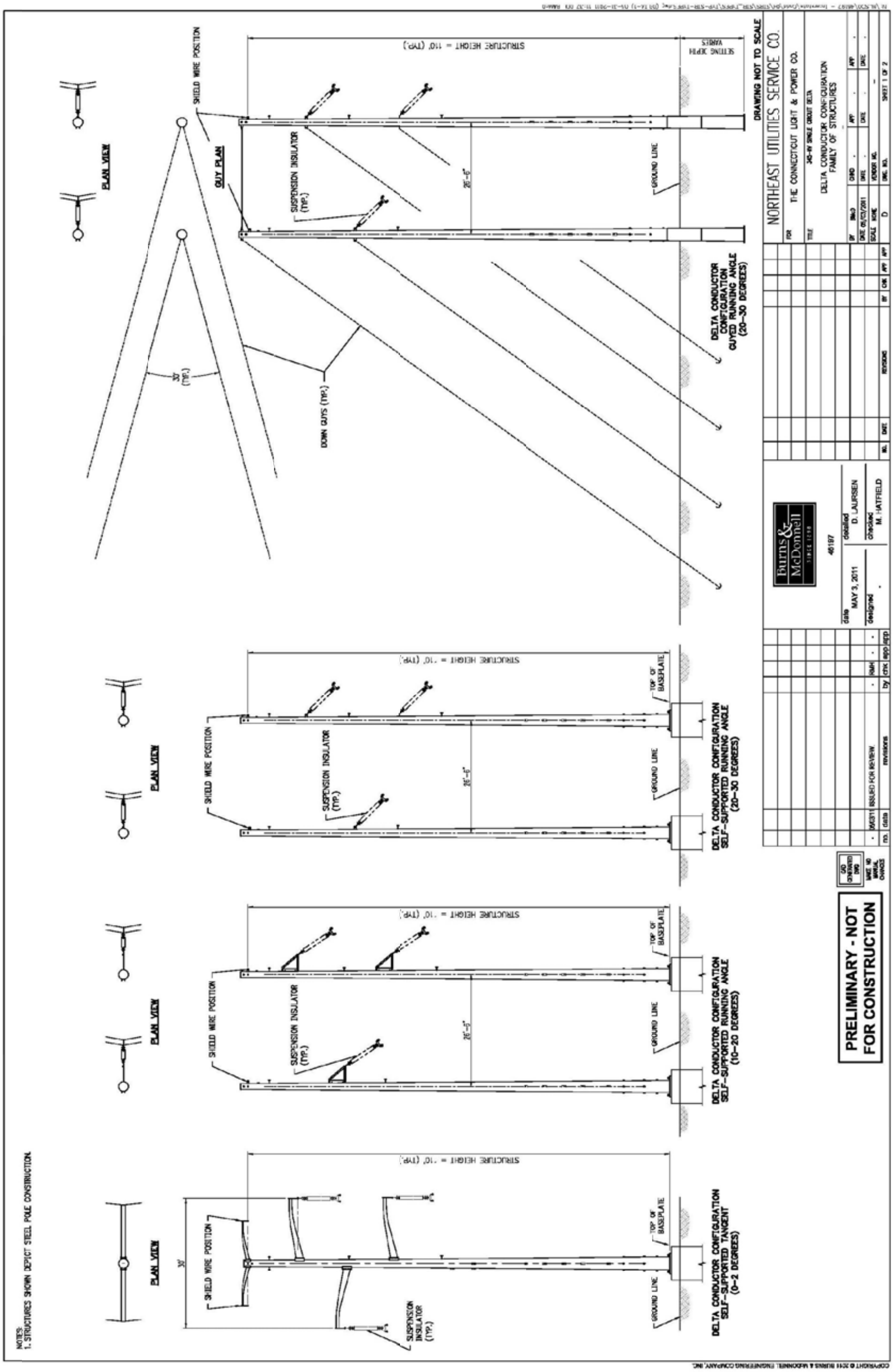
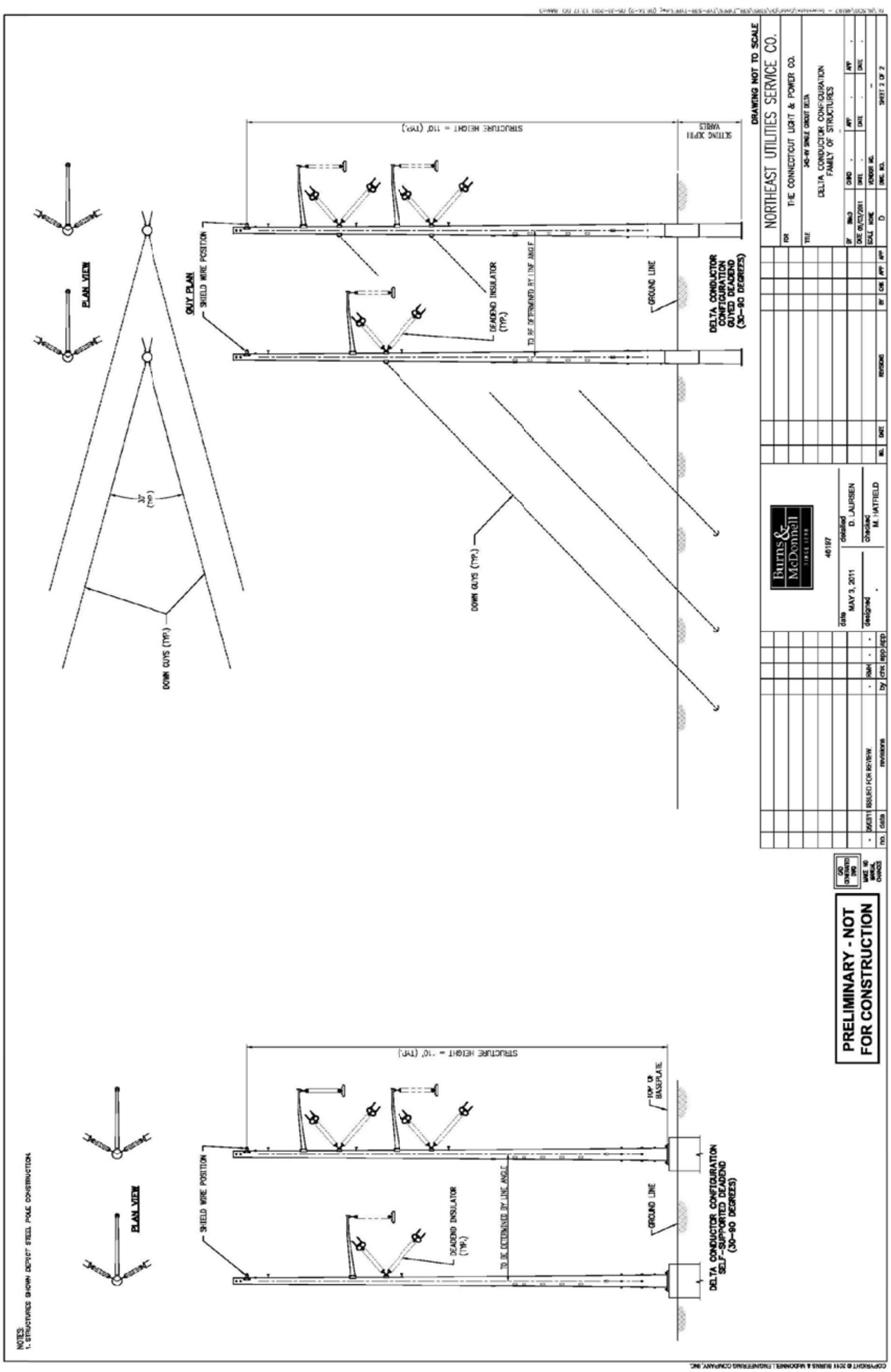

NORTHEAST UTILITIES SERVICE CO.
DRAWING NOT TO SCALE
THE CONNECTICUT LIGHT & POWER CO.
DELTA CONDUCTOR CONFIGURATION FAMILY OF STRUCTURES
PRELIMINARY - NOT FOR CONSTRUCTION
DELTA CONDUCTOR CONFIGURATION GUYED RUNNING ANGLE (20-30 DEGREES)
DELTA CONDUCTOR CONFIGURATION SELF-SUPPORTED RUNNING ANGLE (20-30 DEGREES)
DELTA CONDUCTOR CONFIGURATION SELF-SUPPORTED RUNNING ANGLE (10-20 DEGREES)
DELTA CONDUCTOR CONFIGURATION SELF-SUPPORTED TANGENT (0-2 DEGREES)
NOTES:
1. STRUCTURES SHOWN DEPICT STEEL POLE CONSTRUCTION.
PLAN VIEW
GUY PLAN
DOWN GUYS (TYP.)
SHIELD WIRE POSITION
SUSPENSION INSULATOR (TYP.)
GROUND LINE
TOP OF BASEPLATE
Burns & McDonnell
D. LAURSEN
M. HATFIELD
MAY 3, 2011


NOTES:
1. STRUCTURES SHOWN DEPICT STEEL POLE CONSTRUCTION.
PLAN VIEW
SHIELD WIRE POSITION
DEADEND INSULATOR (TYP.)
TO BE DETERMINED BY LINE ANGLE
GROUND LINE
TOP OF BASEPLATE
STRUCTURE HEIGHT = 110' (TYP.)
DELTA CONDUCTOR CONFIGURATION SELF-SUPPORTED DEADEND (30-90 DEGREES)
PLAN VIEW
GUY PLAN
DOWN GUYS (TYP.)
SETTING DEPTH VARIES
DELTA CONDUCTOR CONFIGURATION GUYED DEADEND (30-90 DEGREES)
PRELIMINARY - NOT FOR CONSTRUCTION
DRAWING NOT TO SCALE
NORTHEAST UTILITIES SERVICE CO.
THE CONNECTICUT LIGHT & POWER CO.
DELTA CONDUCTOR CONFIGURATION FAMILY OF STRUCTURES
Burns & McDonnell
MAY 3, 2011
D. LAURSEN
M. HATFIELD
ISSUED FOR REVIEW

Vertical Steel Pole Family

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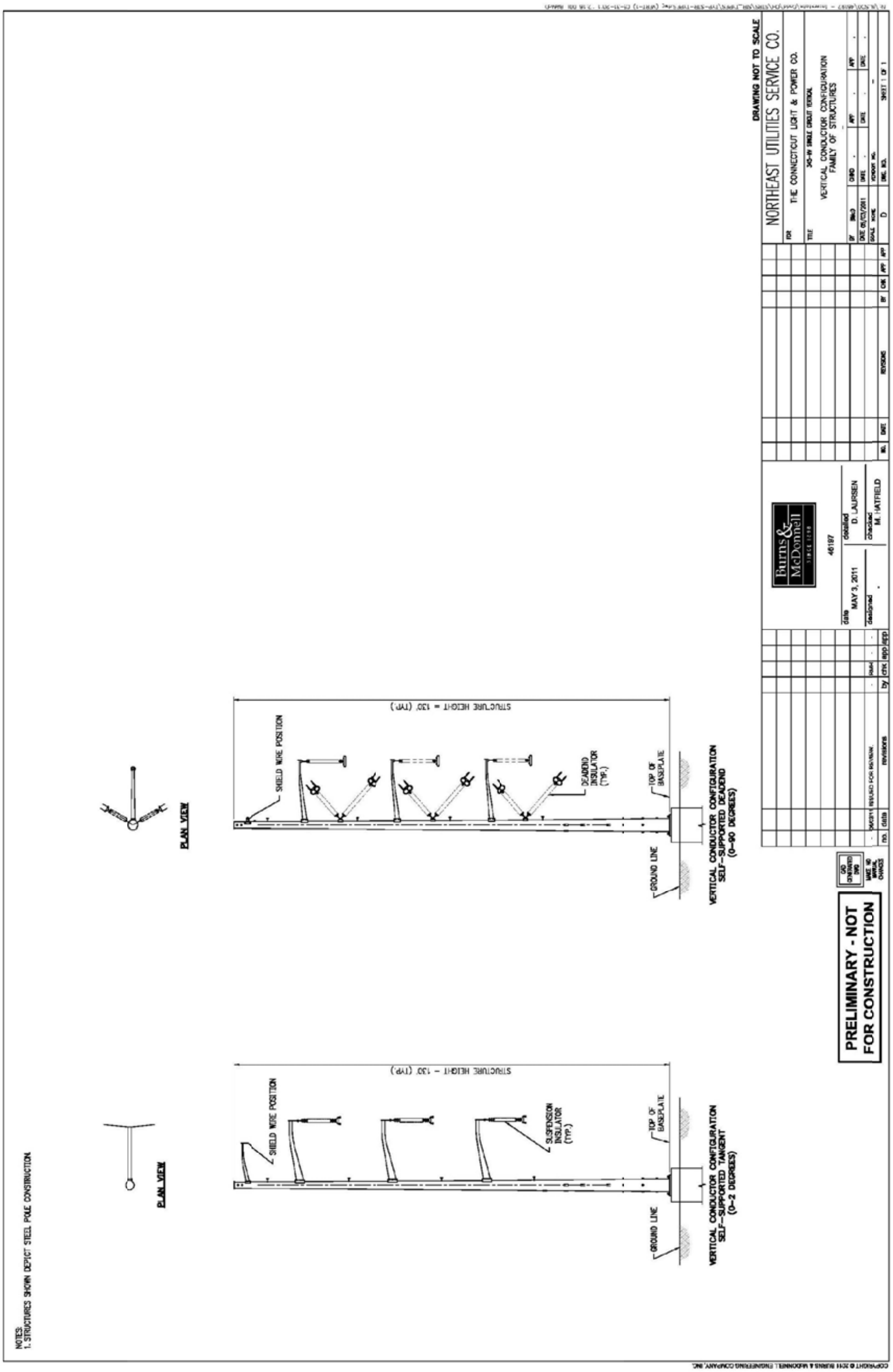
DRAWING NOT TO SCALE
NORTHEAST UTILITIES SERVICE CO.
THE CONNECTICUT LIGHT & POWER CO.
VERTICAL CONDUCTOR CONFIGURATION FAMILY OF STRUCTURES
Burns & McDonnell
MAY 3, 2011
46197
D. LAURSEN
M. HATFIELD
PRELIMINARY - NOT FOR CONSTRUCTION
PLAN VIEW
STRUCTURE HEIGHT = 130' (TYP.)
SHIELD WIRE POSITION
DEADEND INSULATOR (TYP.)
TOP OF BASEPLATE
GROUND LINE
VERTICAL CONDUCTOR CONFIGURATION SELF-SUPPORTED DEADEND (0-90 DEGREES)
PLAN VIEW
STRUCTURE HEIGHT = 130' (TYP.)
SHIELD WIRE POSITION
SUSPENSION INSULATOR (TYP.)
TOP OF BASEPLATE
GROUND LINE
VERTICAL CONDUCTOR CONFIGURATION SELF-SUPPORTED TANGENT (0-2 DEGREES)
NOTES:
1. STRUCTURES SHOWN DEPICT STEEL POLE CONSTRUCTION.

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SECTION 4

CONSTRUCTION AND OPERATION / MAINTENANCE PROCEDURES

4. CONSTRUCTION AND OPERATION / MAINTENANCE PROCEDURES

The proposed Project would be constructed, operated, and maintained in accordance with established industry practices, as well as pursuant to CL&P's specifications. Construction, operation, and maintenance activities also would conform to any conditions identified in the Council's Decision and Order and in federal and state permits obtained for the Project.

Section 4.1 describes the standard procedures to be used for the installation of the proposed overhead 345-kV transmission lines[1], including construction sequencing, material staging sites, construction field offices, access roads, ROW preparation, structure installation[2], counterpoise installation, conductor work, ROW cleanup and restoration, and general considerations for traffic control. Section 4.2 reviews the special procedures that would be followed when specific conditions are encountered during construction (e.g., procedures for water resource crossings, blasting, soils management, and dewatering). The proposed configurations of transmission lines along each ROW segment are depicted on the cross-section drawings, which are included in Section 3 of this volume (refer to Appendix 3A) and in Volumes 9 and 10. (The Volume 10 cross-sections are full-size, scale drawings and include detailed notes; the cross-sections in Appendix 3A and on the Volume 9 maps are reduced-size versions.)

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[1] For the 1.4 miles of ROW across the federally-owned properties in the Mansfield Hollow area, in addition to the Proposed Configuration (involving the proposed acquisition from the USACE of approximately 11 additional acres of easement), CL&P has identified two potentially feasible configuration options. The construction procedures for these two configuration options are discussed in Section 10 of this volume. In addition, underground and overhead route variations to certain portions of the proposed overhead 345-kV transmission line are identified and described in Volume 1A, Section 15. Should the Council approve the development of underground cables along one or more of these variations, Section 14.3 and Appendix 14A (Volume 1A) discusses the standard procedures that would be required to construct such cable systems. Procedures for constructing an overhead 345-kV transmission line on new ROWs also are described in Volume 1A, Section 15.

[2] Six existing 345-kV line structures would be removed and reconfigured along a 0.6-mile segment of ROW in the Town of Putnam, as depicted on XS-12 BMP. The Project as proposed would not involve any other structure removals.

Section 4.3 summarizes the construction methods for the proposed modifications to Card Street Substation, Lake Road Switching Station, and Killingly Substation. Operation and maintenance procedures applicable to the new 345-kV transmission lines and associated substations and switching station are detailed in Section 4.4.

4.1 STANDARD PROCEDURES FOR OVERHEAD TRANSMISSION LINE CONSTRUCTION

4.1.1 Introduction and Overview of Construction Sequencing

CL&P would construct the proposed Project in several stages, some overlapping in time. The following summarizes the activities, materials, and equipment generally expected to be involved in the construction of the overhead transmission lines.

- Survey and stake the ROW boundaries (where necessary), vegetation clearing boundaries, and proposed structure locations.
- Mark the boundaries of previously delineated wetland and watercourse areas.
- Identify and mark areas to be avoided (e.g., sensitive cultural or environmental resource areas).
- Establish construction field office area(s), typically including space for an office trailer, equipment storage and maintenance, sanitary facilities, and parking.
- Install erosion and sedimentation controls in accordance with best management practices (controls are deployed using pickups and other small trucks, or small track vehicles). Erosion and sedimentation controls may be installed before vegetation removal, depending on site-specific characteristics. After vegetation removal, soil erosion and sedimentation controls typically are installed around work limits (e.g., access roads, crane pads) in or near wetlands and streams.
- Perform vegetation clearing. Vegetation would be removed along those portions of the ROWs to be used for the construction of the new transmission lines, as well as areas that contain undesirable, tall-growing, woody species that could grow to interfere with the operation of the proposed transmission lines should they not be removed. For example, as part of construction, vegetation would be removed to the designated limits of clearing as required, including at work sites (crane pads), as well as along existing or new access roads. Vegetation also would be removed, as necessary, along existing or new access roads that may be on the ROW (but outside the designated limits of clearing) or off the ROW (but required to reach the ROW). In addition, danger trees outside the limits of clearing (on or off the ROW) would be removed as necessary to protect the integrity of the proposed or existing transmission lines. Vegetation removal activities typically require flatbed trucks, brush hogs or other types of mowing equipment, skidders, bucket

trucks for canopy trimming, tree shears for larger trees, wood chippers, log trucks, and chip vans. Effects on wetlands, watercourses, or other environmentally sensitive areas would be minimized to the extent practicable (refer to Sections 4.2 and 6 for a discussion of potential mitigation measures). Vehicles with tracks or low-ground-pressure tires may be used to remove vegetation in wetlands. In addition, depending on soil saturation, vegetation removal activities in wetlands may involve the use of temporary timber mats or timber riprap to provide a stable base for clearing equipment.

- Construct new access roads or improve existing roads to provide a minimum travel-way of 12 to 16 feet in width. This typically requires bulldozers or front loaders, excavators, dump trucks for crushed stone or gravel, pickups or stake-body trucks for culverts, and/or mat installers for wetland mats. Roads may be temporary (for use during construction only) or permanent (for use during both construction and the subsequent maintenance of the lines). Temporary roads may be constructed of wood mats or gravel, whereas permanent access roads are generally constructed of gravel only. Roads must have sufficient width and capacity for heavy construction equipment for both over-the-road and off-road vehicles, including oversized tractor trailers. The need for access by flat-bed trailers and concrete trucks often determines the scope of access road improvements. Road grades must be negotiable for over-the-road trucks; grades are typically 10% maximum, less if wet weather or surface conditions result in traction problems.

- Prepare material staging sites (e.g., storage, staging and laydown areas) to support the construction effort. The preferred locations for such areas are typically in the immediate vicinity of the ROWs.

- Prepare level crane pads as necessary at new structure sites. Crane pad installation may involve grading and requires the installation of a stable base (consisting of gravel, timber mats, or equivalent) in order to create a stable base for structure installation equipment.

- Construct foundations and erect/assemble new structures. This requires the same equipment used for access road preparation (e.g., bucket trucks), with the addition of flat-bed trucks for hauling structure components, hardware, and augers, other trucks for hauling reinforcing rods, drill rigs, cranes, concrete trucks for structures that require concrete for foundations, dump trucks for structures that require crushed rock backfill, and bucket trucks. Dump trucks are also needed for foundation work if excess excavated material has to be removed from the ROW. In wet conditions or if groundwater is encountered during excavation, pumping (vacuum) trucks or other suitable equipment would be used to pump water from the excavated areas. The water then would be discharged in accordance with applicable local, state, and federal requirements.

- Install shield wires and conductors. The equipment required for these activities would include conductor reels, conductor pulling and tensioner rigs, and bucket trucks. Helicopters also may be used to install the initial pulling lines for the conductors or shield wires.

- Install counterpoise, where needed. Depending on site-specific soil conductivity, supplemental grounding will be installed. A ditchwich is typical equipment for this activity.

- Remove temporary roads and construction debris and restore disturbed sites. Haul construction debris off the ROW for disposal. Vegetative materials cut along the ROWs and not otherwise planned for use by the landowner (e.g., brush) may be piled, scattered, or chipped on the ROW, depending on site-specific environmental features. In some areas, if allowed, disturbed ground will be back-bladed to preconstruction contours, unless directed otherwise. If the ROW to be restored is in an agricultural field, the soil may be decompacted by disking.

- Maintain temporary erosion and sediment controls until vegetation is re-established or disturbed areas are otherwise stabilized. Steep areas may be stabilized with jute netting or pre-made erosion control fabric containing seed, mulch, and fertilizer. Culverts or crushed stone fords installed along access roads would be either left in place or removed, as directed by the Council or pursuant to other agency approvals. After site stabilization is achieved, all temporary erosion and sedimentation controls that are not biodegradable (e.g., geotextile material, twine, stakes) would be removed from the ROW and disposed of properly.

4.1.2 Material Staging Sites

To support the construction of the new 345-kV transmission lines, a combination of temporary storage areas, staging areas, and crane pads would be necessary. The preferred locations for temporary storage and staging sites are in the general vicinity of the ROWs. Although the staging areas do not necessarily have to be adjacent to the transmission line ROWs, establishing these areas in proximity to construction sites would improve construction efficiency and minimize the potential for inconvenience or nuisance effects to the public (e.g., as a result of the movement of equipment, manpower, and supplies to and from the ROWs along public roads). Crane pads are located within the ROW, at individual transmission structure locations.

Whenever practical, material storage and staging areas would be established on CL&P-owned property. Based on the general acreage requirements for each type of staging location (refer to the discussions in Sections 4.1.2.1 and 4.1.2.2), CL&P performed a preliminary review to identify its owned properties in the vicinity of the ROWs that could potentially serve as storage and staging area locations for the Project. Table 4-1 lists the CL&P-owned sites identified as a result of this preliminary assessment. Because all of the identified sites are more than 2 acres, any of these properties could potentially be used for either material storage or staging in support of Project construction.

Table 4-1: Potential Material Storage or Staging Sites on CL&P-Owned Properties

Town	CL&P Property Location (Volume 9 Mapsheet No.)
Lebanon	Card Street Substation (Mapsheet 1 of 40)
Coventry	Babcock Hill Road (Mapsheet 4 of 40)
Mansfield	Bassetts Bridge Road (Mapsheets 8 and 9 of 40)
Brooklyn	Day Street Junction (Mapsheet 24 of 40)
Pomfret	State Route 101 (Mapsheet 27 of 40)

However, it is likely that additional material storage and staging areas may be necessary to support Project construction. If CL&P-owned properties are not available or suitable, previously developed sites (such as parking lots) or vacant land would be evaluated for use as material storage or staging areas, taking into consideration parcel size requirements and location in relation to the Proposed Route. At any location not already developed (e.g., paved parking lots) or previously used for such construction support, work would likely be required to prepare the site for use as a material storage or staging area. Such site preparation work may include vegetation removal, grading, adding gravel, and installing crushed stone anti-tracking pads at vehicular access points from public roads.

The actual locations of the staging and storage sites would be determined by, or with input from, the contractor responsible for constructing the lines. The contractor would be responsible for finalizing the locations of staging and storage areas, and also for making arrangements with property owners regarding the use of the properties. CL&P would review and approve the contractor's proposed construction support sites, and would obtain approval from the Council and, if necessary, other regulatory agencies.

The development, use, and restoration of any staging sites would conform to conditions of the Council's certificate and any other applicable federal, state, and local requirements. Because the locations of the staging sites would not be finalized until after a construction contractor is selected, CL&P would either specify such sites in the D&M Plan(s) for the Project or submit them separately to the Council for approval prior to use.

4.1.2.1 Temporary Storage Areas

Temporary storage areas typically range in size from approximately 2 to 5 acres. These areas would be used to temporarily store construction materials, equipment, and supplies. Storage areas also would be used for mobile construction offices, parking the personal vehicles of construction crew members, parking construction vehicles and equipment, and performing minor maintenance, if needed, on construction equipment.

In addition, storage areas may function as staging areas. For example, components for new transmission line structures may be temporarily stored at these locations prior to delivery to structure sites. Transmission line materials or structures also may be assembled at storage areas prior to delivery to the ROW.

Storage areas for the proposed Project would typically be selected based upon proximity to work locations along the ROWs. As the construction of the transmission lines progresses, storage areas are typically moved to keep equipment and materials close to the locations where line construction work is being performed. Once a storage area is no longer used to support construction activities, it would be restored to pre-construction conditions, pursuant to the use agreement with the property owner.

4.1.2.2 Staging Areas

Staging areas, which are generally less than 2 acres in size, are typically used for temporarily stockpiling materials for transmission line construction (e.g., erosion and sedimentation control materials, poles and structure components, insulators and hardware, and construction equipment). In addition, staging areas may be used to temporarily stockpile materials removed from the ROW or used during the construction process, prior to off-site disposal. The number and proposed locations of staging areas required to support the construction effort would be determined by the transmission line construction contractor.

Staging areas would be required in proximity to the transmission line route and may be located on or off the ROW. CL&P-owned property that is presently used for utility purposes or otherwise cleared of vegetation would be used for staging areas to the extent practical.[3] Locations along the ROW could also be used, provided sufficient easement rights exist.

As construction progresses, staging areas would likely be relocated to coincide with construction work. When a particular staging area is no longer required, the site would be returned to its pre-construction condition, to the extent practical, as requested by the property owners.

4.1.2.3 Crane Pads

At each transmission line structure site along the ROW, a work area, called a "crane pad", is required in order to stage structure components for final on-site assembly and to provide a safe, level work base for the construction equipment used to erect the structure. The size and configuration of a crane pad at a particular structure location would vary based on site-specific conditions; however, a typical pad averages about 100 feet by 100 feet. The exact locations and configurations of crane pads would be determined during final Project design, based on site-specific conditions (e.g., to avoid or minimize work in wetlands or other environmentally- or culturally-sensitive areas). Generally, however, at each structure site, the crane pad would be situated within the structure location envelope identified on the Volume 11 maps.[4]

A typical (upland) installation of a crane pad involves several steps, beginning with the removal of vegetation, if necessary. The crane pad site then would be graded to create a level work area and, if necessary, the upper 3 to 6 inches of topsoil (which is typically unsuitable to support the necessary

[3] CL&P-owned property that is forested would not be cleared for use as a staging area or other type of construction support site.

[4] Note that each structure location envelope depicted on the Volume 11 maps encompasses an area of 200 feet by 200 feet. However, the crane pad associated with a structure would occupy only a subset of this area.

construction activities) would be removed. The topsoil would be temporarily stockpiled within the ROW. A filter fabric layer then would be installed over the excavated area. A rock base, which allows drainage, then would be layered on top of the filter fabric. Additional layers of rock with dirt/rock fines are typically placed over this rock base. Finally, a roller is used to flatten and compact the pad. Crane pads often can be modified and contoured to the surrounding area to minimize impacts. In areas where crane pads must unavoidably be located in wetlands, layers of removable timber mats are typically used to construct the pads. Alternatively, a large rock base layer may be used to allow water to flow underneath the pad. Smaller rock is layered on top of larger rock, followed by the final layer of gravel intermixed with soil.

Upon completion of construction, crane pads would typically be removed. The rock base and fabric materials would be excavated and removed for off-site disposal. Timber mats, where used for crane support in wetlands, would similarly be removed. The topsoil layer would be re-spread over the crane pad site and the area would be returned to pre-construction grade, to the extent practical and consistent with CL&P’s ROW maintenance program.

4.1.3 Construction Field Offices

Field offices provide headquarters for engineering and supervision personnel near the areas where work is being performed. If not practical to locate in an existing commercial facility, these field office sites typically consist of trailers, portable sanitary facilities, and associated parking areas.

Such construction offices are optimally located on property owned by CL&P (including at substation or switching station sites) or on the existing transmission line ROWs. The field offices also may be collocated with other construction support sites, such as staging or storage areas. As construction progresses along the transmission lines route, field offices may be relocated to allow field management staff to remain near the areas of work activity. When a construction field office site is no longer needed, the office trailers and other construction support equipment or materials would be removed, and the area would be restored.

For construction office sites located on private property, restoration would be in accordance with landowner agreements. If field office sites are located on CL&P-owned property, restoration would be pursuant to CL&P's requirements.

4.1.4 Right-of-Way Preparation

Along with the development or improvement of access roads (refer to Section 4.1.5), ROW preparation constitutes the first step in the transmission line construction process. ROW preparation activities typically involve vegetation removal and the associated deployment of erosion and sedimentation controls. In addition, during this phase of construction, exclusion fencing or other types of boundary markings are typically installed to demarcate areas of restricted construction access or environmental sensitivity.

4.1.4.1 Temporary Erosion and Sedimentation Controls

Temporary erosion controls (e.g., silt fence, hay/straw bales, filter socks, mulch, temporary and/or permanent reseeding) would be initially installed as practicable prior to and/or during vegetation clearing operations, in compliance with the 2002 *Connecticut Guidelines for Soil Erosion and Sedimentation Control* and NU's Transmission Group policy manual entitled, *"Best Management Practices Manual: Construction and Maintenance Environmental Requirements for Connecticut"*. NU's manual is included in Volume 6 of this Application. Temporary controls, such as silt fence, hay/straw bales, and filter socks, also may be deployed during any of the transmission line construction phases involving soil disturbance. Such controls would be maintained (i.e., repaired and replaced as necessary) throughout the construction period, until disturbed areas are revegetated or otherwise stabilized. After stabilization is achieved, these materials would be removed and disposed of appropriately.

Generally, in areas where soils have been or would be disturbed or areas near sensitive environmental resources (e.g., wetlands, watercourses, threatened and endangered habitat), temporary controls would be deployed as appropriate to minimize the potential for erosion and sedimentation off ROW or into water resources (on or off the ROWs).[5] In addition, temporary erosion and sedimentation controls (e.g., silt fence, straw/hay bales) may be deployed after vegetation removal to demarcate the limits of work within sensitive environmental areas (i.e., limits of access roads, crane pads).

The need and extent of temporary erosion and sedimentation controls would be a function of considerations such as:

- Slope (steepness, potential for erosion, and presence of environmentally sensitive resources, such as wetlands or streams, at the bottom of the slope).
- Type of vegetation removal method used and the extent of vegetative cover remaining after clearing (e.g., presence/absence of understory or herbaceous vegetation to minimize the potential for erosion and degree of soil disturbance as a result of the clearing equipment movements).
- Type of soil.
- Soil moisture regimes.
- Schedule of future construction activities.
- Proximity of cleared areas to water resources, roads, or other sensitive environmental resources.
- Time of year. The types of erosion and sedimentation control methods utilized along the ROWs would depend on the time of year construction work is initiated and completed. For example, re-seeding is typically ineffective during the winter months. In winter, with frozen ground, controls other than re-seeding (such as wood chips, straw and hay, geotextile fabric, erosion control logs) typically would be deployed or maintained to control erosion and sedimentation and thus to stabilize disturbed areas until reseeding can be performed under optimal seasonal conditions.

[5] In some locations, such as areas where vegetation is cleared and water resources are situated nearby but no further earth-disturbing construction activities are required, soils may be stabilized with permanent measures (e.g., final revegetation). Refer to Section 4.1.8.1 for a discussion of final revegetation and permanent erosion control measures.

4.1.4.2 Vegetation Removal, Including Tree Clearing

Vegetation Clearing Requirements and Estimates

Along the entire 36.8-mile length of the Proposed Route, the new 345-kV transmission lines would be located adjacent to existing overhead transmission lines, which are situated within CL&P ROWs that vary in width from approximately 150 to 400 feet. Beneath and in the vicinity of the existing transmission lines that occupy these ROWs, CL&P routinely manages vegetation pursuant to requirements for the reliable operation of the overhead transmission lines.

Since April 7, 2006, CL&P's ROW vegetation management practices have been required to comply with mandatory standards adopted by the North American Electric Reliability Corporation (NERC) following the August 14, 2003 Northeast blackout.[6] These vegetation management practices are designed to allow the reliable operation of the transmission facilities by preventing the growth of trees or invasive vegetation that would otherwise interfere with the transmission facilities or hinder access along the ROWs. As a result, the vegetation within the managed portions of the ROWs typically consists of shrubs, herbaceous species, and other low-growing species.

To accommodate the construction and subsequent operation of the new 345-kV lines, additional vegetation removal would be required. Vegetation along the ROWs would be removed where necessary to allow for construction, to provide and maintain access to structures and, as needed, along the ROWs, and to provide safe distances between the conductors and woody vegetation at all times. However, the amount of and type of vegetation clearing required would vary and would depend on factors such as the existing width of the managed ROW, vegetation communities present (e.g., forested, herbaceous, scrub-shrub, open field), the type of the new 345-kV transmission structures, configuration and spacing of the transmission line conductors, transmission line span lengths, and terrain.

[6] Transmission line outages triggered by overgrown vegetation in Ohio were substantial factors in causing the blackout.

Along the ROWs within which the new 345-kV lines would be located, the width of the currently managed portions varies, depending on the number and configuration of the existing transmission lines that occupy the ROWs (refer to the cross-sections of the ROWs in Section 3, Appendix 3A of this volume and in Volume 9 and Volume 10). For example, along the 2.8 miles between Card Street Substation and Babcock Hill Junction, the 350-foot-wide ROW includes one 345-kV circuit supported on H-frame structures and two 69-kV circuits supported on common steel-pole structures. The new 345-kV line is proposed for location between the 345-kV and 69-kV circuits. A large portion of the ROW in this area is presently managed by CL&P for low-growth vegetative communities. As a result, along this segment of ROW, clearing for the construction of the new 345-kV line would predominantly involve the removal of scrub-shrub type vegetation.

On the other hand, along a majority of the Proposed Route, the new 345-kV line would be located adjacent to one existing 345-kV line, within a typical 300-foot-wide ROW. Along these ROW segments, CL&P presently manages (on average) a 140-foot-wide area beneath and adjacent to the existing 345-kV line where it is supported on H-frame structures.

The development of the proposed 345-kV line, where also supported on H-frame structures, would require (typically) an additional 90 feet of new vegetation removal for construction and subsequent management. In areas where the proposed new 345-kV line would use a delta conductor configuration on steel monopoles, slightly less (typically 70 feet) additional vegetation removal and management would be required. Table 4-2 summarizes the widths of the CL&P ROWs along which the proposed 345-kV lines would be located, together with the typical widths of the existing managed portions of the ROWs and the anticipated additional widths of vegetation removal required along each ROW segment of the Project.

Table 4-2: Summary of CL&P ROW Widths, Existing Managed ROW Widths, and Proposed Vegetation Clearing Widths for New 345-kV Transmission Lines

Town	EXISTING CL&P ROWS			
	Cross-Section Reference (refer to Vol. 1, Appendix 3A and to Vol. 10)	**Total ROW Width (feet)**	**Width of Current Vegetation Management Area along ROW (feet, typical)**	**Estimated Width of New Vegetation Clearing* Required for Proposed 345-kV Transmission Lines (feet)**
Lebanon	XS-1	350	275	0
Columbia	XS-1	350	275	0
Coventry	XS-1	350	275	0
Coventry	XS-2 BMP	300	140	70
Mansfield	XS-2 BMP	300	140	70
Mansfield	XS-2	300	140	90
Mansfield	XS-3 (0.9 mile)	150	100	80 (includes vegetation removal in proposed 55-foot-wide expanded ROW)
Mansfield	Within XS-3 (0.1 mile, but not depicted on XS)	300	140	90
Mansfield	XS-4	300	140	90
Chaplin	XS-4	300	140	90
Chaplin	XS-5	150	140	90 (includes vegetation removal in proposed 85-foot-wide expanded ROW)
Chaplin	XS-6	300	140	90
Hampton	XS-6	300	140	90
Brooklyn	XS-6	300	140	90
Brooklyn	XS-6 BMP	300	140	70
Brooklyn	XS-7	360	260	90
Pomfret	XS-7	360	260	90
Killingly	XS-7	360	260	90
Killingly	XS-8	360	345	0
Putnam	XS-8	360	345	0
Killingly	XS-9	250	250	0
Killingly	XS-10	400	385	0
Killingly	XS-11	340	210 (140 transmission line; 70 distribution line)	90
Putnam	XS-11	340	210 (140 transmission line; 70 distribution line)	90
Putnam	XS-12	300	140	90
Putnam	XS-12 BMP	300	140	80
Thompson	XS-12	300	140	90

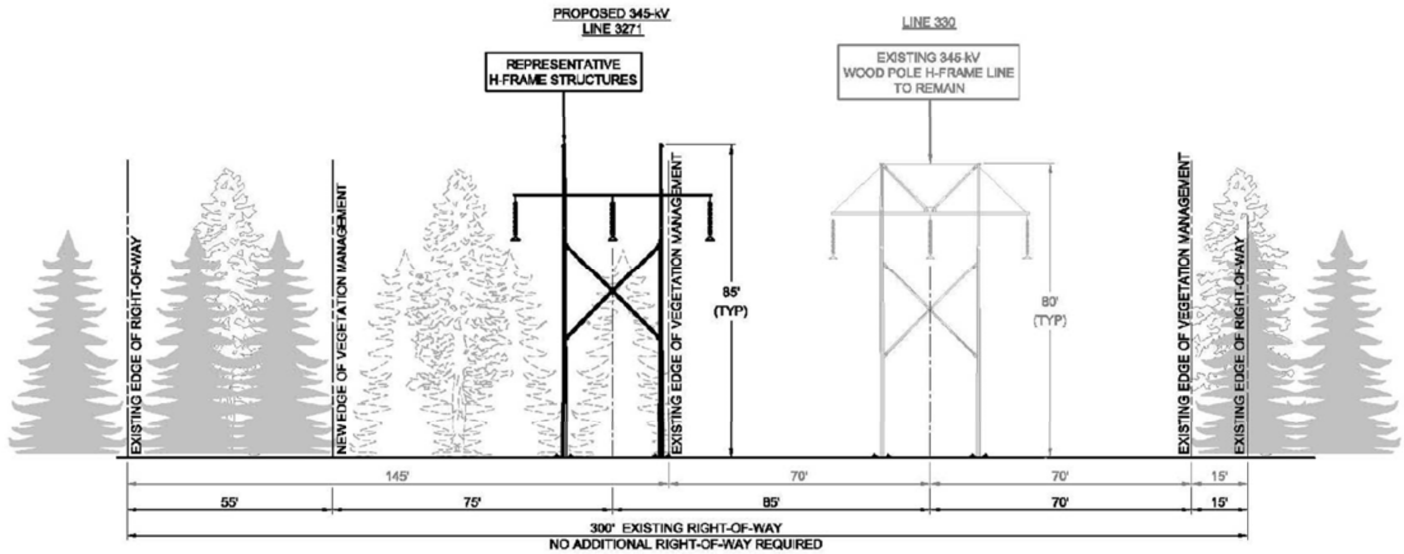
*Note: Clearing refers to vegetation removal required for the Project within un-managed portions of CL&P's existing ROWs or – in the case of the USACE properties in Mansfield and Chaplin – also areas of expanded easement within which vegetation removal would be required. Locations with "0" new clearing pertain to portions of the existing ROWs where the new 345-kV line would be aligned within areas where CL&P presently manages vegetation on a routine basis. To construct the new 345-kV lines, this managed vegetation will be removed as necessary. Within these ROW segments, some areas of forested and other vegetation, located in the center of the CL&P ROW, also would have to be removed.

Most vegetation within the remaining width of ROW would not be affected by construction activities. Where the ROW is 300 feet wide, typically 55 to 70 feet would remain unaffected (50 to 60 feet from the edge of the new clearing limits associated with the new 345-kV line and 5 to 15 feet from the edge of the managed portion of the ROW adjacent to the existing 345-kV line). These unused (non-managed) portions of the ROWs support taller vegetation, including forested uplands and wetlands. Figure 4-1 illustrates the typical 300-foot-wide ROW and identifies the vegetation removal that would be required to construct and operate the new 345-kV H-frame line adjacent to the existing 345-kV H-frame line. This typical drawing is for illustrative purposes only; refer to Appendix 3A and Volumes 9 and 10 for proposed ROW configurations.

As part of the construction of the new transmission lines, undesirable, tall-growing, woody species within the ROW areas proximate to the new lines would be removed. Desirable species would be preserved to the extent practical. In selected cases, certain desirable, low-growing trees may be kept on the ROW in specific locations and only trimmed to ensure adequate clearance from wires and structures, pursuant to CL&P's *Right-of-Way Vegetation Initial Clearance Standard for 115-kV and 345-kV Transmission Lines*. Generally, all tall-growing tree species would be removed from the managed portion of the ROWs and low-growing tree species and taller shrub species would be retained in the areas outside of the conductor zones (the area directly under the conductors extending outward a distance of 15 feet from the outermost conductors).

These activities would modify but not eliminate vegetation and wildlife habitats along the ROWs. In general, the principal long-term effect of vegetation removal along the ROWs would be to forested habitat. Specifically, within the additional 90-foot-wide area where new vegetation clearing would be required to accommodate the proposed 345-kV H-frame line, trees would be removed and would not be allowed to regenerate. Over time, these previously forested areas would be recolonized by native shrubs, forbs, and grasses, creating additional old field and scrub-shrub communities.

Figure 4-1: Typical Vegetation Removal: Proposed ROW Configuration with H-Frame Design



NOTES:

1. Typical existing ROW width as shown is 300 feet. Existing H-frame structures (330 Line) to remain. Typical structure height refers to common heights and is not indicative of structure height.

2. The proposed and existing structure locations, as depicted on this figure, are typical and may not be representative of all locations along the Project ROWs.

3. Approximately 90 feet of new vegetation removal and subsequent vegetation management would be required for the new 345-kV line supported on H-frame structures as shown. Approximately 70 feet of new vegetation removal would be required along the ROW in areas where steel monopole structures are proposed for the new 345-kV line.

4. Low-maturing woody shrub species typically would not be removed for Project construction, except as needed at work sites (e.g., crane pads, access roads). Portions of the ROWs where CL&P presently manages vegetation in conjunction with the operation of the existing 345-kV (and other) transmission lines may be used during Project construction.

5. As part of vegetation removal during construction or after the conductors have been installed, additional trees, located outside of the initially cleared area, may need to be selectively removed or pruned to maintain required clearances.

6. Typical structure heights were determined from typical expected spans. Typical structure heights are subject to change based on the completion of final Project design.

Landowner Outreach and Beneficial Use of Forestry Products

The timber and firewood resources along the Proposed Route belong to the landowners across whose property the ROW is aligned. CL&P's policy is to proactively coordinate with landowners regarding the disposition and use of the trees to be removed along the ROWs. If requested by the landowner, the firewood and timber portions of the trees would be left on the landowner's property, in upland areas on the edge of the vegetatively managed portion of the ROW. After the limbs are removed, the wood would be piled in tree lengths for landowners to cut and remove at their convenience.

Timber and firewood removed along the ROW on CL&P-owned property or on parcels where the landowners are not interested in retaining the wood would become the property of the Project's land clearing contractor. CL&P would competitively bid the vegetation removal work for the Project and would select a contractor taking into consideration the contractor's plans for the beneficial use of the forest products.

Vegetation Clearing Methods

Vegetation would be typically removed from the proposed transmission line construction workspace (including the areas to be vegetatively managed in the vicinity of the new line) using mechanical methods. Where necessary, CL&P will encourage the selected vegetation clearing contractor to use low-impact tree clearing means and methods to remove forested vegetation. Low-impact tree clearing incorporates a variety of approaches, techniques, and equipment to minimize site disturbance and to protect wetlands, watercourses, soils, rare species and their habitats, and cultural resources.

During vegetation removal, timber mats or equivalent may be used to provide a stable base for clearing equipment across wetlands or within wetlands along the ROW. Such temporary support would minimize rutting in wetlands and would be removed after the clearing activities are completed. The locations where temporary support would be required would be determined in the field, based on site-specific conditions (e.g., soil saturation) present at the time of construction, and may not be the same as the permanent or temporary access roads illustrated on the Volume 9 and Volume 11 maps.

Appropriate erosion and sedimentation controls would be deployed as necessary (refer to Section 4.1.4.1). Where removal of woody vegetation is required, vegetation would be cut flush with the ground surface to the extent possible. Where practical, trees would be felled parallel to and within the ROW to minimize the potential for damage to residual vegetation.

CL&P would take particular care to retain lower growing vegetation along stream banks and within wetlands to the extent possible. In general, CL&P may alter to some degree vegetation management activities in the following areas, provided that the construction and operation of the facilities remains in accordance with national transmission line vegetation management standards:

- Areas of visual sensitivity where vegetation removal may be limited for aesthetic purposes;
- Steep slopes and valleys spanned by transmission lines;
- Agricultural lands; and
- Residential areas where maintained landscapes do not interfere with the construction, maintenance, or operation of the transmission lines.

Danger Trees

During and after the 345-kV transmission line construction, on- and off-ROW "danger" trees[7] that threaten the integrity of the transmission lines would be identified and removed or pruned as necessary. Danger trees are weak, broken, decaying, or infested trees that could cause flashovers or damage to the structures or conductors or violate the conductor zones if they were to fall toward the transmission lines.

[7] To the extent that relatively wide, un-managed portions of the existing ROW border the new 345-kV lines, there is a lower potential for off-ROW "danger" trees, but on-ROW danger trees outside the limits of the clearing may be identified and removed.

4.1.5 Access Roads

As discussed in Section 3.1.5, access roads are required during construction. "On-ROW access roads" would be used to move equipment and material between structure locations. Further, in some areas, to avoid traversing along the ROW through sensitive environmental resources (i.e. wetlands and vernal pools) or rugged topography along the ROWs, access roads to the ROW may be developed across private property or across land owned by CL&P ("off-ROW access roads").

Depending on site-specific conditions, grading may be required to develop or to improve access roads. Some access roads would be needed only during construction and thus would be used temporarily, whereas other access roads will be required permanently for the long-term operation and maintenance of the new transmission lines.

Typically, at points of intersection with public roads, CL&P would install signs along the access roads that specify the roads are for construction purposes and are restricted from use by public vehicular traffic. In addition, where on-ROW access roads or off-ROW dirt roads intersect with public roads, rock aprons or equivalent are typically used to minimize tracking of dirt from the ROW onto the public road as a result of construction vehicle movements. Public roads in the vicinity of access roads may also be periodically swept to remove dirt that is tracked from construction activities.

4.1.5.1 On-ROW Access Roads

Contiguous access along the existing ROWs is generally not necessary for the construction of the proposed 345-kV overhead transmission lines, although access is required to each proposed transmission structure location. Along most of the Proposed Route, the existing 345-kV lines (and other transmission and distribution lines) have been in service for approximately 40 years and, as a result of the ongoing operation and maintenance activities along those transmission lines, some access roads are already established. Such existing access roads would be used for the construction of the new transmission lines wherever possible. The on-ROW access roads expected to be used for the proposed Project are illustrated on the maps in both Volume 9 and Volume 11.

However, most of the existing access roads would have to be improved, widened, or otherwise modified in order to be used safely and effectively during construction. For example, to safely support the heavy construction equipment (e.g., flat-bed trailers, cranes, and concrete trucks) required to install 345-kV transmission line structure foundations and transmission line structures, access roads must be sufficiently wide, with a stable base and grades that typically must be 10% or less.

Access road improvements typically include clearing adjacent vegetation and widening roads as needed to provide a minimal travel surface approximately 12 to 16 feet wide (additional width would be needed at turning or passing locations). Access roads may be graveled. Where access roads traverse streams or wetlands, culverts and timber mats (or equivalent) may be used. Existing culverted crossings may also be improved. Erosion and sedimentation controls would be installed as necessary before the commencement of any improvements to or development of access roads.

4.1.5.2 Off-ROW Access Roads

Along portions of the Proposed Route, terrain and environmental features (e.g., steep slopes, rock outcrops, large wetland complexes, rivers, Mansfield Hollow Lake) make linear construction access along the ROW difficult or impractical. In such locations, to avoid or minimize adverse environmental effects while allowing safe access to the ROWs, CL&P proposes to use off-ROW access roads as necessary. Such off-ROW access roads will entail the use of public roads or access roads across private property.

CL&P performed an initial review of existing access roads leading to the transmission line ROW for the Project. Based on this initial review, an inventory of possible access roads was prepared. Table 4-3 lists the public roads that provide the access to the transmission line ROWs.

Table 4-3: Potential Public Road Access to ROW

Town	400-Scale Aerial Mapsheet No. (Volume 9)	Existing Access to ROW via the following Town/City Streets or Sites
Lebanon	1 of 40	Card Street
Lebanon/Columbia	1 & 2 of 40	Baker Hill Road
Columbia	2 of 40	Cards Mill Road
Columbia	2 & 3 of 40	Old Willimantic Road
Columbia	3 of 40	Route 66 (Willimantic Road)
Coventry	3 & 4 of 40	U.S. Route 6
Coventry	4 of 40	Babcock Hill Road
Coventry	5 of 40	Flanders River Road
Mansfield	5 of 40	Route 32 (Stafford Road)
Mansfield	6 of 40	Highland Road
Mansfield	7 of 40	Mansfield City Road
Mansfield	8 of 40	Route 195 (Storrs Road)
Mansfield	8 & 9 of 40	Bassetts Bridge Road
Mansfield	9 of 40	Hawthorne Lane
Mansfield	10 of 40	Bedlam Road
Chaplin	11 of 40	Route 6 (Willimantic Road)
Chaplin	12 of 40	Chewink Road
Chaplin	12 of 40	Fiske Road
Hampton	13 of 40	South Brook Street
Hampton	13 & 14 of 40	Parker Road
Hampton	15 of 40	Route 97 (Pudding Hill Road), Cemetery Road, South Bigelow Road
Hampton	16 of 40	Drain Street
Hampton	17 of 40	Drain Street
Brooklyn	18 of 40	Stetson Road
Brooklyn	19 of 40	Windham Road, Route 6 (Hartford Road), Appell Road
Brooklyn	20 of 40	Laurel Hill Road, Wolf Den Road
Brooklyn	21 of 40	Costello Road
Brooklyn	21 & 22 of 40	Route 169 (Pomfret Road)
Brooklyn	23 of 40	Barrett Hill Road
Brooklyn	24 of 40	Darby Road, Church Street, Day Street
Brooklyn	25 of 40	Woods Hill Road
Pomfret	26 of 40	Route 101 (Killingly Road)
Pomfret	27 of 40	Route 101 (Killingly Road)
Killingly	28 & 29 of 40	Lake Road
Putnam	30 of 40	River Road
Killingly	30 of 40	Louisa Viens Road
Putnam	32 of 40	Park Road
Putnam	33 of 40	Route 12 (Killingly Avenue)
Putnam	34 of 40	Heritage Road
Putnam	34 & 35 of 40	Tourtellotte Road
Putnam	35 of 40	Route 21 (Liberty Highway), Aldrich Road
Putnam	36 of 40	Fox Road
Putnam	37 of 40	U.S. Route 44 (Providence Turnpike), Munyan Road
Thompson	38 & 39 of 40	Quaddick Town Farm Road
Thompson	38 & 39 of 40	Elmwood Hill Road
Thompson	40 of 40	Elmwood Hill Road

As planning for the Project continues and off-ROW access roads are further defined, some of the in-ROW access roads depicted on the Volume 9 and Volume 11 maps may be modified or eliminated to minimize adverse effects on environmental resources (e.g., to avoid or minimize wetland crossings). Conversely, new access roads that optimize ingress and egress to the ROW may be identified. A detailed evaluation of the access roads required for construction would be conducted and included in the D&M Plan to be prepared for the Project.

4.1.6 Structure Installation

4.1.6.1 Foundation Work (Foundation Types and Excavation)

The proposed new 345-kV transmission line structures may be direct embedded or may require drilled shaft foundations. H-Frame and guyed structures are typically direct embed. All others will typically have a drilled shaft foundation. Most excavations for line-structure foundations are expected to be accomplished using mechanical excavators (drill rigs) and pneumatic hammers. Fencing or other barricades would be placed around or over open foundation excavations for structures during non-working hours.

If blasting is required, a controlled drilling and blasting plan would be developed by a certified blasting contractor in compliance with state and local regulations. Residents would be contacted in advance of the blasting, and pre-blast surveys would be performed as appropriate. The specific locations where blasting would be required are determined by conducting field studies (borings) at the proposed structure locations. In the unlikely event that there is damage to a property as a result of the blasting, CL&P would compensate the property owner for the actual damage.

4.1.6.2 Structure Placement

Structures (steel or laminated wood poles and arms) would be delivered to installation locations in sections, then assembled and installed with a crane. Insulators and connecting hardware would be installed on most structures at this time. Structures that are not self-supported (angle or deadend) will be guyed and anchored to the ground. Supplemental grounding also would be installed on the new structures. Such grounding consists of a ground ring and sometimes counterpoise (i.e., buried conductors). The type of grounding at each structure depends on the electrical characteristics of the soil.

4.1.7 Conductor Work

The installation of the overhead line conductors and shield wires requires the use of special pulling and tensioning equipment, which is positioned at pre-determined locations at intervals of 1 to 3 miles. Helicopters also may be used to install the initial pulling lines at the commencement of the conductor / shield wire pulling process.

The wires would be pulled under tension to avoid contacting the ground and other objects. The remaining insulators and hardware would then be installed at angle and deadend structures. Finally, the conductors and shield wires would be pulled to their design tensions and attached to the hardware by linemen in bucket trucks in accordance with industry standards and design specifications.

Various pulling sites would be established along the approximately 36.8-mile transmission line route. These sites, which are typically 50 to 100 feet wide and 100 to 200 feet long, are usually located within the ROW. Specific conductor pulling sites would be identified by the Project construction contractor, in consultation with CL&P.

The selection of conductor pulling sites is based upon a variety of factors including: accessibility, terrain, angles within the line sections where the conductors would be pulled, the locations of deadend structures (which keep installed conductors under high tension), the length of conductors to be pulled, puller capacity, and snub structure[8] loads. Other considerations include the placement of pullers, tensioners, conductor anchors, and other associated pulling equipment, including the installation of a temporary

[8] A structure located at one end of a sag section and considered as a zero point for sagging and clipping offset calculations. A snub is a pole stub or log that is set or buried in the ground to serve as a temporary anchor. Snubs are often used at pull and tension sites.

grounding system. Along the Proposed Route, conductor pulling sites would be determined based on the consideration of these factors, the design load of the structures, and the avoidance or minimization of environmental effects.

Steps would be taken to minimize temporary disturbance to adjacent landowners from noise and activity associated with the pulling operation. In addition, conductor pulling sites would be located outside of wetlands, and would avoid other areas of environmental sensitivity to the extent practical.

4.1.8 Right-of-Way Cleanup and Restoration

ROW cleanup and restoration activities would include the removal of construction debris, removal of temporary access roads, final re-grading of areas affected by construction, and site stabilization using revegetation or other measures.

4.1.8.1 Final Grading, Revegetation, and Permanent Erosion and Sedimentation Controls

During final grading, disturbed ground generally would be back-bladed to approximate preconstruction contours, unless otherwise noted in a landowner agreement. Some areas (e.g., slopes, bluffs) affected by construction activities cannot be fully restored to original contours. Such areas would be stabilized as warranted by site-specific conditions.

Permanent controls, such as water diversion bars or crushed stone, would be installed as appropriate to minimize the potential for erosion and sedimentation. Other permanent ROW stabilization measures include revegetation, or the use of erosion control blankets to promote revegetation.

For work sites along the ROWs in actively used agricultural fields, the soil may be decompacted by disking or using equivalent methods. Where permanent access is not required across wetlands or streams, temporary crossings (e.g., timber mats, other temporary crossing materials such as rock) would be removed and the affected areas re-graded to match the grade of areas outside of the construction work zone, to the extent applicable.

Temporary erosion and sedimentation controls would be left in place and maintained until final stabilization is achieved. Steep areas would be stabilized with jute netting, pre-made erosion and sedimentation control fabric containing seed, mulch, and fertilizer or the equivalent.

Restoration typically is deemed successful, based on the effectiveness of stabilization measures (such as percent vegetative cover) as defined in accordance with applicable permit and certificate requirements. Based on the results of post-construction inspections of ROW stabilization (refer to Section 4.1.11), CL&P would determine the appropriate time frame for removing temporary erosion controls.

Upland areas disturbed by construction activities typically would be seeded with appropriate seed mixes and fertilized as appropriate. Mulch or other erosion controls would be applied as needed based on slope and land use. Fertilizer and mulch would not be applied in wetlands. Wetland areas disturbed by construction would be reseeded in annual rye, or an equivalent mix, which would serve to provide a temporary vegetative cover until wetland species become reestablished.

Vegetative species compatible with the use of the ROWs for transmission line purposes are expected to regenerate naturally over time. CL&P would promote the re-growth of desirable species by implementing vegetation management practices to control tall-growing trees, and where practicable, undesirable invasive species, thereby enabling native plants to dominate the ROWs. Vegetation management practices along the ROWs also would conform to Project-specific conditions regarding habitat restoration and enhancement as may be included in approvals from the Council, CT DEEP, and USACE (refer to Section 4.4.1 for additional information regarding CL&P's long-term ROW vegetation management program, including invasive species control).

4.1.8.2 Permanent Access Roads

The locations of permanent access roads that would be maintained to facilitate the operation and maintenance of the transmission lines would be identified in the D&M Plan(s). Such roads would be in accordance with the Council's approval, as well as (for permanent roads across streams and wetlands) the conditions of regulatory permits and certificates from the CT DEEP and the USACE.

At streams where culverts or crushed stone fords are installed to facilitate construction, the access roads would be left in place for use during the operation and maintenance of the transmission lines. However, CL&P would remove access roads across streams if directed by the Council or required pursuant to the conditions of other state or federal permits.

4.1.8.3 Methods to Prevent or Discourage Unauthorized Use of the ROWs

CL&P's existing transmission line easements restrict the types of activities that can be conducted within the ROWs. Easements typically prohibit the construction of buildings, pools, and other structures within the ROWs. Additionally, CL&P has policies addressing requests from property owners and other parties external to CL&P. These policies outline an evaluation process and provide guidelines for allowing certain uses (such as driveways or parking lots), where appropriate.

In addition, CL&P routinely works with landowners to discourage unwarranted access onto and use of its ROWs, such as by third-party users of off-road vehicles such as all-terrain vehicles (ATVs) and snowmobiles. Where CL&P holds an easement rather than land ownership in fee, CL&P must receive landowner approval prior to installing barriers (such as fences, gates, and access control berms) to discourage such access onto the ROWs.

Pursuant to Connecticut General Statutes Section 14-387, written landowner permission is required for the use of ATVs and snowmobiles on privately-owned property. CL&P does not grant permission for ATV or snowmobile use on its property or easements (other than for its own purposes), and seeks the cooperation of local police departments in discouraging these off-road vehicular uses along its ROWs. In addition, upon request, CL&P will provide landowners along the ROWs with "no trespassing" signs for posting on their property and will install gates[9] or other barriers at public road crossings to deter unauthorized vehicular access along the ROWs.

4.1.9 Traffic Considerations and Control

During the installation of the new transmission lines, construction-related vehicular and equipment movements would occur on roads in the Project area. However, the Project-related traffic is generally expected to be temporary and highly localized in the vicinity of the ROWs and staging areas. Due to phasing of construction work, these Project-related traffic movements are not expected to significantly affect transportation patterns or levels of service on public roads.

During the Project construction phase, vehicles and equipment also would enter and exit the ROWs from various public roads. To safely move construction vehicles and equipment onto and off the ROWs while minimizing disruptions to vehicular traffic along public roads, CL&P would develop both an "access plan" for its construction contractors and traffic control plans, as appropriate.

4.1.10 Construction and Post-Construction Monitoring: D&M Plan(s)

In accordance with the Council's requirements, after the certification of the Project, CL&P would prepare and submit for Council approval D&M Plan(s) that would detail the procedures to be used to construct the proposed transmission facilities. The D&M Plan(s) would incorporate the conditions of the Council's Certificate of Environmental Compatibility and Public Need (Certificate) for the Project, as well as the conditions of the permits received from other regulatory agencies, as appropriate.

[9] Of the possible types of access barriers, CL&P typically prefers to install locking gates, which best allow company access to the ROW when needed. Typically, locked gates are installed along the ROW at public access points (e.g., public road crossings) to deter unauthorized off-road vehicular use.

CL&P would retain engineering and environmental consultants to monitor the conformance of construction activities to the D&M Plan(s), the Council's Certificate, and other regulatory requirements and company standards. CL&P also anticipates that the Council would conduct periodic inspections of construction and would require the submission of routine reports concerning construction status.

After the completion of construction activities (including ROW restoration), CL&P would continue to conduct periodic monitoring of the Project ROWs and would prepare reports concerning the status of ROW revegetation or stabilization. The monitoring would continue until ROW revegetation is determined to be successful, as defined by Project permits.

4.2 CONDITIONS REQUIRING SPECIAL CONSTRUCTION PROCEDURES

The Proposed Route extends across various wetlands and waterbodies, as well as areas of bedrock outcrops or where bedrock is close to the surface. In some locations, the water table also is close to the surface, resulting in the potential for encountering groundwater in excavations for structure installations. Furthermore, the Proposed Route traverses certain areas that may potentially contain contaminated soils or groundwater. The following subsections describe the general construction procedures that CL&P would use for water resource crossings, blasting, soils / groundwater characterization and management, and construction site dewatering. Additional, site–specific procedures would be provided in the D&M Plan(s), as applicable, after the completion of a final Project design.

4.2.1 Water Resource Crossings

During the construction of the Project, CL&P proposes, to the extent practical, to avoid or limit work in watercourses (streams, rivers, lakes), and to minimize the placement of structures and permanent access roads in wetlands. In addition, CL&P would implement erosion and sedimentation controls in upland areas near water resources to limit the potential for upland erosion and sedimentation into water bodies or wetlands.

All construction activities involving water resources would be performed in accordance with the conditions of the Council's Certificate, as well as pursuant to the conditions of the Project-specific water resource permits issued by the CT DEEP and the USACE. In addition, construction activities will conform to NU's *Best Management Practices Manual: Construction & Maintenance Environmental Requirements for Connecticut*, as well as the requirements of plans (e.g., Stormwater Pollution Control Plan; Invasive Species Control Plan; Spill Prevention, Containment, and Control Plan), which would be prepared for the Project prior to the commencement of construction.

The water resource permit conditions and related plans would be incorporated into the D&M Plan(s) or similar Project documents. CL&P would require the construction contractor(s) to adhere to such conditions and plans during the construction of the Project facilities.

4.2.1.1 Wetlands

To minimize or avoid adverse effects to wetlands, CL&P has attempted to locate new transmission line structures in upland areas wherever practical and to avoid access roads across wetlands if there are practical upland alternative access routes available to reach the structure locations. Where new structures must unavoidably be located in wetlands, CL&P would limit the effects to the wetlands to the extent practical. Mitigation measures may include, for example, reducing the crane pad size or by configuring the crane pad, if practical, to avoid or minimize the placement of temporary fill in wetlands. In general, where a new structure must be located in a wetland, temporary construction mats would be used for construction support. In some wetland areas, however, field conditions (such as thickness of organics, depth of water or steep slopes, etc.) may require the use of a temporary crushed stone pad to provide a safe working surface. After the completion of structure installation, the temporary fill used for the crane pads in wetlands would be removed, to the extent practicable and in accordance with the conditions of the Project-specific water resource permits issued by the CT DEEP and the USACE.

The wetland boundaries along the ROWs would be clearly flagged prior to the commencement of work.

When working in or traversing wetlands, CL&P would:

- Comply with the conditions of the Council's certificate and of federal and state permits related to wetlands.
- Install, inspect, and maintain erosion and sedimentation controls and other applicable construction best management practices.
- Conduct vegetation clearing in wetlands to minimize adverse effects such as by using low-impact equipment and installing temporary timber mats (or equivalent) to minimize rutting.
- Pile cut woody wetland or upland vegetation in upland areas so as not to block surface water flows within wetlands or otherwise to adversely affect the wetland integrity.
- Cut forested wetland vegetation without removing stumps unless it is determined intact stumps pose a safety concern for the installation of structures, movement of equipment, or the safety of personnel.
- Limit grading for access roads and structure foundations in wetlands to the amount necessary to provide a safe workspace.
- Install temporary construction matting or geotextile and stone pads for access roads across wetlands or to establish safe and stable construction work areas/crane pads within wetlands, where necessary. The type of stabilization measures to be used in wetlands would depend on soil saturation.
- 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 wetland functions.
- Install and maintain temporary erosion controls around work sites in or near wetlands to minimize the potential for erosion and sedimentation.
- Implement procedures for petroleum product management that would avoid or minimize the potential for spills into wetlands. For example, to the extent practical, store petroleum products in upland areas more than 100 feet from wetlands; refuel construction equipment, except for equipment that cannot be practically moved, in upland areas and if refueling must occur within a wetland, provide temporary containment. Similarly, except for equipment that cannot be practically moved (e.g., cranes), equipment would not be parked overnight on access roads or crane pads in wetlands.

- Restore structure work sites in – and temporary access ways through – wetlands following the completion of line installation activities.

- Restore wetlands, after transmission facility construction, to pre-construction configurations and contours to the extent practicable, and re-vegetate with annual ryegrass or equivalent.

To provide new access across wetlands (where no access road currently exists), CL&P would either construct a new gravel and crushed stone access road underlain by geotextile fabric, or install a timber mat (swamp mat) road. In wetlands where there is a deep organic layer or the wetlands are prone to extended inundation, the crushed stone access roads would remain in place permanently to provide a firm base for future access to the transmission facilities. The surficial fill materials used to construct the access roads would be removed down to the pre-construction elevation so as to not interfere with the wetland surface hydrology. The underlying material serves as either a firm base for equipment access or for the future placement of temporary timber mats to cross these larger wetland systems. CL&P anticipates this practice of establishing a permanent "access road base" may occur in some wetland systems. All other timber mat or gravel access roads would be removed in their entirety after construction.

4.2.1.2 Waterbodies

CL&P proposes to avoid direct construction work in watercourses to the extent feasible and to limit the potential for effects associated with erosion, sedimentation, or spills into streams, rivers, and lakes from nearby upland construction activities. The proposed transmission line conductors would span all major watercourses, and no transmission line structures are proposed for location in waterbodies. However, temporary and possibly permanent access would be required (i.e., use of existing access roads or creation of new access roads) across some of the smaller streams along the ROWs.

Along the Proposed Route, no access would be required across Mansfield Hollow Lake and the larger watercourses, such as the Willimantic, Natchaug, and Quinebaug rivers. Instead, the ROW would be accessed from either side of the lake and these rivers.

In contrast, temporary and possibly permanent access across smaller streams along the ROW would be required. However, the installation of new access roads for construction equipment crossings would be minimized to the extent practical. Whenever possible, equipment would use existing (permanent) culverted access roads to traverse watercourses. As part of pre-construction planning, CL&P would conduct integrity inspections of the existing culverted access roads. Culvert structures that are deemed to be either in disrepair or unable to support the weights of the construction equipment would be replaced at the same location and designed to maintain the stream flows. At some stream crossings, new access roads may have to be constructed or existing roads, involving fords, may require culverts or temporary bridges. Any proposed new culvert crossings would be designed and installed in accordance with applicable regulatory requirements.

Alternatively, temporary bridges consisting of timber mats, metal bridges, or equivalent may be used for equipment stream crossings. The temporary bridges would be installed and removed to limit or avoid direct effects to banks and stream-bottom sediments.

Where the ROWs traverse streams, only the minimum amount of vegetation necessary for the construction and safe operation of the transmission facilities (including the provision of access) would be removed. Vegetation removal near streams would be performed selectively, preserving desirable streamside vegetation within a 25-foot-wide riparian zone adjacent to either stream bank for habitat enhancement, shading, bank stabilization, and erosion/sedimentation control.

CL&P would take the following actions for construction activities across or near watercourses:

- Where existing access roads crossing stream bottoms must be improved, clean materials would be used (e.g., clean riprap or equivalent, rock fords). To the extent possible, the improvement of existing access roads across streams supporting fishery resources would be scheduled to avoid conflicts with fish spawning/migration.

- Water flows (if water is present at the time of construction) would be unconstrained throughout construction.
- Concrete would not be mixed, placed, or disposed of so as to enter a watercourse.

4.2.2 Blasting

If blasting is necessary, CL&P would take the following steps:

- A certified blasting specialist would develop site-specific blasting procedures, taking into account geologic conditions and nearby structures, and ensuring compliance with State regulations.
- The blasting plan would be provided to the local Fire Marshal for approval. Blasting charges would be designed to loosen only the material that must be removed to provide a stable foundation, and to avoid fracturing other rock.
- CL&P would seek to meet with each property owner in proximity to the blasting to explain where and when the blasting is expected to occur, and why blasting is necessary.
- Pre-blast surveys, to document existing conditions, would be conducted for any property within a specified distance of the area where blasting is to occur. This distance would be determined by CL&P's blasting contractor, in consultation with the Fire Marshal, and with CL&P's approval.
- The areas where blasting is to occur would be covered with heavy blanketing materials and charges would be sized appropriately.
- Seismographs would measure each blast to confirm that levels are within prescribed limits.
- Excavated material that cannot otherwise be used at the site would be removed and properly disposed of elsewhere, pursuant to Project specifications (e.g., the *Material Handling Guideline*).

4.2.3 Soils and Groundwater Testing and Management

4.2.3.1 Pre-Construction Studies and Plans

During the construction of the transmission lines, the effective management of soils and groundwater would be a key consideration. As part of the final Project design, CL&P would develop specific plans for characterizing the soils and groundwater (i.e., presence/absence of contaminants) along the ROWs, and subsequently for handling and managing such materials during construction. These plans would be developed based upon the results of agency file reviews, pre-construction sampling and analyses along the approved transmission line route, and the incorporation of applicable permit requirements.

Prior to the commencement of Project construction, CL&P would commission a due diligence review of existing data regarding the current and historical uses of areas along the ROWs, properties along the ROWs, and nearby off-site sources. The scope of the due diligence work would comply with Sections 8.1 and 8.2 of the American Society for Testing and Materials (ASTM) Standard E1527-05. The objective of the work would be to identify known locations of potential past or current contamination sources, such as leaking underground storage tanks, sites designated as hazardous by federal or state government, locations of reported spills of oil or hazardous material, etc.

Based upon the results of the due diligence research review, a sampling and analysis plan, referred to as an *In-Situ Soil and Groundwater Characterization Work Plan* (*Characterization Work Plan*), would be developed to characterize the soils and groundwater along the Project ROWs. This plan would identify the locations and depths of the soils and groundwater samples that would be collected, as well as the analytical tests that would be performed on the samples. In-situ characterization data would be collected along the ROW in the vicinity of locations of environmental concern, as identified in the due diligence review, and at appropriate intervals along the ROW. The resultant information would be used to determine appropriate soil / groundwater reuse and disposal options and to support permit applications for such activities, as required.

The results of the field investigations would be used to determine where oil and/or hazardous material is present in the soil or groundwater at levels equal to or greater than the applicable reportable concentration values. Iterative sampling and analysis may be completed, as needed, to define the extent of such areas along the ROWs. Such investigations would not extend beyond the construction limits of the Project.

For soil and groundwater testing and management, CL&P would conform to the guidance issued by the CT DEEP for Utility Company Excavation. This guidance applies to cases where contaminated soils / waste are encountered during construction or maintenance activities on property not owned by the utility and the contamination was not created by the utility. The utility may reuse the contaminated soil in the same excavation, within the same area of concern, without prior approval by CT DEEP provided:

- Any condition that would be a significant environmental hazard, as defined in Connecticut General Statutes Section 22a-6(u), is reported by the utility and that the location is identified on a map submitted to the CT DEEP Remediation Division.
- Any excess contaminated material is disposed of appropriately in accordance with solid and hazardous waste regulations.
- The upper 1 foot of the excavation is filled with clean fill material or paved.

Construction contractors would be require to conform to CT DEEP requirements and to any Project-specific material handling plans.

4.2.3.2 Soils / Groundwater Handling and Management

The approach used to handle and manage soils disturbed by construction activities would depend on whether or not contamination is present, as determined by the pre-construction field investigations.

In locations along the ROWs where in-situ levels of contaminants exceed acceptable concentrations, CL&P would prepare a Project-specific *Material Handling Guideline*, as necessary, to assist the Contractor in the proper handling of potentially impacted soils or groundwater and to facilitate the proper disposal of such materials. The *Material Handling Guideline* would be implemented in areas where the excavation of potentially contaminated soils or the dewatering of potentially contaminated groundwater may be necessary during Project construction. The *Material Handling Guideline* would detail the procedures that would be followed to properly handle and manage the potentially contaminated soil and groundwater in order to minimize exposure to the general public and environmental receptors.

Excavated materials to be transported from the ROWs would be loaded directly onto trucks for off-site disposal at an appropriate facility, or stockpiled temporarily at a permitted facility before being disposed at a permanent facility. Soil transported from the ROWs would be transported under a Bill of Lading or a

Hazardous Waste Manifest, as appropriate. These soils would be disposed of in accordance with the applicable federal, state, and local regulations.

4.2.4 Groundwater and Construction Site Dewatering

Neither the construction nor the operation of the Project is expected to result in adverse effects on groundwater resources or public water supplies. During construction, care would be taken to avoid effects to municipal water lines that may be located within road ROWs or that otherwise extend across the transmission line ROW.

If groundwater is encountered during excavations for transmission line structure foundations, the water would be pumped from the excavated areas and discharged in accordance with applicable local and state requirements. Depending on regulatory authorizations, the water may be discharged on-site into an appropriate sediment control basin or directly into municipal storm water catch basins, if available. Water also may either be pumped into a temporary fractionization (frac) tank and then discharged into the municipal storm water system or pumped into a tanker truck for disposal at appropriate wastewater treatment facilities. Residual silt/sediment collected at the bottom of the frac tanks would be disposed off-site at an appropriately designated disposal facility. Proper catch-basin inlet protection would be installed as needed to prevent disturbed soils excavate and construction debris from entering storm water systems.

4.3 CONSTRUCTION PROCEDURES FOR SUBSTATION AND SWITCHING STATION MODIFICATIONS

4.3.1 Overview of Proposed Construction at Stations

The proposed Project will involve modifications to three existing CL&P stations: Card Street Substation, Lake Road Switching Station, and Killingly Substation. The proposed modifications at all of these stations would be entirely within the developed station footprints, inside the existing station fence lines.

The following summarizes the sequential, phased, approach to be used in modifying the existing stations. The actual sequence of construction activities and methods of construction may vary, based upon the specific engineering design ultimately developed for each substation and switching station site. Furthermore, more detailed construction requirements and, as appropriate, environmental mitigation measures specific to each substation and the switching station, may be defined during the Council's Project review process.

4.3.2 Site Preparation

The type of site preparation work required at each site would vary, in accordance with the characteristics of each station and the areas proposed for the facility modifications. Site preparation work may include:

- Installing and maintaining, as necessary, temporary soil erosion and sedimentation controls (e.g., silt fence, hay/straw bales) around areas of planned soil disturbance
- Removing minimal vegetation (if present) from work areas and equipment staging locations
- Creating temporary access to the sites for heavy construction equipment
- Grading (rough), if necessary, to create level work areas
- Excavating unsuitable soils
- Installing protective fencing around work sites

Site preparation work typically could involve the use of construction equipment such as bulldozers, backhoes, man-lift vehicles, compressors, trucks (various sizes), a large capacity crane (e.g., 100-ton), and flat-bed trailers.

4.3.3 Foundations and Equipment Installation

The foundation installation process generally involves excavation, form work, use of steel reinforcement, and concrete placement. Excavated material would either be reused on-site or disposed of off-site in accordance with applicable requirements.

If groundwater is encountered in excavations, the procedures described in Section 4.2.4 would be followed. Similarly, if contaminated soils are encountered, the procedures summarized in Section 4.2.3.1 would be followed.

After the foundations are installed, construction activities would shift to the erection of structures and equipment as specified for each station modification. Such structures and equipment include steel structures, bus and insulators, circuit breakers, switches, voltage transformers, lightning masts, relay / control enclosures or expansion of existing enclosures, cable trench, ground grid, surge arresters, conduits and cables.

4.3.4 Testing and Interconnections

New structures and associated conductors and wires would be installed, as necessary, to connect the new 345-kV facilities at the substations and switching stations. All of the substation and switching station equipment would be commission-tested prior to final connection to the transmission grid.

4.3.5 Final Cleanup, Site Security, and Landscaping

After the completion of construction, any remaining construction debris would be collected and removed from the station site. Temporary erosion controls would be maintained until the disturbed areas are satisfactorily stabilized.

Because the proposed Project modifications would be within the developed (fenced) station property at each site, landscaping is not expected to be warranted. However, the need (if any) for additional landscaping at the substations and switching station sites would typically be identified during the Council's review of the Project, and then addressed during the D&M Plan development phase of the siting process. Station-specific landscape requirements and plans, if appropriate, would be identified as part of the station's final engineering and design.

4.4 OPERATION AND MAINTENANCE PROCEDURES

4.4.1 Rights-of-Way Vegetation Management

CL&P's long-term vegetation management program includes the selective removal of targeted species (e.g., tall growing trees and selected state-listed invasive woody shrubs) within the portions of the ROWs occupied by transmission lines. In addition to tree removal within the ROW, danger trees adjacent to the managed ROW that could fall onto a conductor will be trimmed or removed. Brush control within CL&P's ROWs is performed every four years, and side trimming (i.e., removal of trees or tree limbs that encroach along the edge of the managed ROW) is performed every 10 years. All work is performed in accordance with NU's *Specification for Rights-of-Way Vegetation Management (2011)*.

In addition, based on recent experience in the development of other 345-kV transmission line facilities, CL&P anticipates that an *Invasive Species Control Plan* would be required for the Project. The *Invasive Species Control Plan* for the Project would be developed after consultations with the USACE, CT DEEP, and other involved agencies regarding the types of invasive species to be targeted for control along the Project ROWs and the overall objectives of the control program. Typically, the *Invasive Species Control Plan* is prepared as part of CL&P's regulatory applications to the USACE and CT DEEP.

4.4.2 Substation and Switching Station Maintenance

The proposed Project modifications to the three existing CL&P stations would not substantially affect or alter existing maintenance practices at these facilities.

4.4.3 Compliance with Applicable Codes and Standards

The proposed Project would be constructed in full compliance with the National Electrical Safety Code (NESC), standards of the Institute of Electrical and Electronic Engineers (IEEE) and the American National Standards Institute (ANSI), good utility practice, and the CT DEEP PURA (formerly DPUC) regulations covering the method and manner of high voltage line construction.

4.4.3.1 Emergency Operations and Shutdown

If one of the transmission lines experiences an insulation or conductor failure, then high-speed protective relaying would immediately remove the line from service, thereby protecting the public and the line. If equipment at the stations experiences a failure, then protective relaying would immediately remove the equipment from service, thereby protecting the public and the equipment within the substations and switching station.

Protective relaying equipment is incorporated into the Project design to automatically detect abnormal system conditions and send a protective trip signal to the respective circuit breaker(s) at each end of a line to isolate the faulted section of the transmission system. The protective relaying schemes include fully redundant primary and backup equipment. This ensures that if a line or station equipment failure were to occur at the time when one of the protective relaying schemes fails or is removed from service for maintenance, the redundant protective relaying scheme would initiate the removal from service of the faulted transmission facility being monitored.

Fiber optic strands will be installed within the lightning shield wires above the overhead line. These strands provide a robust and reliable communications path for the protective relaying systems. Additionally, the overhead transmission line facilities may also provide for electronic communications between substations using signals impressed upon line conductors ("carrier signal") for protective relaying and operations.

4.4.3.2 Fire Suppression Technology

Fire/smoke detection systems are already in place in the existing relay and control enclosures at Killingly Substation and Lake Road Switching Station. In the event that fire or smoke is detected, these fire/smoke detection systems would automatically activate an alarm at the Connecticut Valley Electric Exchange (CONVEX), and the system operators then would take the appropriate action. The relay/control enclosures at each station are equipped with fire extinguishers.

The new protective relaying and associated equipment within the substations, along with a Supervisory Control and Data Acquisition (SCADA) system for remote control and equipment monitoring, would be installed in the existing relay and control enclosures.

4.4.4 Security of Facilities

Pursuant to Section VI.N.4 of the Council's A*pplication Guide*, a description of siting security measures for the proposed Project facilities, consistent with the Council's "White Paper on the Security of Siting Energy Facilities", has been prepared. This facilities security description is critical energy infrastructure information and is included in the CEII Appendix to Volume 5.

SECTION 5

DESCRIPTION OF EXISTING ENVIRONMENT

5. DESCRIPTION OF EXISTING ENVIRONMENT

This section describes the existing environmental and cultural resources along, and in the vicinity of, the proposed Project. Section 5.1 discusses the environmental conditions in the vicinity of the proposed new 345-kV transmission lines, which would follow existing CL&P ROWs between CL&P's existing Card Street Substation, Lake Road Switching Station, and the Connecticut/Rhode Island border (Proposed Route). Section 5.2 presents existing environmental and cultural resource information concerning CL&P's existing Card Street Substation, Lake Road Switching Station, and Killingly Substation.

Data concerning existing environmental and cultural resources were compiled, mapped, and are described in this section in accordance with the Council's *Application Guide for an Electric Transmission and Fuel Transmission Line Facility* (April 2010). Existing environmental conditions for the Project were characterized using a combination of baseline research, field investigations, aerial photographic interpretation, and consultations with representatives of environmental agencies and the public. Information was collected using available published resource information, the CT DEEP[1] GIS database, and the Environmental Systems Research Institute, Inc. (ESRI) database. CL&P also contacted representatives of various federal, state and local agencies, and considered public input (e.g., comments received during the Project's 2008 *Municipal Consultation Filing [MCF] and 2011 Supplemental MCF* processes) relating to environmental and cultural features. In addition, baseline research was performed concerning the relationship of the Project to specially designated environmental features, such as federal

[1] As of July 1, 2011, the former Connecticut Department of Environmental Protection (CTDEP) was consolidated with the former Department of Public Utility Control into the Connecticut Department of Energy and Environmental Protection (CT DEEP). In this document, references to CTDEP pertain to publications and Project-related consultations conducted prior to July 1, 2011. References to CT DEEP pertain to ongoing agency programs or anticipated Project consultations.

or Connecticut Heritage Areas, aquifer protection zones, protected rivers, parks, state forests, scenic areas, and critical wildlife and plant habitats.[2]

Along the proposed transmission line ROWs and at the substations and switching station, field investigations were performed to identify and characterize site-specific natural resources (e.g., soils, topography, wetlands, watercourses, vegetative communities, amphibian breeding habitats, breeding bird habitat), cultural resources, and visual resources. The results of these field investigations are summarized in this section; detailed reports are included in Volumes 2, 3, 4, and 8.

Two sets of aerial-photography based maps depict the environmental and historic resources in the Project vicinity: the Volume 9 maps show the proposed Project facilities in relation to environmental and historic resource features in the surrounding areas, whereas the Volume 11 maps provide a closer view of the environmental and historic features in the immediate vicinity of the proposed Project facilities. The principal environmental conditions, land-use features, and natural resources shown on the maps include:

- Locations of existing transmission line ROWs, transmission line structures, and access roads, as well as substations and switching stations
- Locations of CL&P-owned properties
- Vegetative community types, including areas of upland and deciduous and mixed forest
- Areas of steep slopes and rock outcrops
- Land uses, including residences as well as forest, agricultural, commercial, and industrial areas
- Municipal boundaries
- Municipal zoning classifications
- Federal and state jurisdictional wetlands, depicting field-surveyed wetland boundaries

2 The Project area does not encompass any portion of the state's coastal management boundary and therefore does not have the potential to affect any coastal resources.

- Watercourses and waterbodies, including streams, rivers and lakes, as well as drainage ditches and culverts
- Floodplain boundaries, as identified by the Federal Emergency Management Agency (FEMA), and Stream Channel Encroachment Lines (SCEL) as identified by CT DEEP
- Public recreational, scenic, open space, and other protected areas, including forests, parks, water supply areas, hunting/wildlife management areas, and designated recreational trails
- Statutory Facilities, defined by Connecticut General Statutes § 16-50p(i) as settled areas, schools, day-care centers, youth camps, and group homes
- Designated cultural resources (historic sites)[3]
- Habitat for endangered, threatened, or special concern species
- Existing infrastructure, including roads, major pipeline/utility corridors, and railroads

During the Project planning process, CL&P consulted with the public and with representatives of local governments, both to provide information to them about the proposed Project and to solicit information from them regarding existing conditions in the Project area and the Project issues of concern to potentially affected stakeholders. Pursuant to the Council's requirements, CL&P prepared and distributed a MCF (August 2008) to the municipalities that would be traversed by or within 2,500 feet of the Proposed Route or potential route variations. The 2008 MCF included technical reports and information available at that time concerning the Project need, alternative route/site selection process, existing environmental features, and potential environmental effects and mitigation measures.

In July 2011, CL&P prepared and issued a *Supplemental MCF* to the same potentially affected municipalities. The 2011 Supplemental MCF provided updated information concerning the proposed Project and solicited additional feedback and recommendations from each municipality concerning the Project.

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3 Note: In order to protect the integrity of the resource, information regarding archaeological (buried) sites is not included on publicly-available mapping. This information is provided to the State Historic Preservation Office (SHPO).

5.1 PROPOSED ROUTE: CARD STREET SUBSTATION TO LAKE ROAD SWITCHING STATION TO CONNECTICUT / RHODE ISLAND BORDER

The Proposed Route, which traverses approximately 36.8 miles generally in a northeasterly direction, extends between CL&P's existing Card Street Substation in the Town of Lebanon, Lake Road Switching Station in the Town of Killingly, and the Connecticut/Rhode Island border in the Town of Thompson. The Proposed Route follows existing CL&P ROWs, adjacent to existing 345-kV overhead transmission lines and – in certain segments – other overhead transmission lines and electric distribution lines, through portions of the following 11 towns:

- Lebanon (New London County)
- Columbia, Coventry, and Mansfield (Tolland County)
- Chaplin, Hampton, Brooklyn, Pomfret, Killingly, Putnam, and Thompson (Windham County)

5.1.1 Topography, Geology and Soils

5.1.1.1 Topography

The Proposed Route lies in the Eastern Highlands physiographic province. Topography along and in the vicinity of the Proposed Route is generally characterized by hills and valleys. Elevations along the Proposed Route range from approximately 210 feet National Geodetic Vertical Datum (NGVD) to approximately 600 feet NGVD.

The Proposed Route does not traverse any traprock ridge[4] or amphibolite ridge[5] areas as specified in Connecticut General Statutes Section 8-1aa (1). These areas are located in western Connecticut, well

[4] According to definitions provided in Connecticut General Statutes Section 8-1aa, "traprock ridge" means Beacon Hill, Saltonstall Mountain, Totoket Mountain, Pistapaug Mountain, Fowler Mountain, Beseck Mountain, Higby Mountain, Chauncey Peak, Lamentation Mountain, Cathole Mountain, South Mountain, East Peak, West Peak, Short Mountain, Ragged Mountain, Bradley Mountain, Pinnacle Rock, Rattlesnake Mountain, Talcott Mountain, Hatchett Hill, Peak Mountain, West Suffield Mountain, Cedar Mountain, East Rock, Mount Sanford, Prospect Ridge, Peck Mountain, West Rock, Sleeping Giant, Pond Ledge Hill, Onion Mountain, The Sugarloaf, The Hedgehog, West Mountains, The Knolls, Barndoor Hills, Stony Hill, Manitook Mountain, Rattlesnake Hill, Durkee Hill, East Hill, Rag Land, Bear Hill, and Orenaug Hills.

[5] According to definitions provided in Connecticut General Statutes Section 8-1aa, "amphibolite ridge" means Huckleberry Hill, East Hill, Ratlum Hill, Mount Hoar, and Sweetheart Mountain.

outside of the proposed Project area. Following CL&P's existing ROWs, the Proposed Route generally does not parallel ridgelines.[6]

Of the 11 municipalities crossed by the Proposed Route, five (Lebanon, Columbia, Mansfield, Hampton, and Pomfret) have zoning ordinances that specifically protect ridgelines. The zoning ordinances typically address visual impacts related to telecommunications facilities (e.g., cell towers) and microwave towers. A brief discussion of the ridgeline protection ordinances in these five towns along the Proposed Route is provided below:

- ***Lebanon***
  Section 4.2.1 – h(16) of Lebanon's zoning ordinance indicates that the design of the towers should have characteristics that reduce or eliminate visual obtrusiveness, including but not limited to, the potential visual impact to ridgelines. Within Lebanon, the proposed transmission line route would be aligned within CL&P's existing ROW, between two existing overhead transmission lines.

- ***Columbia***
  Section 52.7.15.4 – 7(c) of Columbia's zoning ordinance indicates that where the proposed location of wireless telecom facilities (towers) are visible in a visually sensitive area (e.g., views and vistas of ridgelines, Columbia Lake, Mono Pond, and historic districts, either state or federally designated) the project proponent shall describe the efforts and measures taken to pursue alternative locations and why such location was not technologically, legally, or economically feasible. The Proposed Route follows CL&P's existing ROW through the northeastern corner of Columbia. Within this ROW segment, the new 345-kV transmission line would be aligned between two existing transmission lines.

- ***Mansfield***
  Section Q-1-(c) of Mansfield's zoning ordinance recommends siting telecommunication facilities (including towers) below visually prominent ridgelines. Additionally, section Q-3-(n) of Mansfield's zoning ordinance indicates that a viewshed analysis showing all areas from which a tower would be visible should be submitted for review, and that the analysis should also describe efforts that have been made to avoid prominent ridgelines and plans that have been made to screen the proposed site, camouflage proposed facilities and otherwise minimize adverse visual impacts. Within Mansfield, the new 345-kV structures for the proposed Project would be aligned adjacent to CL&P's existing 345-kV transmission line.

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[6] According to definitions provided in Connecticut General Statutes Section 8-1aa, "ridgeline" means the line on a traprock or amphibolite ridge created by all points at the top of a 50% slope, which is maintained for a distance of 50 horizontal feet perpendicular to the slope and which consists of surficial basalt geology, identified on the map prepared by Stone et al., United States Geological Survey, entitled "Surficial Materials Map of Connecticut".

- ***Hampton***
  Section 6.22.4-7(c) of Hampton's zoning ordinance states that where the proposed location of a project is visible in a visually sensitive area (e.g., views and vistas of ridgelines; Pine Acres Lake; valley of the Little River; and historic districts, either state or federally designated) the project proponent shall describe the efforts and measures taken to pursue alternative locations and why such location was not technologically, legally, or economically feasible. Within CL&P's existing ROW, the Proposed Route crosses the Little River; however, the crossing is within the Howard Valley, nearly perpendicular to the river channel and is not near any ridgelines. In addition, the new 345-kV line would be aligned adjacent to CL&P's existing 330 Line.

- ***Pomfret***
  Pomfret's June 2002 *Plan of Conservation and Development* states that projects should avoid any development on ridgelines unless such development would reduce impact on wetlands and water quality or balance the effect of development by mitigation. Within Pomfret, the Proposed Route would be located within CL&P's existing transmission line ROW and avoids ridgelines.

5.1.1.2 Geology

Connecticut's bedrock geology has a direct effect on landscape forms due to differing resistances to weathering and erosion. Along the Proposed Route, bedrock consists mainly of Paleozoic Era igneous granites, gneisses, quartzites, and metamorphic schists folded into north-south belts. Over time, south-flowing streams and rivers incised the softer rock types into valleys, cutting the slopes now bordering the floodplains of rivers traversed by the Proposed Route, such as the Willimantic, Shetucket, Fivemile, and Quinebaug rivers.

Surficial geology along the Proposed Route is varied and consists of different thicknesses of tills, sands, gravels, fines, alluvia, and elongated hills called drumlins. The depth to bedrock along the Proposed Route typically exceeds 60 inches, although stones and boulders are common on the surface in most places and outcrops of bedrock are typically present along steep hill slopes and stream cuts. Table 5-1 (located at the end of this section) identifies the estimated depth to bedrock along the Proposed Route, based on the review of soils and surficial geology data.

The Proposed Route is aligned within CL&P's existing ROW across two drumlins (i.e., streamlined, elongate hill composed of glacial drift), as identified in the Town of Mansfield *Plan of Conservation and*

Development[7]. One of these drumlins is located along Highland Road, and the other is located approximately 2,000 feet west of Storrs Road (State Route 195).

5.1.1.3 Soils

Information regarding the soils along the Proposed Route was obtained from on-line county soil surveys and maps published by the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS)[8]. These surveys and maps provide soil classifications and characteristics, including depth to bedrock, slope, drainage, and erosion potential.

Table 5-1 summarizes the principal soil associations, as identified by the USDA NRCS along and in the general vicinity of the Proposed Route. The table also identifies soils classified by the USDA NRCS as “Prime Farmland” soils or “Farmlands of Statewide Importance”.

“Prime Farmlands” are soils defined by the USDA as best suited to producing food, feed, forage, fiber, and oilseed crops, whereas “Farmland of Statewide Importance” is defined as land that is nearly prime farmland and that economically produces high yields of crops similar to prime farmland when properly treated and managed. Because development pressure has resulted in the loss of a significant portion of the state’s agricultural base, Connecticut has determined that the conservation of certain arable agricultural land and adjacent pastures, woods, natural drainage areas and open space areas is vital for the well-being of the people of Connecticut (refer to Connecticut General Statutes Section 22-26aa).

In addition to providing information about agricultural productivity, the USDA NRCS data provides useful baseline characteristics regarding other soil types found along the ROWs. For example, the soils data included in Table 5-1 can be used to identify areas of hydric soils (a soil formed under conditions of saturation, flooding, or ponding, and generally indicating the presence of state- and potential federal-jurisdictional wetlands); to assess “erodability potential” of the soil and therefore the potential for erosion

7 http://www.mansfieldct.org/town/departments/pnz/pocd/maps/map_08.jpg
8 The NRCS was formerly the Soil Conservation Service (SCS).

and sedimentation during construction; and to plan for the appropriate type and deployment of erosion and sedimentation controls during construction to minimize adverse effects associated with soil disturbance.

Based on a review of soils mapping data, the existing CL&P ROWs within which the Proposed Route would be located encompass approximately 24 acres of soils considered to be prime farmland soils and approximately 30 acres of soils considered to be farmlands of statewide importance. These acreages represent the approximate amounts of such soils mapped within the width of CL&P's easements and not necessarily the soils that occur directly within the construction area for the new 345-kV line along the Proposed Route.

As summarized in Table 5-2, the ROW segments through the towns of Pomfret, Hampton, and Columbia contain the most prime farmland soils (9.4 acres, 4.6 acres, and 4.5 acres, respectively), whereas the ROW through the Town of Putnam traverses more soils considered to be farmlands of statewide importance (12.1 acres) than any other town along the Proposed Route. No prime farmland soils or soils considered to be farmland of statewide importance are located along the ROWs in the towns of Coventry or Thompson.

Table 5-2: Prime Farmland Soils and Farmland Soils of Statewide Importance within the existing CL&P ROWs along the Proposed Route, by Town

Town	Prime Farmland Soils (acres)	Farmland Soils of Statewide Importance (acres)
Lebanon	1.5	0
Columbia	4.5	0
Coventry	0	0
Mansfield	0	2.2
Chaplin	1.2	0.3
Hampton	4.6	3.6
Brooklyn	0	5.8
Pomfret	9.4	1.3
Killingly	0.4	4.8
Putnam	2.5	12.1
Thompson	0	0
TOTAL	**24.1**	**30.1**

To identify and characterize both state and federal jurisdictional wetlands, field investigations of the Proposed Route and associated facilities were conducted. Connecticut jurisdictional wetlands are defined solely based on the presence of "hydric" (poorly or very poorly drained), alluvial, or floodplain soils. In contrast, federal jurisdictional wetlands are characterized based on the presence of hydric soils, as well as two other parameters (vegetation and hydrology). Approximately 242 acres of hydric soils occur within the existing CL&P ROWs along which the Proposed Route would be located.[9]

During the field investigations, the state and federal jurisdictional wetlands along the Proposed Route were identified and described by Connecticut-registered soil scientists and wetland delineators. The results of these wetland investigations are summarized in Section 5.1.2.2; the locations of wetlands along the Proposed Route are illustrated on the maps in Volume 9 and Volume 11. Complete documentation concerning the wetland delineations, including a report and associated wetland data forms and

[9] Includes hydric soils within the entire width of CL&P's ROWs, but not necessarily along the Proposed Route, which would be located within portions of these ROWs.

photographs, are presented in Volume 2, *Inventory and Delineation of Wetlands and Watercourses Report*.

5.1.2 Water Resources

Water resources along the existing CL&P ROWs include inland wetlands, watercourses (intermittent and perennial streams and rivers), waterbodies (lakes and ponds), and groundwater resources, including public water supplies and floodplains. CL&P commissioned both baseline research to identify these water resources and field investigations to delineate state and federal wetlands and watercourses along the Proposed Route.

To define floodplain, SCELs, and groundwater resources along the Proposed Route, CL&P reviewed databases maintained by the CT DEEP and FEMA. To characterize the wetlands and waterbodies along the Proposed Route, CL&P initially examined published data sources and aerial photography to determine the approximate location and extent of water resources likely to occur along the ROWs. Sources consulted included the U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) mapping, CT DEEP Wetland Soils Mapping, USDA/NRCS Soil Surveys, and the USGS's National Hydrography Dataset (NHD).

After the performance of these initial analyses, CL&P's consultants conducted field delineations of the wetlands and watercourses along the Proposed Route ROWs. Wetland and watercourse field investigations for the proposed Project were initially performed from January through April 2008. In addition, in the spring of 2009, water resource field studies were conducted of the following areas:

- Two segments of the Proposed Route across USACE properties in the Mansfield Hollow Area where, for 1.4 miles, CL&P proposes to expand the ROW by acquiring additional easements from the USACE, totaling approximately 11 acres. (This 11-acre easement expansion is the Proposed Configuration for the new transmission lines across these federally-owned properties. Field investigations also were conducted of two other configuration options, which are discussed in Section 10 of this volume.)

- Potential off-ROW access roads on CL&P-owned property.

In November 2010 and in May of 2011, CL&P's consultants reconfirmed the accuracy of the 2008 and 2009 wetland delineations by conducting a ground-truthing survey of wetlands along the Proposed Route. Watercourse locations were also reviewed in the field. In addition, the 2010 and 2011 surveys verified that the previous wetland delineations comply with the October 2009 *Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region*.

During the delineations, CL&P's consultants field-demarcated the boundaries of each wetland and watercourse using numbered flagging. These boundary flags subsequently were surveyed using a Trimble Global Positioning System (GPS) survey unit. Each watercourse and wetland was also assigned a unique Project-specific number, which distinguishes the individual water resources in the discussions in this Application, including on the Volume 9 and Volume 11 maps and in the *Inventory and Delineation of Wetlands and Watercourses Report* in Volume 2.

5.1.2.1 Drainage Basins and Waterbodies

Connecticut is divided geographically into eight major drainage basins/watersheds. The Proposed Route is located within the Thames River drainage basin, which is characterized by watercourses that flow into Long Island Sound in the cities of New London and Groton. Within the Thames River Basin, regional drainage basins / watersheds along the Proposed Route include the Natchaug River, Shetucket River, Willimantic River, Quinebaug River, and Fivemile River.

The CT DEEP maintains detailed water-resources information concerning the drainage basins in Connecticut and promotes watershed management efforts to improve water quality. As a central element of the state's clean water program, the CT DEEP also has established Water Quality Standards and Classifications, which identify the water quality management objectives for each waterbody.

Overall, Connecticut's water quality policies are established to protect surface and groundwater from degradation, to restore degraded surface waters to conditions suitable for fishing and swimming, to restore degraded surface and groundwater to protect existing and designated uses, and to provide a framework for establishing priorities for pollution abatement. The classifications and criteria that the state has established for surface waters and groundwater are summarized in Table 5-3.

Table 5-3: Summary of Connecticut Water Classifications and Criteria

WATER RESOURCE	CLASSIFICATION USE DESCRIPTION
Surface Waters	
Class AA	Existing or proposed drinking water supplies, habitat for fish or wildlife or other aquatic life, recreation, and water supply for industry and agriculture.
Class A	Potential drinking water supplies, habitat for fish and other aquatic life and wildlife, recreation, navigation, industrial water supply, agricultural water supply.
Class B	Fish and other aquatic life and wildlife habitat, recreation, navigation, industrial water supply, agricultural water supply.
Ground Waters	
Class GAA	Existing or potential public supply of water suitable for drinking without treatment; baseflow for hydraulically-connected surface water bodies.
Class GAAs	Sub-classification of GAA. Groundwater that is tributary to a public water supply reservoir.
Class GA	Existing private and potential public or private supplies of water suitable for drinking without treatment; baseflow for hydraulically-connected surface water bodies.
Class GB	Industrial process water and cooling water; baseflow for hydraulically-connected surface water bodies; presumed not suitable for human consumption without treatment.
Class GC	Assimilation of discharges authorized by the Commissioner pursuant to Connecticut General Statutes Section 22a-430.

Source: CT DEEP 2011, Connecticut Water Quality Standards.

The Proposed Route crosses a total of 104 watercourses. Of these, 54 are perennial lakes, streams, or rivers and 50 are intermittent watercourses. Table 5-4 (located at the end of this section) lists these water crossings, each of which is characterized by location (town) along the ROWs, watercourse type [perennial or intermittent], water quality classification, and presence of fishery resources. Of the 104 watercourses along the Proposed Route, five perennial streams have existing culverted crossings and seven intermittent watercourses have existing culverted crossings associated with existing access roads (refer to Table 5-4 and Volume 11 maps).

The Quinebaug River, which the Proposed Route crosses three times in the towns of Killingly, Pomfret, and Putnam, is the largest of the rivers crossed. The Proposed Route traverses the Quinebaug River at the Pomfret/Killingly border north of State Route 101, at the Killingly/Putnam border north of Lake Road, and at the Putnam/Killingly border west of Interstate 395. None of the watercourses crossed by the Proposed Route met the criteria for federal designation as navigable[10] pursuant to Section 10 of the Rivers and Harbors Act. All of these watercourses are presently spanned by CL&P's overhead transmission lines that occupy the existing ROWs along which the Proposed Route would be located.

Of the 54 perennial water crossings along the Proposed Route, 13 are lakes or ponds. The Proposed Route traverses approximately 600 feet across Mansfield Hollow Lake in the Town of Mansfield and approximately 800 feet across Lester Williams Pond (located northeast of Pomfret Road) in the Town of Brooklyn. Additional unnamed ponds or areas of open water along the Proposed Route include:

- Town of Chaplin: four unnamed ponds (one located west of Willimantic Road/U.S. Route 6, two located east of Chewink Road, and one located west of Chewink Road).
- Town of Hampton: one unnamed pond located south of Drain Street.
- Town of Brooklyn: four unnamed ponds (one located northeast of Laurel Hill Road, one located south of Wolf Den Road, one located northeast of Pomfret Road, and one located west of Church Street).
- Town of Putnam: two unnamed ponds, one located east of River Road and one located along Munson Brook.

[10] The USACE's general definition of navigable waters of the United States is "those waters subject to the ebb and flow of the tide shoreward to the mean high water mark and/or presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce." Waterways considered to be navigable waters may be subject to regulatory jurisdiction under Section 10 of the Rivers and Harbors Act.

These unnamed ponded areas include natural areas of standing water, man-made agricultural and recreational ponds, and beaver ponds. All of these lakes and ponds are already spanned by CL&P's overhead transmission lines that occupy the existing ROWs along the Proposed Route.

The locations of these water bodies and watercourses were initially identified based on map and aerial photograph analyses, and then confirmed during the field surveys conducted along the ROWs. As summarized in Table 5-4, most of the streams along the ROWs exhibit good water quality based on the CT DEEP Water Quality Standards.

None of the rivers crossed by the Proposed Route are designated as a National Wild and Scenic River under the National Wild and Scenic Rivers Act (16 U.S.C. 1271-1287). The Connecticut Protected Rivers Act (Connecticut General Statutes Sections 25-200 through 25-210) requires CT DEEP to adopt a list of rivers in the state considered appropriate for designation as protected river corridors. To date, the CT DEEP has not compiled that list; thus, no rivers along the Proposed Route are designated under the Protected Rivers Act.[11]

5.1.2.2 Wetlands

As listed in Table 5-5 (located at the end of this section), 227 wetlands are located within the existing CL&P ROWs (along which the Proposed Route would be located) and within the proposed 11-acre easement expansion area on the federally-owned properties in Mansfield Hollow.[12] All of these wetland areas meet the criteria, as discussed below, for Connecticut jurisdictional wetlands, whereas 222 also are classified as federal jurisdictional wetlands pursuant to the USACE's delineation parameters. Specific descriptions of wetlands along the ROWs are included in the *Inventory and Delineation of Wetlands and*

[11] Thomas, E. 2010. Written communication regarding Protected Rivers Act between Mr. Eric Thomas, Watershed Manager, CTDEP and Mr. Jim Berg, Fisheries Biologist, AECOM. December 3, 2010.

[12] Wetlands were delineated within the entire width of the CL&P ROWs, including the portions of the ROWs that: (1) would be encompassed by the footprint of the Proposed Route; (2) are occupied by existing overhead transmission lines and presently subject to CL&P's ROW vegetation management program; and (3) are within the portions of CL&P's easement characterized by vegetation that is not affected by the existing transmission line management activities and would not be affected by the proposed Project.

Watercourses Report (Volume 2). The report summarizes the characteristics of each wetland and watercourse and includes representative photographs and wetland data forms. CL&P's consultants also prepared analyses of each wetland's functions and values; this information will be presented in the Project's Section 401 Water Quality Certification application (to be filed with the CT DEEP and also submitted to the USACE). The Volume 9 and Volume 11 maps illustrate the locations of the wetlands along the Proposed Route.

State jurisdictional wetlands were characterized using Connecticut delineation methodology pursuant to the Connecticut Inland Wetlands and Watercourses Act, Connecticut General Statutes Sections 22a-36 through 22a-45 (the Act). The Act defines a wetland as land, including submerged land, consisting of poorly drained, very poorly drained, alluvial, and floodplain soils as defined by the USDA Cooperative Soil Survey. Such areas may include filled, graded, or excavated sites possessing an aquic (saturated) moisture regime as defined by the USDA Cooperative Soil Survey. The Act defines watercourses as rivers, streams, brooks, waterways, lakes, ponds, marshes, swamps, bogs, and also other bodies of water, natural or artificial, public or private, contained within, flow through or border upon the state, or any portion thereof.

As part of the field investigations, federal jurisdictional wetlands were delineated in accordance with the USACE's *Wetland Delineation Manual* (Technical Report Y-87-1, "1987 USACE Manual") and the USACE New England District Wetland Delineation Datasheet and Supplemental Information (CENAE-R-PT Version 9/1/04). According to the 1987 USACE Manual, areas must exhibit three distinct characteristics to be considered federal jurisdictional wetlands:

1. **Vegetation**. The prevalent vegetation must consist of plants adapted to life in hydric soil conditions. These species, due to morphological, physiological, and/or reproductive adaptations, can and do persist in anaerobic soil conditions.

2. **Hydric Soils**. Soils in wetlands must be classified as hydric or they must possess characteristics associated with reducing soil conditions (typically resulting in redoximorphic features or gleyed soils).

3. **Hydrology**. The soil must be inundated either permanently or periodically at mean water depths less than 6.6 feet (2 meters) or the soil must be saturated at the surface for some time during the growing season of the prevalent vegetation.

Wetlands meeting the above criteria may be subject to regulatory jurisdiction under Section 404 of the Clean Water Act. Jurisdictional wetlands and other "waters of the United States" typically include the following:

- Navigable waters of the United States
- Wetlands
- Tributaries to navigable waters of the United States, including adjacent wetlands, lakes and ponds
- Interstate waters and their tributaries, including adjacent wetlands
- All other waters of the United States not identified above, such as isolated wetlands, intermittent streams, and other waters not part of a tributary system to interstate waters or to navigable waters of the United States, where the use, degradation or destruction of these waters could affect interstate or foreign commerce

Section 404 of the Federal Clean Water Act defines the landward limit of jurisdiction as the high tide line in tidal waters and the ordinary high water mark in non-tidal waters. When adjacent wetlands are present, the limit of jurisdiction extends to the limit of the wetland.

Wetlands meeting the above technical criteria and determined to be traditional navigable waters, tributaries to traditional navigable waters, or wetlands exhibiting significant nexus are subject to federal jurisdiction under Section 404 of the Clean Water Act (33 CFR §§ 320-332). The USACE has determined that the wetlands along the Proposed Route that meet the federal criteria will be regulated pursuant to Section 404 of the Clean Water Act.

Due to differences in state and federal wetland delineation criteria and methodology, the boundaries of state and federal jurisdictional wetlands do not correspond in all cases. For example, in Connecticut, areas of alluvial and floodplain soils, which may not support wetland plant communities or exhibit evidence of wetland hydrology, would be characterized as state, but not federal, jurisdictional wetlands. For the most part, however, the state and federal wetland boundaries along the Proposed Route are comparable. Of the 227 wetlands delineated along the ROWs in the vicinity of the Proposed Route, portions of only five were identified as being strictly state jurisdictional (refer to Table 5-5 and the Volume 9 and Volume 11 maps).

In accordance with *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al., 1979), wetlands delineated for the proposed Project were classified as palustrine[13] forested (PFO), palustrine scrub-shrub (PSS), palustrine emergent (PEM), palustrine open water (POW), and palustrine unconsolidated bottom (PUB). These wetland classifications, which are used on the Volume 9 maps, are characterized as follows:

1. **Palustrine Forested Wetlands (PFO).** Forested wetlands are characterized by woody vegetation that is 6 meters (approximately 20 feet) tall or taller and normally includes an overstory of trees, an understory of young trees or shrubs, and an herbaceous layer. These wetland types are located predominantly in the unmanaged areas of the existing ROWs or in adjacent off-ROW areas.

2. **Palustrine Scrub-Shrub Wetlands (PSS).** Scrub-shrub wetlands are typically dominated by woody vegetation less than 6 meters (approximately 20 feet) tall. Scrub-shrub wetland types may represent a successional stage leading to a forested wetland and include shrubs, saplings, and trees or shrubs that are small and/or stunted due to environmental conditions or human vegetation management practices.

3. **Palustrine Emergent Wetlands (PEM).** Emergent wetlands are characterized by erect, rooted, herbaceous hydrophytes, not including mosses and lichens. These wetlands maintain the same appearance year after year, are typically dominated by perennial plants, and the vegetation of these wetlands is present for the majority of the growing season.

[13] **Palustrine wetlands** are wetlands occurring in the Palustrine System, one of five systems in the classification of wetlands and deepwater habitats. Palustrine wetlands include all non-tidal wetlands dominated by trees, shrubs, persistent emergent plants, or emergent mosses or lichens, as well as small, shallow open water ponds or potholes. Palustrine wetlands are often referred to as swamps, marshes, potholes, bogs, or fens.

4. **<u>Palustrine Open Water (POW).</u>** Areas of permanent open water that border palustrine systems are referred to as POW. Areas of open water may exist as man-made or natural waterbodies.

5. **<u>Palustrine Unconsolidated Bottom (PUB).</u>** Areas of open water with unconsolidated bottoms that border palustrine systems are referred to as PUB.

Some wetlands along the Proposed Route exhibit more than one wetland classification type (i.e., PFO / PSS) or have inclusions of multiple vegetative cover types. In such situations, transitions between wetland classifications are demarcated on the maps in Volume 9 and cover types are categorized based on the most dominant wetland vegetation present.

The results of the wetland field surveys demonstrate that wetland types within CL&P's existing ROWs vary. In the vicinity of the existing overhead transmission lines that presently occupy these ROWs, the majority of the wetlands are well-vegetated and dominated by PSS and shallow PEM communities. These shrub and emergent marsh wetlands are consistent with CL&P's ROW vegetation management procedures for overhead transmission lines. However, the majority of the PSS and PEM wetlands located on the managed portions of the ROWs also extend into adjacent, unmanaged portions of CL&P's easement, transitioning into PFO wetlands characterized by mixed hardwood deciduous and coniferous forested vegetation.

The 227 wetlands that are located in the vicinity of the Proposed Route account for approximately 271 acres (19%) of the total 1,397 acres contained within the limits of the existing CL&P ROWs and the proposed 11-acre ROW expansion on the federally-owned properties in Mansfield Hollow. These 271 acres encompass a range of wetland types, including 109 acres of PSS, 93 acres of PFO, 31 acres of PEM, 28 acres of POW, and 10 acres of state wetlands. Along CL&P's ROWs between Card Street Substation and the Connecticut / Rhode Island border, 47 of the existing 345-kV line structures are presently located in wetlands.

However, the "footprint" of the Proposed Route would occupy only portions of the existing CL&P ROWs, with the new 345-kV lines aligned either between or adjacent to existing overhead transmission lines (refer to the discussion and cross-sections in Section 3, Appendix 3A, as well as to the cross-section drawings in Volume 9 and Volume 10). Based on the alignment of the proposed 345-kV lines within the existing ROWs, approximately 7 miles (19%) of the 36.8-mile Proposed Route thus would extend across federal or state wetlands. Of these 7 miles, approximately 6.8 miles are federal wetlands, consisting of the following wetland types: approximately 1.6 miles of PSS, 3.7 miles of PFO, 0.7 mile of PEM, and 0.8 mile of POW. Approximately 0.2 mile of the Proposed Route extends across state-only wetlands (i.e., based on soils).

5.1.2.3 Groundwater Resources, Public Water Supplies, and Aquifer Protection Zones

In the vicinity of the Proposed Route, potable water is derived from groundwater wells and surface water supplies or reservoirs. For the most part, in the vicinity of the Proposed Route, the groundwater quality is classified as "GA" (i.e., existing private water supply and potential public water supply suitable for drinking without treatment).

The CT DEEP's Aquifer Protection Area Program, identifies Level A and Level B Aquifer Protection Areas by municipality. Aquifer Protection Areas are delineated for active public water supply wells in stratified drift that serve more than 1,000 people, in accordance with Connecticut General Statutes Sections 22a-354c and -354z. Level A mapping delineates the final Aquifer Protection Area, which becomes the regulatory boundary for land use controls designated to protect the well from contamination. Level B mapping delineates a preliminary Aquifer Protection Area, providing an estimate of the land use controls designated to protect the well from contamination.[14]

[14] CTDEP, August 6, 2010. Aquifer Protection Area Mapping.

According to the CTDEP, the towns of Coventry, Mansfield, Brooklyn, Killingly, Putnam, and Thompson have designated aquifer protection areas.[15] Table 5-6 identifies these areas in relation to the Proposed Route. As this table shows, with the exception of the Thompson Aquifer Protection Area in the Town of Putnam, all of the aquifers are more than 1.5 miles from the Proposed Route. In Putnam, the Proposed Route crosses the eastern edge of Level A Aquifer Protection Area No. 112, encompassing approximately 3.3 acres of this 498-acre aquifer protection area.

Table 5-6: List of Connecticut Aquifer Protection Areas in Towns along the Proposed Route

Municipality	Aquifer Protection Area	Protection Level	Aquifer Protection Area Number	Size of Aquifer (Acres)	Proximity to Proposed Route
Coventry	Willimantic River	A	136	510	6 miles
Mansfield	Willimantic River	A	136	510	6 miles
Mansfield	Fenton River	A	135	1,360	4 miles
Brooklyn	Brooklyn	B	68	1,970	1.7 miles
Killingly	Hopkins	A	69	406	1.8 miles
Killingly	Brooklyn	B	68	1,970	3.4 miles
Killingly	Plainfield	B	71	1,396	6.7 miles
Putnam	Thompson	A	112	498	Crosses (Approximately 3.3 acres of this aquifer protection area are within Proposed Route ROW)
Thompson	Park Street	B	70	675	3.4 miles

Source: CTDEP Protected Aquifers Data Layer, Updated August 2010 and again in October 2011.

Apart from the designated aquifer protection zones, drinking water in a number of towns along the Proposed Route is provided solely by individual groundwater wells, with one private well typically sourcing one house or business. Surface water from reservoirs such as the Willimantic Reservoir (which straddles the border between Mansfield and Windham approximately 0.5 mile south of the Proposed Route) provides potable water to portions of Windham, Mansfield, and Chaplin, especially in the more

[15] CTDEP Aquifer Protection Area Maps, http://www.ct.gov/dep/cwp/view.asp?a=2685&q=322248&depNav_GID=1654 (Accessed December 2010)

densely developed areas. Groundwater wells, often located in stratified drift deposits, also provide public drinking water to portions of certain towns, as described below.[16]

- **Lebanon** – Water is provided to most homes and businesses by private wells. Exceptions to this rule are at Amston Lake, Frankel Acres, Carriage Drive, and Norwich's Deep River Reservoir, which provides service to limited properties along Norwich Avenue (Town of Lebanon, 2010)[17]. Groundwater in the vicinity of the route is classified as "GA".

- **Columbia** – Columbia's residents rely on private groundwater wells for all drinking and household water needs. Groundwater in the vicinity of the route is classified as "GA".

- **Coventry –** In the areas near the Proposed Route, Coventry residents rely on private groundwater wells for potable water supply. South Coventry Village, located approximately 3 miles north of the transmission line route, is served by public water and sewer (Town of Coventry, 2010)[18]. Groundwater in the vicinity of the route is classified as "GA". Coventry shares an Aquifer Protection Area (No. 136) with the Town of Mansfield. This Aquifer Protection Area is located in the northeast corner of Coventry and is not crossed by the Proposed Route.

- **Mansfield** – Potable water in the vicinity of the Proposed Route is supplied by private groundwater wells. Two public water supply systems (Windham Water Works and the Windham Sewer System) supply water to users in southern Mansfield, just south of the Proposed Route. According to the Surface and Groundwater Resources Map in the April 2006 Town of Mansfield *Plan of Conservation and Development*, several high-yielding aquifers have been identified in stratified drift deposits beneath the Willimantic River valley and Mansfield Hollow State Park where the Proposed Route crosses Mansfield.[19] The Proposed Route follows CL&P's existing transmission line ROW across two zones of the stratified drift aquifer associated with the Willimantic River Valley aquifer and also a portion of the watershed to the reservoir (Town of Mansfield, 2006)[20]. Groundwater in the vicinity of the Proposed Route is classified as "GA","GAA-Impaired" and "GAAs". Mansfield shares an Aquifer Protection Area (No. 136) with Coventry and the Town of Willington (No. 135). However, these Aquifer Protection Areas are located in the northern portion of Mansfield and are not near the Proposed Route.

- **Chaplin** – The vast majority of residences and businesses in Chaplin obtain potable water through individual on-site artesian wells that are regulated by the Eastern Highlands Health District (Town of Chaplin, 2010)[21]. Chaplin Woods Condominiums, located adjacent to U.S. Route 6 approximately 200 feet north of the Proposed Route, is supplied by the Windham Water Department. The Carelot Children's Learning Center, Chaplin Elementary School, and Parish Hill High School are served by Non-Transient Non-Community Water Systems. In addition,

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16 Information on groundwater quality and municipal water supplies was obtained from CTDEP Geographic Information System Ground Water Quality Classifications, August 12, 2010 and by personal communication with municipal officials and/or through review of municipal planning documents.
17 Town of Lebanon 2010 *Draft Plan of Conservation and Development*
18 Town of Coventry *Plan of Conservation and Development*, May 2010
19 http://www.mansfieldct.org/town/departments/pnz/pocd/maps/map_10.jpg
20 Town of Mansfield *Plan of Conservation and Development*, 2006
21 Town of Chaplin *Draft Plan of Conservation and Development*, June 2010

several restaurants, campgrounds, and town buildings are served by Transient Non-Community Water Systems (Town of Chaplin, 2010). A stratified draft aquifer capable of providing large volumes of drinking water underlies much of the Natchaug River valley (Town of Chaplin, 2010). Groundwater in the vicinity of the route is classified as “GAAs”.

- **Hampton** – Hampton relies solely on private individual groundwater wells. Groundwater in the vicinity of the Proposed Route is classified as “GA” and “GAAs”.

- **Pomfret** – Pomfret residents rely on private groundwater wells, with the exception of one factory located approximately 0.5 miles west of the Proposed Route, which relies on a municipal source. Groundwater in the vicinity of the Proposed Route is classified as “GA”.

- **Brooklyn** – The majority of homes in Brooklyn are served by on-site deep wells. However, two sections of the town, totaling 500-600 customers, have public water service provided by the Connecticut Water Company: businesses and residents in the East Brooklyn area and the town center. The Town of Brooklyn has a critical aquifer (Aquifer Protection Area No. 68) in East Brooklyn along the Quinebaug River that represents an important resource for active management and protection.[22] The Connecticut Water Company operates a wellfield of groundwater supply wells near the west side of the Quinebaug River, in the vicinity of Quebec Street in east Brooklyn. The Proposed Route is located more than 1 mile from this wellfield at its closest point. Groundwater in the vicinity of the Proposed Route is classified as “GA” and “GAA-Well-Impaired”. Brooklyn shares an Aquifer Protection Area (No. 68) with Killingly. This Aquifer Protection Area is located in eastern Brooklyn and is not crossed by the Proposed Route.

- **Killingly** – Potable water (water used for drinking purposes) is derived from private wells and public water supplies – which also come from wells. These wells draw upon groundwater which comes from both bedrock and stratified drift aquifers underlying the Town of Killingly and surrounding towns.[23] These areas of stratified drift are associated with the Quinebaug River and are crossed by the Proposed Route. Groundwater in the vicinity of the Proposed Route is classified as “GA”. Killingly has designated three Aquifer Protection Areas. Two of these are shared with neighboring towns (i.e., No. 68 with Brooklyn and No. 71 with the Town of Plainfield). One Aquifer Protection Area (No. 69) is located solely within the Town of Killingly. The Proposed Route does not cross any of these Aquifer Protection Areas.

- **Putnam** – There are two primary water supply sources for the Town of Putnam. Surface water from the Little River is diverted via a man-made dam to the Peake Brook Road Water Treatment Plant in Woodstock. This source provides approximately 60% of total water demand. The second source is groundwater from a wellfield on the Quinebaug River at Park Street (Park Street Level A Aquifer). Groundwater is diverted to the water system from the two production wells located in the three-well field. Diverted groundwater provides about 40% of total demand, servicing the industrial park and the southern portion of the system. The Proposed Route is located approximately 3,000 feet east of the wells at its closest point. Groundwater in the vicinity of the Proposed Route is classified as “GA” and “GB”. One Aquifer Protection Area (No. 112) is located in Putnam. The Proposed Route crosses the eastern edge of this aquifer protection area; approximately 3.3 acres of the aquifer protection area are within the Proposed Route ROW.

[22] Town of Brooklyn *Plan of Conservation and Development*, 2011
[23] Town of Killingly *Plan of Conservation and Development*, 2010

- **Thompson** – The Crystal Water Company operates a groundwater supply wellfield east of French River, in the vicinity of Rachel Drive and Route 200 near the center of town. This area is included within a Level B Aquifer Area designated in the Thompson zoning regulations. The wells supply developed areas of the State Route 12 corridor in Thompson, while more rural areas rely on individual groundwater wells. The Proposed Route is located approximately 2.5 miles south of the wellfield at its closest point. The Quaddick Reservoir, which is located approximately 0.3 mile north of the Proposed Route, is not a drinking water supply, but is a recreational area. The Proposed Route would cross an area of glacial outwash designated as a Stratified Drift Protection Area, west of Quaddick Town Farm Road and south of the Quaddick Reservoir. Groundwater in the vicinity of the Proposed Route is classified as "GA". The only designated Aquifer Protection Area (No. 70) in Thompson is located approximately 3.4 miles northeast of the Proposed Route.

5.1.2.4 Flood Zones and SCELs

The FEMA classifies flood zones for insurance and floodplain management purposes and has prepared maps designating certain areas according to the frequency of flooding. An area within the 100-year flood designation has a 1% chance of flooding each year or is expected to flood at least once every 100 years.

A review of FEMA maps indicates that the Proposed Route extends across various watercourses, as well as Mansfield Hollow Lake and Lester Williams Pond, which have associated 100-year flood boundaries. These waterbodies are listed in Table 5-7 and illustrated on the Volume 9 and Volume 11 maps.

Mansfield Hollow Lake, which is a flood-control project that was completed by the USACE in 1952, lies at the confluence of the Natchaug, Fenton, and Mt. Hope rivers, in Mansfield Center. The Mansfield Hollow Lake Dam is part of a network of six flood-control dams in the Thames River Basin constructed and maintained by the USACE. Water stored during potential flooding conditions is released after water levels downstream recede. Along CL&P's ROW, four existing 345-kV transmission line structures are located within the 100-year floodplain associated with Mansfield Hollow Lake and five existing 345-kV transmission line structures are located within the 100-year floodplain associated with the Natchaug River in the Mansfield Hollow WMA in Chaplin.

Table 5-7: List of Watercourses and Waterbodies with FEMA 100-Year Floodplains along the Proposed Route

Municipality	Watercourses and Water Bodies with Designated 100-Year Floodplain
Columbia	Tenmile River, Hop River
Coventry	Hop River, Willimantic River
Mansfield	Willimantic River, Saw Mill Brook, Mansfield Hollow Lake
Chaplin	Natchaug River
Hampton	Cedar Swamp Brook, Little River
Brooklyn	Stony Brook, Blackwell Brook, Lester Williams Pond, White Brook, Creamery Brook
Pomfret	Quinebaug River
Killingly	Quinebaug River
Putnam	Quinebaug River, Culver Brook, Little Dam Tavern Brook, Lippits Brook, Munson Brook, Fivemile River
Thompson	Teft Brook

The Proposed Route also traverses the state-designated SCEL associated with the Willimantic River, which forms the border between the towns of Coventry and Mansfield (refer to the Volume 9 and Volume 11 maps). The CT DEEP Bureau of Water Protection and Land Reuse, Inland Water Resources Division, regulates the placement of encroachments and obstructions riverward of SCELs to reduce hazards to property due to flooding.

Along the ROW within which the proposed 345-kV transmission lines would be located, two of CL&P's existing 345-kV transmission line structures (Nos. 9033 and 9034, refer to mapsheet 5 of 40 in Volume 9 and mapsheet 13 of 134 in Volume 11) are located within the Willimantic River SCEL. In the initial Project design, one of the new 345-kV line structures (No. 35) was proposed for location within the Willimantic River SCEL. However, CL&P subsequently modified the Project design to increase the span length between proposed structure Nos. 34 and 35, thereby aligning proposed structure No. 35 outside the

SCEL. The existing 345-kV transmission line structures (Nos. 9033 and 9034) within the SCEL would remain in place.

5.1.3 Biological Resources

5.1.3.1 Vegetative Communities

Vegetation along the Proposed Route consists of a mix of associations and cover types, providing a variety of wildlife habitats. With the exception of the 1.4 miles across the federally-owned lands in the Mansfield Hollow area, the Proposed Route is located entirely within CL&P's existing transmission line ROWs.

As shown in the cross-sections in Section 3, Appendix 3A and in Volumes 9 and 10 and summarized in Table 3-1, CL&P's existing ROWs between Card Street Substation, Lake Road Switching Station, and the Connecticut / Rhode Island border vary in width from approximately 150 feet to 400 feet. In total, these ROWs encompass approximately 1,386 acres.

Along portions of these ROWs, CL&P routinely manages vegetation to ensure consistency with existing transmission line use and clearance requirements. The managed portions of the ROWs range in width from approximately 100 feet to 350 feet, for a total of approximately 456 actively managed acres. The remaining 930 acres within CL&Ps existing ROWs are currently unmanaged.

In addition to the 1,386 acres within CL&P's existing ROWs, 11 acres are contained within the proposed expanded easement on the federally-owned properties in the Mansfield Hollow area. The vegetation within these 11 acres consists predominantly of upland forest, with some forested wetlands and open field / shrubland located within the proposed easement expansion area in the WMA in the Town of Chaplin and Mansfield Hollow State Park in the Town of Mansfield, respectively.

In accordance with CL&P's ROW vegetation management program, woody vegetation that could interfere with the operation of the overhead transmission lines is periodically removed from the managed portion of the ROWs, and trees located along the edges of the managed ROWs are periodically trimmed or removed. As a result, the predominant vegetation types within the managed portions of CL&P's transmission line ROWs consist of dense shrub and herbaceous species. Along the Proposed Route, the vegetation near the existing overhead lines has been managed pursuant to CL&P's vegetation management program for the past approximately 40 years.

In contrast, the primary vegetation types on the unmanaged portions of the CL&P ROWs and land adjacent to these ROWs are upland deciduous (hardwood) and mixed hardwood forest (in varying successional stages), intermixed with areas of agricultural use, old field, and wetlands. The primary vegetation types within the proposed area of easement expansion on the federally-owned property in the towns of Mansfield and Chaplin consist of upland deciduous (hardwood) and mixed hardwood forest. These areas are intermixed with areas of open water (e.g., Mansfield Hollow Lake and the Natchaug River) and forested wetlands. The Volume 9 and Volume 11 maps illustrate the different vegetation types along and in the vicinity of the Proposed Route.

Specifically, as illustrated on the Volume 9 maps[24], eight habitat types/land uses either occur within the managed portions of the existing ROWs or in adjacent, presently unmanaged portions of the ROWs where the proposed 345-kV transmission lines would be aligned:

- **Open (Old) Field/Shrub land**: This habitat type is found on the existing managed ROWs and also includes abandoned fields, natural shrub lands, and early successional forests.

- **Upland (Mature Mixed) Forest**: This forest type includes mature mixed deciduous/coniferous forests found in upland areas. Mature mixed forests consist typically of tree species common to

[24] Note that the habitat types are specifically identified only on the Volume 9 maps. However, vegetation can generally be discerned on the Volume 11 maps, which provide a more detailed view of the location of the proposed 345-kV line in relation to the managed portions of CL&P's ROWs.

the Northeast such as maples, oaks, hickories, spruce, and pine. The ratio of deciduous to coniferous species and age of stands varies.

- **Forested Wetland**: Forested wetlands generally include swamps dominated by a mature canopy including deciduous and coniferous trees.

- **Scrub-Shrub Wetland**: Shrub-swamp wetlands typically include components of emergent marsh, where shrub coverage is substantial.

- **Emergent Wetland**: Emergent marshes are dominated by herbaceous wetland plant species.

- **Open Water**: This habitat includes substantial areas of open water, such as lakes, ponds, reservoirs, and large streams/rivers, along with the vegetation found along the shorelines of such areas.

- **Agricultural Lands**: This habitat includes cultivated fields, croplands, hay fields, pastures, and orchards in active agricultural use.

- **Urban Areas**: The urban areas habitat refers to suburban and urban residential developments, subdivisions, industrial or commercial uses, recreational areas (such as parks and golf courses), maintained lawns, and roadside vegetation.

Overall, the existing CL&P ROWs within which the Proposed Route is located encompass approximately 1,397 acres, including the approximately 11-acre proposed ROW expansion in the Mansfield Hollow area. Of this total, approximately 504 acres (36%) are presently forested (upland and wetland), including approximately 495 acres of wooded areas within the existing, unmanaged portions of CL&P's ROWs and approximately 9 acres of forest lands (upland and wetland) located within the proposed area of ROW expansion on the federally-owned property in the towns of Mansfield and Chaplin. The remaining approximately 893 acres consists of open (old)-field, scrub-shrub, agricultural, or other non-forested lands, including the vegetation along the presently managed portions of CL&P's ROWs.

5.1.3.2 Wildlife and Fisheries Resources

This section first describes the general wildlife resources expected to be common in the Project region, and then presents specific information, including data developed as a result of research and field investigations of the ROWs, regarding amphibians, birds, invertebrates (e.g., moths, butterflies), and fisheries.

5.1.3.2.1 General Wildlife Description

The following summarizes the wildlife habitats and some of the species that commonly occur in the vegetative communities found along and in the vicinity of the Proposed Route, as identified on the Volume 9 and Volume 11 maps, and as discussed in Section 5.1.3.1.

- **Upland (Mature Mixed) Forest**: In general, forest vegetation supports a high diversity of wildlife. Many species exhibit a preference for either coniferous or deciduous forest types, or for various age classes of forest stands, whereas other species may be found in a wide range of forest habitat types. Further, wildlife species may exhibit seasonal habitat preferences. For example, white-tailed deer may frequent mature deciduous forest areas in the fall when oak and beech mast crops are available for food, but move in the winter into coniferous areas providing better shelter from snow and wind. At other times, deer would utilize agricultural lands, wetlands, or residential areas. Species typically common in forested habitats include white-tailed deer, rabbit, coyote, gray fox, striped skunk, Virginia opossum, chipmunk, squirrel, and numerous small mammals (e.g., deer mouse, red-backed vole, shrews, and bats). Various species of birds, as well as reptiles and amphibians (collectively referred to as herpetofauna), also are common in forested areas. Birds typical of forested areas include raptors (owls, hawks), grouse, wild turkey, woodpeckers, and numerous species of songbirds. Herpetofauna likely to occur in forested areas include salamanders, as well as certain species of toads, frogs, turtles, and snakes.

- **Open (Old) Field/Shrub lands**: Species inhabiting these areas rely on herbaceous vegetation, grasses, shrubs, and young trees for food and cover. Open lands bordered by forest habitat generally support the greatest variety of wildlife because of the interspersion of different habitat types. Mammalian wildlife typical of these habitats include small mammals such as meadow voles, short-tailed shrews, and deer mice; woodchuck, rabbit, and white-tailed deer; and predators such as red fox, coyote, weasel, striped skunk, and raccoon. Various species of birds and herpetofauna also typically are present.

- **Wetlands/Open Water**: Freshwater wetlands and other aquatic habitat (e.g., streams, ponds) provide excellent habitat for a wide range of wildlife species. Many of the species using forested and shrubland (successional upland) habitats also utilize forested wetland, shrub swamp, shallow marsh, or wet meadow communities. Additionally, there are species that are adapted primarily to wetland or other aquatic habitat. These include mink, beaver, otter, muskrat and water shrew, as well as birds such as heron, waterfowl and certain types of raptors and songbirds. Herpetofauna are particularly adapted to wetlands and aquatic habitats; typical species include most salamanders at some time in their life-cycle, frogs, turtles, and snakes.

- **Agricultural and Urban Lands**: A variety of habitats are included in this category, such as cultivated crop fields, hay fields, pastures, orchards, suburban and urban residential areas, commercial and industrial developments, recreational areas (e.g., golf driving range, parks), maintained lawns, and road corridors. Wildlife in these habitats can be abundant as animals are attracted to human food sources (e.g., crop fields, orchards, bird feeders, landfills), but the species inhabiting them must be tolerant to some degree of human disturbance. Some of the most recognizable wildlife species can be found in these areas, such as white-tailed deer, raccoons, woodchucks, and birds such as Canada geese, robins, house sparrows, and the numerous species frequenting feeders. Other less visible species such as red fox, coyotes, and skunk are also common. Nuisance wildlife species such as crows, rats, and other small rodents are often abundant in these habitats. Some wildlife species are even dependent on human activity to thrive, such as birds nesting almost exclusively in human structures (e.g., chimney swift, barn swallow, purple martin). Herpetofauna tend to be scarce in these habitats because they are typically less tolerant of human activity than birds or mammals.

5.1.3.2.2 Fisheries

As summarized in Table 5-4, the Proposed Route traverses various freshwater watercourses that support cold- or warm-water fish habitat. Compared to warm-water fisheries, cold-water fisheries are more sensitive, requiring lower temperatures and higher oxygen, making them less tolerant of water quality impacts or habitat degradation.

In addition to these streams and rivers, the Proposed Route also spans Mansfield Hollow Lake, adjacent to CL&P's existing 345-kV transmission line crossing. Mansfield Hollow Lake, also known as Naubesatuck Lake or Mansfield Hollow Reservoir, is located in the towns of Mansfield and Windham and encompasses approximately 460 acres. The lake is contained entirely within the USACE-owned Mansfield Hollow properties. The shoreline is predominately forested, with some areas of open land. A public boat launch, owned by the USACE and maintained by the CT DEEP, is located off Bassetts Bridge Road in the Town of Mansfield, approximately 2,000 feet north of the Proposed Route.

The CT DEEP Inland Fisheries Division has identified 20 freshwater fish species inhabiting Mansfield Hollow Lake: largemouth bass, smallmouth bass, brown trout, rainbow trout, northern pike, chain pickerel, black crappie, yellow perch, brown bullhead, yellow bullhead, bluegill, pumpkinseed, green sunfish, bluegill/pumpkinseed hybrid, tessellated darter, fallfish, golden shiner, spottail shiner, banded killifish, and white sucker. The CT DEEP has designated Mansfield Hollow Lake a Bass Management Lake/Northern Pike Lake. CT DEEP's goal for "Big Bass Lakes" such as Mansfield Hollow Lake is to increase the numbers of quality bass. The CT DEEP also is stocking northern pike in Mansfield Hollow Lake to develop the lake for that fishery (CTDEP, 2010).

Based on a review of data concerning freshwater fisheries maintained by the CT DEEP Inland Fisheries Division, the perennial streams in the vicinity of the Proposed Route provide habitat for various fish species, ranging from trout to white sucker. The CT DEEP's inland fisheries management efforts for rivers and streams are directed primarily toward providing trout fishing opportunities, which have traditionally been an important part of Connecticut's angling activity.[25] The implementation of the 1999 *Trout Management Plan*, developed based upon the compilation of fish population, physical habitat and water chemistry information for approximately 800 Connecticut streams, is designed to improve fishing quality by diversifying angler opportunities. The *Trout Management Plan* designates various special management areas for trout. These include streams where self-sustaining wild trout populations are encouraged through catch-and-release angling, trout management areas, streams where CT DEEP stocks catchable size hatchery trout, trophy trout areas (stocked with larger hatchery trout), trout parks (offering easy access to the public and stocked more frequently to promote angler success), and streams believed to be able to support sea-run trout (anadromous brown trout).

The CT DEEP typically stocks hatchery-raised, adult-sized trout (adult brook, brown, and rainbow trout) for put-and-take purposes in publicly-accessible portions of certain rivers. Stocked streams traversed by the Proposed Route include: Tenmile River, Hop River, Willimantic River, Natchaug River, Merrick Brook, the Little River, Blackwell Brook, White Brook, Quinebaug River, and the Fivemile River. In the fall, the Shetucket River is also stocked with large (2 to 15 pound) Atlantic salmon below the Scotland Dam.

[25] CT DEEP also has a *Bass Management Plan*, which recognizes the importance of warm water species (e.g., smallmouth and largemouth bass, northern pike, panfish, and catfish) to angling in the state. However, because such warm water fish species in the vicinity of the Proposed Route are found primarily in lakes and ponds (which the proposed Project would generally not affect), this discussion only focuses on coldwater fisheries (trout).

Under the *Trout Management Plan* and pursuant to subsequent updates to trout management objectives, CT DEEP has proposed or designated several streams and rivers for further fishery management. In the vicinity of the Proposed Route, the Little River is proposed for wild trout put-and-grow management, while the Natchaug River (including the entire reach of the river in the towns of Eastford, Chaplin, and Windham) and the Shetucket River (in the towns of Windham and Norwich, neither of which is traversed by the Proposed Route) are designated Trophy Trout Streams. The portion of the Natchaug River in Eastford, north of the Proposed Route, is a designated Trout Park and Intensive/High Yield Area. Trout Parks are waterbodies in easily accessible areas that the CT DEEP (or others) frequently stocks to enhance trout fishing opportunities for young and novice anglers, as well as for those with mobility challenges. Intensive/High Yield Areas are waterbodies identified as good trout habitat that are frequently stocked to increase angler success.

Since March 2006, the CT DEEP has implemented an alewife and blueback herring fishery closure throughout Connecticut as a result of declining populations of these fish. Alewife and blueback herring, collectively referred to as river herring, are anadromous fish, migrating between saltwater and freshwater to spawn. The Project does not cross any streams or rivers supporting a population of river herring, although the Little River and Quinebaug River have been targeted by the CT DEEP for the restoration of anadromous fish.[26]

5.1.3.2.3 Amphibians

Field investigations for amphibians were performed in conjunction with the identification and evaluation of wetlands located along the CL&P ROWs within which the Proposed Route would be located. During the spring and early summer of 2008 and in the spring of 2011, all wetlands with potentially suitable vernal pool/amphibian breeding habitat (as defined below) were investigated to confirm the presence/absence of such amphibian breeding activity. The surveys were conducted during the optimum

[26] Gepard, S. 2010. Written communication regarding river herring between Steve Gephard CTDEP Fisheries Supervisor, and Jim Berg, Fisheries Biologist AECOM. December 3, 2010.

time to identify areas functioning as vernal pools and/or amphibian-breeding habitat; typically, amphibian breeding follows the first significant rain in the spring when evening low temperatures remain in the 40s (^{o} Fahrenheit). A detailed account of the survey methodology and results is presented in the *Inventory of Vernal Pools and Amphibian Breeding Habitats Report* (Volume 4).

The CT DEEP defines vernal pools as small bodies of standing fresh water found throughout the spring that typically result from various combinations of snowmelt, precipitation, and high water tables. In Connecticut, to meet the definition of a vernal pool, an area must:

- Contain water for approximately two months during the growing season;
- Occur within a confined depression or basin lacking a permanent outlet stream;
- Lack any fish populations; and
- Dry out most years, usually by late summer.

Many species critically rely upon vernal pool habitat for reproductive success, and these species are referred to as obligate vernal pool species. According to the CT DEEP (2011[27]), obligate vernal pool species that occur in the state and may have ranges within the Project area include the following:

- Wood frog (*Rana sylvatica*)
- Eastern spadefoot toad (*Scaphiopus holbrookii*)[28]
- Spotted salamander (*Ambystoma maculatum*)
- Jefferson salamander (*Ambystoma jeffersonianum*)[29]

[27] CT DEEP. 2011. Vernal Pools. Available URL: http://www.ct.gov/dep/cwp/view.asp?a=2720&q=325676&depNav_GID=1654

[28] Note that the Eastern spadefoot toad is a Connecticut-listed endangered species. During the vernal pool / amphibian habitat surveys of the ROWs, no Eastern spadefoot toads were observed. Further, consultations with the CT NDDB did not indicate any known occurrences of this species in the Project region.

- Marbled salamander (*Ambystoma opacum*)
- Fairy shrimp (*Branchiopoda anostraca*)

Vernal pools and amphibian breeding habitats are influenced by local environmental conditions and seasonal weather patterns. For the purposes of the studies of the CL&P ROWs, a vernal pool was defined as an area that supported obligate species in the 2008 or 2011 breeding season and met the majority of the vernal pool criteria. Vernal pool habitats remain as relatively consistent features in the landscape and are therefore used by successive generations of obligate vernal pool species that belong to a regional population.

Facultative vernal pool species are fauna that use, but do not necessarily require, vernal pools for reproductive success. Examples of facultative species include spring peeper (*Pseudacris crucifer)*, spotted turtle (*Clemmys guttata*), red-spotted newt (*Notophthalmus viridescens viridescens*), green frog (*Rana calimtans*), and bull frog (*Rana catesbeiana)*. Such facultative species can not only use vernal pool habitats, but also breed successfully in the margins of permanent water bodies including streams, rivers, and lakes.

Federal agencies define vernal pools and amphibian breeding habitat slightly differently than the CT DEEP. Specifically, USACE defines a vernal pool as an often temporary body of water occurring in a shallow depression of natural or human origin that fills during spring rains and snow melt and typically dries up during summer months.[30] Vernal pools also are defined as supporting populations of species specially adapted to reproducing in these habitats, which may include wood frogs, mole salamanders (*Ambystoma* sp.), fairy shrimp, fingernail clams (*Sphaeriidae*), and other amphibians, reptiles, and invertebrates. Vernal pools lack breeding populations of fish. The USACE will determine on a case-by-

[29] Note that the Jefferson salamander is a Connecticut-listed species of special concern. During the vernal pool / amphibian habitat surveys of the ROWs, no Jefferson salamanders were observed. Further, consultations with the CT NDDB did not indicate any known occurrences of this species in the Project region.

[30] Definition as included in the USACE's General Permit for Connecticut.

case basis which vernal pools are within their jurisdiction; however, all vernal pools are subject to the jurisdiction of the CT DEEP under Connecticut Water Quality Standards.

Wetland areas associated with the Project ROWs were surveyed to identify the presence or absence of obligate vernal pool species (presence/absence surveys). Where obligate species were observed, the area was further investigated to identify whether the state and federal vernal pool criteria had been satisfied. Observed facultative species were noted, but these species were not used to identify an area as a vernal pool. If an area had facultative species only, it was classified as "amphibian breeding habitat", but not a vernal pool.

"Amphibian breeding habitat" refers to wetlands encountered along the CL&P ROWs in which signs of amphibians, both obligate and facultative, were observed, but the overall habitat did not meet the specific vernal pool criteria. These distinctions were made by field biologists during the field surveys and are described in more detail in the *Inventory of Vernal Pools and Amphibian Breeding Habitat* report in Volume 4. For example, floodplain areas adjacent to perennial watercourses that were observed to provide amphibian breeding habitat were not identified as vernal pool habitat because of the probable presence of adult fish populations. In addition, where large wetland systems exhibited expansive flooded areas within which obligate vernal pool species were documented as breeding, the breeding evidence was recorded and if appropriate, based upon the observed vernal pool criteria, the areas were identified as a vernal pool. These types of areas are typically referred to as "cryptic vernal pools" and, as their name suggests, may be easily overlooked.

As a result of the 2008 and 2011 field investigations, 62 of the 227 wetlands along the CL&P ROWs within which the Proposed Route would be located were determined to contain vernal pools, while 26 wetlands were determined to contain amphibian breeding habitats. In addition, the 2008 and 2011 field investigations revealed that several of the large wetland systems along the ROWs contain multiple vernal pool and/or amphibian breeding habitat areas. As a result, 88 vernal pools and 29 amphibian breeding habitats were identified in total along the CL&P ROWs.

These areas were identified based upon physical characteristics of the wetlands observed in the field and evidence of obligate or facultative species, such as pools of water (when present), breeding choruses of obligate vernal pool amphibians, direct evidence of obligate amphibian breeding (egg masses, amphibian larvae), distinct depressions in wetlands combined with water stained leaves (if dry), significant water marks on vegetation and/or rocks, as well as marked pit and mound topography. The wetlands that provide vernal pool / amphibian breeding habitats are listed in Table 5-5 (located at the end of this section) and illustrated on the Volume 9 maps. The Volume 11 maps provide more specific information about the location of vernal pools and amphibian breeding habitats. (Note that each vernal pool and amphibian breeding habitat has been assigned a Project-specific numerical identifier; these identifiers are included in Table 5-5 and shown on the Volume 11 maps.)

As summarized in Table 5-5 and explained in detail in the *Inventory of Vernal Pools and Amphibian Breeding Habitat* report (Volume 4), the majority (80) of the 88 vernal pools located along the Project ROWs are found in the following five towns: Mansfield (19 vernal pools), Brooklyn (19 vernal pools), Putnam (15 vernal pools), Chaplin (14 vernal pools), and Hampton (13 vernal pools). Of the 29 amphibian breeding habitats found, the majority (19) are located along the Project ROWs in the Towns of Chaplin (seven amphibian breeding habitats), Hampton (six amphibian breeding habitats), and Brooklyn (six amphibian breeding habitats).

Along the ROWs within which the proposed 345-kV transmission lines would be located, four of CL&P's existing 345-kV transmission line structures (Nos. 9091, 9099, 9100, and 9119) are located within areas identified as amphibian breeding habitat. These amphibian breeding habitat areas (identified as MA-2/CH-1-ABH, CH-2-ABH, and CH-7-ABH) are associated with wetlands W20-68, W20-77, and W20-91 in the Town of Chaplin. In addition, the access roads that are currently used to facilitate maintenance of the existing transmission lines along CL&P's ROWs traverse 10 vernal pools and seven amphibian breeding habitat areas. These access roads generally extend along the managed portions of the ROWs.

5.1.3.2.4 Birds

A wide variety of bird species are known to occur in Connecticut, as documented in the *Atlas of Breeding Birds of Connecticut* (*Atlas*; Bevier [ed] 1994). Further, considerable studies have been performed regarding both the bird species that occur in the state and the species that use, or are potentially affected by, linear ROWs. The bird study conducted for the proposed Project involved both a review of these published studies, as well as analyses of the species that may occur in the Project region, based on the habitats present along and adjacent to the CL&P ROWs. In addition, subsequent to consultations with CTDEP, field studies were conducted to determine the presence of bird species along certain segments of the Proposed Route. The results of these studies, which are summarized in this section, are presented in the *Inventory of Potential Breeding Bird Species and Habitats along the Connecticut Portion of the Interstate Reliability Project* (included in Volume 4).

Habitat Summary

In Connecticut as well as in the Northeast in general, open (old) field / shrubland habitat typically is becoming scarce as abandoned farmlands revert to forest and as existing woodlands mature. At its peak around the middle of the 19th century, agriculture resulted in the clearing of nearly 75% of the forestland in Connecticut. In comparison, a decade ago, approximately 60% of the state was forested (USDA 2001).

The amount of forestland in Connecticut has remained relatively stable since 1972, with losses due to development being approximately offset by new forest land overgrowing abandoned farms (USDA 2001). However, it is unlikely that this trend will continue, as there are no longer large amounts of farmland to revert to forest, and development pressures are increasing on both habitat types (Wharton et al. 2004). Managed ROWs therefore represent an important component of regional habitat diversity, providing a stable, long-term source of shrubland habitat in a region where it is becoming scarce. Of the Neotropical migrant bird species from all habitats that show a decline in abundance from 1980 to 2000 in the Northeast, 90% use disturbance-generated habitats such as open fields, shrublands, mid-successional forests, open parkland, and forest edge, and 72% prefer disturbance and non-climax habitats (Confer and Pascoe 2003).

Consequently, perpetuating disturbance-generated habitats such as those typical of managed ROWs is becoming an increasing concern for avian conservation as species dependent upon those habitat types are becoming less common. The exchange of forested habitats for shrublands is often interpreted as a net gain for regional biodiversity (Confer and Pascoe 2003).

Scrub-shrub habitats along the ROWs are dominated by low-growing, woody vegetation, with trees nearly or entirely absent. Historically, these habitats were created by natural and anthropogenic disturbances, which have declined over time. Due to these reductions in disturbances, this habitat type currently represents a small and declining portion of the overall landscape in the Northeast (Trani et al. 2001). The overall lack of this type of habitat places additional value on existing and newly created scrub-shrub habitat often associated with utility corridors and the “edge effect” that these utility corridors create. The importance of these grassland and shrubland habitat types to birds in Connecticut is exemplified by the Connecticut Audubon Society’s 2006 *State of the Birds* report, which identifies the preservation of grasslands and the management of land to create more shrublands as key recommendations for protecting the state’s birds and their habitats.

<u>Research Summary</u>

For the Project, CL&P first conducted an extensive review of the existing literature to identify the bird species that may occur in the vicinity of the Proposed Route. Information regarding species that might inhabit the general Project region then was correlated to the habitat types along and in the vicinity of the

Project in order to assess the birds' potential use of the ROWs and adjacent habitats for breeding and other purposes.

The *Atlas of Breeding Birds of Connecticut* (*Atlas*; Bevier [ed] 1994), which presents the results of detailed, state-wide field surveys of bird species and behavior conducted by more than 500 volunteers over a five-year period (1982-1986), was the primary source consulted to determine which bird species are likely to breed in the Project area. The *Atlas* confirmed a total of 170 bird species as breeding in Connecticut. For each of these breeding species, the Atlas includes distribution maps that identify the general geographic areas in which the species was observed and whether breeding was confirmed, probable, or possible.

To assess the potential breeding bird species in the Project region, the distribution maps included in the *Atlas* were correlated to the Proposed Route. Using the aerial photographs of the ROWs (refer to Volume 9 and Volume 11), CL&P evaluated the vegetative community types (as identified in Section 5.1.3.1) along and in the vicinity of the Proposed Route to further refine the list of bird species that could potentially occur in each habitat.

As a result of this review, 146 bird species were identified as potentially occurring in the vicinity of the Proposed Route.[31] A list of these species is included in the *Inventory of Potential Breeding Bird Species and Habitats* in Volume 4.

In addition to this baseline research, to determine whether any federal or state listed bird species of concern are known to occur in the vicinity of the Proposed Route, CL&P consulted with staff at the CT DEEP Natural Diversity Database (CT NDDB), Environmental & Geographic Information Center, and

[31] The 146 bird species identified as potentially occurring in the vicinity of the Proposed Route were either confirmed breeders in New London, Tolland, or Windham counties and/or were listed as a protected bird species in the State of Connecticut and are known to use the types of habitat found within CL&P ROWs. Some bird species that met these criteria (e.g., breed in New London County) are not typically found in the habitats common to the Project region (e.g., birds that inhabit coastal areas, salt marsh habitat). Such species are not included in the bird species table in the *Inventory of Potential Breeding Bird Species and Habitats* in Volume 4.

the USFWS. The USFWS (in responses dated November 21, 2007 and April 2009) indicated that no federally-listed bird species are present in the Project region and, consequently, that no further coordination with USFWS is necessary regarding federally-listed birds. As requested in previous response letters from USFWS, CL&P consulted the USFWS website on December 9, 2010 to identify updated listed species occurrence information. No species were listed on the USFWS website as occurring within the towns in the Project area.

The CT NDDB, in correspondence dated February 25, 2008, identified six state-listed species as potentially occurring near the Proposed Route. Subsequently, field surveys were conducted to determine the presence / absence of these six state-listed bird species. The six state-listed bird species are identified and discussed in Section 5.1.3.3, along with the results of the field studies to assess the presence / absence of these species in the vicinity of the Proposed Route. A detailed report of the breeding bird research and field studies is included in the *Inventory* report in Volume 4.

5.1.3.3 Federal- and State-Listed or Proposed Threatened, Endangered, or Special Concern Species

Consultations

CL&P consulted with the USFWS and the CT NDDB to: (1) determine whether any species listed, or proposed for listing, by the federal or state governments as threatened, endangered, or species of special concern are known to occur along or in the vicinity of the Proposed Route; and (2) assess if there is a potential for the Project to affect such species.

In November 2007 and April 2009, the USFWS indicated that the Proposed Route does not encompass the known habitat of any federally-listed species under the jurisdiction of the USFWS. However, the USFWS did indicate the New England cottontail (*Sylvilagus transitionalis*), a candidate species[32], is

[32] The USFWS completed a status assessment for the New England cottontail and determined that federal listing is “warranted, but precluded”; i.e., the status of the species indicates that it should be listed, but the listing is superseded by higher listing actions.

known to occur in the Town of Lebanon (refer to USFWS consultation letter and response in Volume 4). The USFWS further indicated that because there are no federally-listed species, preparation of a Biological Assessment[33] or further consultation with the USFWS under Section 7 of the Endangered Species Act is not required. As requested in previous response letters from USFWS, CL&P consulted the USFWS website on December 9, 2010 and October 28, 2011 to identify updated listed species occurrence information. No other species were listed on the USFWS website as occurring within the towns in the Project area.

In addition to consultations with USFWS, CL&P submitted written requests to the CT NDDB for information concerning the presence / absence of state-listed or state proposed threatened, endangered, or special concern species in the vicinity of the Proposed Route (refer to Volume 4, CL&P correspondence to the CT NDDB dated October 11, 2007, March 17, 2009, and March 19, 2010). Based on both written and personal correspondence with the CT NDDB between February 2008 and December 2010 (refer to Volume 4 for copies of correspondence between CL&P representatives and the CT NDDB), 26 state-listed species were identified as potentially occurring in the vicinity of the Proposed Route. The CT NDDB determined that no state-listed plant species were known to occur in the Project vicinity. (Refer to Volume 4, March 17, 2008 correspondence from the CT NDDB, concluding…"…this project will not impact any known extant population of state-listed plant species that may occur within the study corridor.")

Subsequent to the receipt of the CT NDDB's initial correspondence regarding the state-listed species in the vicinity of the Project, CL&P and its representatives met with the CT NDDB on April 1, 2008. The purpose of the meeting was to discuss the proposed Project; to review methods, as necessary; for determining the actual presence / absence of the state-listed species along the Proposed Route; and to

[33] Section 7 of the Endangered Species Act requires the preparation of a Biological Assessment Report to document the effects of proposed actions on federally-protected species and resources.

assess options for mitigating or avoiding adverse effects on the listed species as a result of the development of the Project. The CT NDDB also provided the following recommendations:

- Surveys of the ROWs to evaluate the presence / absence of the state-listed bird, butterfly, and moth species must be performed. CT NDDB recommended conducting host plant and species-specific surveys in an effort to locate Lepidoptera (moths and butterflies) along the Proposed Route.

- No surveys for wood turtles, Eastern ribbon snakes, or Eastern hognose snakes are required. However, specific mitigation measures must be implemented during the construction of the Project to ensure the well-being of these species (refer to Section 6 for a discussion of potential mitigation measures).

- No field surveys for the aquatic snail are required. However, during construction, the proper deployment and maintenance of erosion and sedimentation controls will be critical to the long-term viability of this species and its habitat (refer to Sections 4 and 6 for a discussion of erosion and sedimentation control measures proposed during Project construction).

In response to the CTDEP request for field investigations to document moth and butterfly species along the ROWs, CL&P retained the University of Connecticut (UCONN), Center for Conservation and Biodiversity (CCB). CL&P commissioned AECOM to perform the bird surveys. The CTDEP-recommended field surveys for moths, butterflies, and birds were subsequently conducted in 2008-2011. During the 2008 bird surveys, another state-listed bird species of special concern (the Brown Thrasher) was identified in the vicinity of the Proposed Route; this species was not previously identified by the CT NDDB as occurring in the Project vicinity. As a result of the Lepidoptera surveys, two additional state-protected invertebrate species were found in the Project area: a butterfly species, the Persius duskywing (*Erynnis persius*), and buck moth (*Hemileuca maia*). Table 5-8 lists the 29 listed species reported to occur or with the potential to occur in the Project vicinity (i.e., the 26 species initially identified from the CT NDDB information, as well as the bird and Lepidoptera species identified during the field surveys).

Table 5-8: State-Listed Species in the Vicinity of the Proposed Route

Species (Common Name)	Species (Scientific Name)	Status*	General Location Reported in NDDB and Habitat Type
Butterflies			
Horace's duskywing	*Erynnis horatius*	SSC	Mansfield and Chaplin - open woodlands and edges
Frosted elfin	*Callophryus irus*	ST	Mansfield, Chaplin, Brooklyn, and Killingly - xeric and open disturbance-dependent habitats on sandy soil
Sleepy duskywing	*Erynnis brizo*	ST	Mansfield, Barrens, and areas with poor, thin or well drained (often sandy) soils
Harris' checkerspot	*Chlosyne harrisii*	ST	Mansfield, Chaplin, and Windham - moist areas such as bogs, meadows and marshes
Persius duskywing[1]	*Erynnis persius*	SE	Killingly - open, sunny oak woodlands, balds, and barrens
Moths			
Noctuid moth	*Zale oblique*	SSC	Mansfield - pitch pine-scrub oak barrens
Pine barrens noctuid moth	*Zanclognatha martha*	SSC	Mansfield - pitch pine-scrub oak barrens
Scribbled sallow	*Sympistis pescripta*	SSC	Mansfield - disturbed areas with sandy soil
Noctuid moth	*Apamea burgessi*	SSC	Mansfield and Hampton - xeric, sandy areas
Noctuid moth	*Chaetaglaea cerata*	SSC	Mansfield - pitch pine-scrub oak barrens on heathlands and sand plains
Noctuid moth	*Eucoptocnemis fimbriaris*	SSC	Mansfield - dry grassy or sandy fields with remnant pine barrens and scrub oak barrens
Noctuid moth	*Shinia spinosae*	SSC	Mansfield - associated with jointweed
Shrub euchlaena	*Euchlaena madusaria*	ST	Mansfield - scrub oak shrubland
Barrens metarranthis	*Metarranthis apiciara*	SE	Killingly - dry rocky woods to pitch pine barrens
Slender clearwing	*Hemaris gracilis*	ST	Killingly - open wooded areas
Noctuid moth	*Lepipolys prescripta*	SSC	Thompson - disturbed sandy soil habitats
Buck moth[1]	*Hemileuca maia*	SE	Putnam - Expansive, open (sunny), pitch pine-scrub oak barrens and woodlands
Birds			
Horned Lark	*Eremophila alpestris*	SE	Mansfield - open areas with little cover
Grasshopper Sparrow	*Ammodramus savannarum*	SE	Mansfield - grasslands, pastures and old fields
American Kestrel	*Falco sparverius*	ST	Mansfield - grassland or shrubland at the edge of forest; requires cavities for nesting
Savannah Sparrow	*Passerculus sandwichensis*	SSC	Mansfield - grassy fields with damp soils
Eastern Meadowlark	*Sturnella magna*	SSC	Mansfield - large, grassy fields
Brown Thrasher[2]	*Toxostoma rufum*	SC	Mansfield - dry thickets, second-growth areas, brushy fields

Table 5-8: State-Listed Species in the Vicinity of the Proposed Route

Species (Common Name)	Species (Scientific Name)	Status*	General Location Reported in NDDB and Habitat Type
Whip-poor-will	*Caprimulgus vociferus*	SSC	Putnam - scrubby immature woods, wooded areas following a disturbance
Turtles			
Wood turtle	*Glyptemys insculpta*	SSC	Pomfret - riparian areas with large floodplains, forests, and fields
Snakes			
Eastern ribbon snake	*Thamnophis sauritus*	SSC	Putnam - wetlands, edges of ponds, and streams
Eastern hognose snake	*Heterodon platirhinos*	SSC	Mansfield - sandy, wooded areas
Aquatic Species			
Aquatic snail	*Gyraulus circumstriatus*	SSC	Mansfield - fresh, clear water
Moustached clubtail dragonfly	*Gomphus adelphus*	ST	Mansfield and Chaplin - clean gravelly or rocky rivers

*Key: SSC=State Species of Special Concern, ST=State Threatened, SE=State Endangered

[1] The Persius duskywing and buck moth were identified during field surveys of the ROW conducted by CCB.

[2] The Brown Thrasher was observed in the vicinity of the ROW during 2008 field surveys conducted by CL&P consultants.

These 29 state-listed species include five species of butterflies, 12 species of moths, seven species of birds, one turtle species, two snake species, and two aquatic species (a snail and a dragonfly). The table also summarizes the habitats that each species typically occupies, as well as the towns traversed by the Proposed Route in which the species is reported to occur, based on either the CT NDDB data or the Project field surveys.

The remainder of this section reviews the results of the field surveys for the listed species, and summarizes the habitat requirements of the listed species for which CT DEEP has indicated no field investigations are required.

Butterflies and Moths

UCONN's CCB conducted Lepidoptera investigations of the 36.8-mile Proposed Route. Details regarding the survey methods used and the results of these investigations are presented in Volume 4 (refer to the *Final Report: Insect Survey for the Interstate Reliability Project*, April 2011).

Preliminary field reconnaissance of the ROWs was conducted in May 2008, with formal field investigations (walk overs) of the ROWs performed in May 2009. In early 2010, the CCB team returned to all sites deemed to be of potential conservation interest to map plant communities and important host plant species. The surveys focused both on the collection of Lepidoptera species at certain key sites and on the assessment of plant community types known to host the state-listed species of Lepidoptera. Five such community/host-plant types were distinguished and mapped: bluestem grassland, low-bush blueberry, scrub oak, wild indigo, and bluestem-scrub oak-low-bush blueberry mosaic.

The focus of the surveys was on the identified state-listed species reported to occur in the vicinity of the ROWs and the vegetative communities / host-plant types that such species typically utilize. Table 5-9 lists the species host plants, habitat, and seasonal occurrence period.

Table 5-9: Focal State-listed Lepidoptera

Scientific Name	State Status	Seasonality (adult)	Hostplants	Habitat/Comments
BUTTERFLIES				
Callophrys irus	Threatened	May into very early June	wild indigo and lupine	Sandplains, grasslands, and transmission line ROWs
Chlosyne harrisii	Endangered	June	flat-topped aster	Wet and mesic meadows; possibly extirpated (last known Connecticut colony was in Chaplin along IRP ROW)
Erynnis brizo	Special Concern	May into early June	scrub and other red oaks	Barrens, scrub, and open woodlands
Erynnis horatius	Special Concern	May into early June, then again in July	scrub and other oaks	Barrens, scrub, and open woodlands
Lycaena epixanthe	Threatened	June into early July	cranberry	Bogs and acid wetlands with host
MOTHS				
Apamea burgessi	Special Concern	Late August into September	dry season grasses such as little bluestem	Grasslands, sandplains, barrens, and other open, dry sites
Chaetaglaea cerata	Special Concern	September into early October	unknown, likely various heaths and/or scrub oak	Dry fields, scrub, balds, open woodlands
Euchlaena madusaria	Special Concern	June and August	presumably lowbush blueberry	Lowbush blueberry heathlands and grasslands with host
Eucoptocnemis fimbriaris	Special Concern	mid August into September	dry season grasses such as little bluestem	Grasslands, sandplains, barrens, and other open, dry sites
Hemaris gracilis	Threatened	May and June	lowbush blueberry	Heathlands
*Hemileuca maia**	Endangered	Late September into early October	scrub oak	Scrub oak barrens
Sympistis (*Lepipolys*) *perscripta*	Special Concern	June	toadflax	Sandplains and open disturbed sites
*Meropleon ambifuscum**	Special Concern	Mostly September	big bluestem (*Andropogon gerardii*)	Wetlands
Metaranthis apiciaia	Endangered	June	unknown	Barrens, shrublands, and open woodlands
*Psectraglaea carnosa**	Threatened	Early October	often assoc. with lowbush blueberry	Barrens and heathlands
Schinia spinosae	Special Concern	September	common jointweed	Sandplains and open disturbed sites
Zale obliqua	Special Concern	June	pitch pine	Pine barrens
Zanclognatha martha	Threatened	Late June into early July	general feeder	Late successional pine barrens

* Species not listed in CTDEP NDDB records as being present along ROWs, but thought by CCB to be potentially present.

Day-time reconnaissance collection efforts emphasized surveys for state-listed butterflies, and particularly *Callophrys irus* (frosted elfin), a globally imperiled animal. The entire length of the transmission line ROWs was walked in May 2009, during the peak of the insect's flight season, to document activity and suitable habitats. Seven populations were located, six of which were new colonies for Connecticut. Night-time blacklight sampling was limited to sections of the ROWs likely to harbor rare species as determined by the plant communities present along a given section of the transmission line ROW. In essence, sites with known hostplant or plant communities were surveyed. Fifty blacklight trap samples yielded more than 5,700 moths: 424 species of moths were identified from these samples.

Seventeen butterfly and moth species deemed to be of conservation importance were found along the ROWs. Of these, 10 are state-listed species (including eight listed by the CT NDDB as potentially occurring in the Project area and the two additional state-listed species found during the field surveys):

- *Apamea burgessi* (burgess cutworm) (Special Concern)
- *Callophrys irus* (frosted elfin) (Threatened)
- *Erynnis brizo* (sleepy duskywing) (Special Concern)
- *Erynnis persius* (Persius duskywing) (Endangered) (verification on ID pending)
- *Euchlaena madusaria* (scrub euchlaena) (Threatened)
- *Eucoptocnemis fimbriaris* (no common name) (Special Concern)
- *Hemiaris gracilis* (slender clearwing) (Threatened)
- *Hemileuca maia* (buck moth) (Endangered)
- *Metarranthis apiciaria* (barrens metarranthis) (Endangered)
- *Sympistis perscripta* (=*Lepipolys perscripta*) (scribbled sallow) (Special Concern)

A total of 23 rare animal occurrences for state-listed species were documented and submitted to CTDEP. These are listed in Table 5-10. The most significant of these is the globally-imperiled barrens metarranthis (*Metarranthis apiciaria*). The colony identified along the ROW in the Town of Killingly that the CCB team discovered in 2008 has yielded more individuals than have been seen in New England over the last half century.

In addition, seven other rare moths were identified during the field surveys: *Acronicta falcula*, *A. fragilis*, *Derrima stellata*, *Digrammia equivocata*, *Hyparpax aurora*, *Schinia obscurata*, and *Schinia septentrionalis*. The CCB recommends that these species warrant state protection and that several are more imperiled than many of the moths already included on Connecticut's list of endangered, threatened, and special concern species.

Finally, as a result of the investigations, two portfolio sites, identified by CCB as having potential regional or even global significance, were identified along the transmission line ROWs. These sites, both of which are located along segments of transmission line ROWs in the eastern portion of the Project area, are:

- Towns of Putnam and Killingly. The portion of transmission line ROW extending from River Road, west of the Quinebaug River, to the southwest-facing slope above Park Road/Tracy Road, and including the ROW in the vicinity of CL&P's Lake Road Switching Station, Killingly Substation, and Tracy Substation.

- Town of Thompson. The portion of the transmission line ROW that extends from Elmwood Hill Road northeast to the Connecticut / Rhode Island border.

Table 5-10: Results of Lepidoptera Surveys: Occurrence of State-listed Butterflies and Moths along the Project ROWs

TAXON SPECIES	TOWN	SITE NAME	DATE
Apamea burgessi	Killingly	Louisa Viens Drive	7-Sep-09
Apamea burgessi	Chaplin	East of Rt. 6	12-Sep-09
Callophrys irus	Thompson	Elmwood Hill Road transmission line ROW	22-May-09
Callophrys irus	Chaplin	East of Rt. 6	16-May-09
Callophrys irus	Brooklyn	Route 97 Transmission line ROW	13-May-09
Callophrys irus	Killingly	ROW vicinity of Tracy Road and substation	26-May-09
Callophrys irus	Killingly	Lake Road transmission line	19-May-09
Callophrys irus	Pomfret	Route 101 Transmission line ROW	21-May-09
Callophrys irus	Mansfield	ROW north of Sawmill Brook Lane	20-May-09
Erynnis brizo	Thompson	Elmwood Hill Road transmission line	11-May-09
Erynnis persius	Killingly	Louisa Viens Drive	12-May-09
Euchlaena madusaria	Thompson	Munyan Road, Lower Pond	19-Aug-09
Eucoptocnemis fimbriaris	Killingly	Lake Road transmission line	30-Sep-09
Hemaris gracilis	Killingly	Park Street transmission line ROW	26-May-09
Hemaris gracilis	Pomfret	River Road, quarry & adjoining ROW	30-May-09
Hemaris gracilis	Thompson	Elmwood Hill Road transmission line	22-May-09
Hemaris gracilis	Killingly	Louisa Viens Drive	8-Jun-08
Hemileuca maia	Pomfret	River Road, quarry & adjoining ROW	30-May-09
Metarranthis apiciaria	Killingly	Louisa Viens Drive	22-Jun-08
Metarranthis apiciaria	Killingly	Louisa Viens Drive	26-Jun-09
Metarranthis apiciaria	Killingly	Louisa Viens Drive	7-Jul-09
Metarranthis apiciaria	Killingly	ROW vicinity Tracy Road	25-Jun-09
Sympistis pescripta	Thompson	Elmwood Hill Road transmission line ROW	14-Jun-08

Birds

The CT NDDB records identified six state-listed birds as potentially inhabiting certain areas in the vicinity of the Proposed Route (refer to Table 5-11, which provides information concerning these species, including their habitat preferences and the towns along the Proposed Route in which each was reported by CT NDDB records). The CT NDDB recommended the performance of field surveys to confirm the presence / absences of habitat for these species along the Proposed Route.

Table 5-11: State-Listed Bird Species Potentially Occurring in the Vicinity of the Proposed Route (As Identified by CT NDDB Records)

Species Designation	Species Name (Common, *Scientific*)	Species Habitat (Potential Location, by Town, along Proposed Route)
State Threatened		
	American Kestrel (*Falco sparverius*)	Generally prefer open areas (such as woodland edges, parks or open fields) and are cavity nesters, seeking out abandoned woodpecker or flicker holes in which to nest. (Mansfield Hollow, Town of Mansfield)
State Endangered		
	Grasshopper Sparrow (*Ammodramus savannarum*)	Nests in open, grassy areas such as open fields, meadows, and marshes. (Mansfield Hollow Area, Town of Mansfield)
	Horned Lark (*Eremophila alpestris*)	Prefers large fields, open areas, shoreline beaches, grasslands, and agricultural areas. (Mansfield Hollow Area, Town of Mansfield)
State Species of Concern		
	Whip-poor-will (*Caprimulgus vociferus*),	Nocturnal bird, found in dry open woodlands usually near fields. (Towns of Chaplin, Hampton, and Putnam)
	Savannah Sparrow (*Passerculus sandwichensis*),	Nests in open, grassy areas (Mansfield Hollow Area, Town of Mansfield)
	Eastern Meadowlark (*Sturnella magna*)	Typically nests in open, grassy fields larger than 15 acres (Mansfield Hollow Area, Town of Mansfield)

In response to the CT NDDB's request for field investigations of these state-listed bird species, wildlife biologists conducted ground surveys for potential nesting habitat along two segments of the CL&P transmission line ROWs where CT NDDB records indicated these six species may occur. These two ROW segments are from Bassetts Bridge Road to Mansfield Hollow Lake in the Town of Mansfield (i.e., within Mansfield Hollow State Park) and from Killingly Avenue (State Route 12) to approximately Ridge Road in the Town of Putnam. Field studies were conducted along the Mansfield portions of the ROW on May 27 and 29, 2008 and along the Putnam portions of the ROW on June 3 and 5, 2008 and on June 15, 16, and 20, 2011.

Two of the state-listed species identified by CT NDDB as potentially occurring in the Project region were observed during the 2008 field surveys. These species were a female American Kestrel and an Eastern Meadowlark, both of which were observed in the vicinity of the ROW in the Town of Mansfield. The 2011 surveys did not find any evidence that state-listed species occur along the Putnam portions of the ROW.

During the 2008 field surveys, CL&P's consultants identified the Brown Thrasher (*Toxostoma rufum*), a state-listed species of special concern that CT NDDB previously had not recorded as occurring in the Project vicinity. This species, which was observed in the vicinity of the ROW in Mansfield Hollow State Park (in the Town of Mansfield), inhabits thickets, fields with scrub-shrub, and woodland borders.

The following were documented as a result of these field surveys:

- On May 27, 2008, a female American Kestrel was observed perching on top of an unused water well drilling rig derrick in an active farm field approximately 600 feet west of the CL&P ROW in Mansfield.

- On May 27 and 29, 2008, a single Eastern Meadowlark was heard singing and observed flying from the same farm field in which the kestrel was observed.

- On May 27 and 29, 2008, two Brown Thrashers were observed repeatedly flying in and out of a large multiflora rose bush on land owned by the USACE just to the south of the active farm field.

- An area of potential American Kestrel and Eastern Meadowlark foraging habitat was identified in an active agricultural field along the CL&P ROW in an area of Mansfield Hollow State Park in the Town of Mansfield. The potential foraging habitat is located in open field/shrubland within the existing ROW to the north and south of Bassetts Bridge Road, between existing pole structures 9081 and 9082 and is shown graphically on Figure 1 of the *Addendum to the Inventory of Potential Breeding Bird Species and Habitats* in Volume 4.

In addition to these listed species, during the spring 2008 field surveys, a Great Blue Heron (*Ardea herodias*) rookery was identified within and adjacent to a portion of CL&P's existing ROW in the Town of Thompson, west of Quaddick Town Farm Road (refer to Mapsheet 38 of 40 in Volume 9). The rookery is located in the northern unmanaged portion of the existing CL&P ROW. The rookery identified during the field surveys is associated with wetland W20-203. Great Blue Herons congregate at rookeries (nesting sites) from March (early spring) through August, coinciding with the breeding season. The sites often consist of hundreds of breeding pairs of Great Blue Herons. These habitats / breeding grounds are significant to maintaining local populations of Great Blue Heron.

<u>Wood Turtle (Glyptemys insculpta)</u>

The CT NDDB identified wood turtles (*Glyptemys insculpta*) as potentially occurring near the Proposed Route in the Town of Pomfret. Wood turtles have extensive landscape-scale habitat requirements, requiring clean rivers and large streams with deeply undercut banks for hibernation, as well as extensive areas of floodplain, forest, and fields for summer foraging.

<u>Snakes</u>

Two species of snakes, the Eastern hognose snake (*Heterodon platirhinos*) and the Eastern ribbon snake (*Thamnophis sauritus*), were identified by the CT NDDB as potentially occurring in proximity to the Proposed Route. The Eastern hognose snake is reported to inhabit areas near the Mansfield Hollow portion of Mansfield, whereas the Eastern ribbon snake is reported as potentially occurring near the Aldrich Road area of Putnam.

Field surveys of the CL&P ROWs in 2008 and 2011 to identify vernal pools and amphibian breeding habitats resulted in the identification of Eastern ribbon snakes in several wetland complexes. In 2008, one Eastern ribbon snake was observed and photographed in wetland W20-87 in the Town of Chaplin. Ribbon snakes were observed in three separate wetlands along the ROWs during the 2011 surveys. Specifically, during the 2011 field surveys of vernal pools and amphibian breeding habitat, four ribbon snakes were observed in wetland W20-87, one individual was observed in wetland W20-100 in the Town of Hampton, and one individual was observed in wetland W20-169 in the Town of Killingly. Rare species observation forms and accompanying photographs are being prepared for submittal to the CT NDDB.

Aquatic Species

Two state-listed species – an aquatic snail (*Gyraulus circumstriatus*) and the moustached clubtail dragonfly (*Gomphus adelphus*) –were identified by the CT NDDB as potentially occurring in the vicinity of the Proposed Route near the Mansfield Hollow area of Mansfield and Chaplin. Both species inhabit aquatic environments. The snail is found in lakes and their shorefronts, whereas the dragonfly is found in coldwater streams.

5.1.3.4 Designated Wildlife Management Areas (WMAs)

The Project region does not encompass any national wildlife refuges, forests, or parks. However, several state-designated WMAs and forests, along with private hunting and fishing clubs, are located along or in the vicinity of the Proposed Route, as described below.

State WMAs and Forests

One state WMA (i.e., the Mansfield Hollow Lake WMA) and certain other wildlife use areas are designated along or in the vicinity of the Proposed Route. These are described below and identified on the Volume 9 and Volume 11 maps. In addition to these designated wildlife management properties, several other designated forested open space areas and parks exist along the Proposed Route, as described in Section 5.1.4.4.

State-designated WMAs are established by funding related to the federal Pittman-Robertson Act of 1937, which specifies the use of taxes/fees on hunting for game management. Such WMAs, which in Connecticut are typically managed by the CT DEEP for hunting and other uses, are established by the state through an administrative process when the properties are acquired.

The Mansfield Hollow Lake WMA encompasses approximately 2,000 acres owned by the USACE in the towns of Mansfield, Windham, and Chaplin. Lands within this WMA provide a range of wildlife habitats and are managed for the regulated hunting of small game, waterfowl, turkey, and deer. In addition, the WMA includes a 300-acre field trial area for hunting dog training, which is located south of the Proposed Route. The WMA borders Mansfield Hollow State Park, a 251-acre recreation area adjacent to Mansfield Hollow Lake. Mansfield Hollow Lake, which is bordered by the state park and the WMA, has an area of approximately 460 acres and offers public boating, fishing, and other recreational opportunities.

The Proposed Route follows CL&P's existing ROW across two sections of the WMA. Within the Town of Mansfield, the route traverses approximately 0.9 mile across portions of Mansfield Hollow State Park, Mansfield Hollow Lake, and the WMA located on the eastern side of the lake. Along this segment of the ROW, about 0.1 mile is within the WMA. In the Town of Chaplin, the Proposed Route traverses approximately 0.5 mile across a second portion of the WMA, which extends along either side of the Natchaug River.

Through both areas of the WMA (and the other USACE-owned properties), the existing CL&P ROW is only 150 feet wide. In order to collocate the new 345-kV transmission line adjacent to CL&P's existing 345-kV line using structures similar in appearance and height to this existing line through the WMA and other USACE-owned properties in the Mansfield Hollow area, additional easements, totaling approximately 11 acres would be required. Of this proposed ROW expansion, approximately 5.8 acres would be in the WMA.

In the Town of Chaplin, the Proposed Route also traverses an isolated parcel of the Natchaug State Forest for a distance of approximately 0.1 mile (refer to maps 11 and 12 of 40 in Volume 9). Overall, the Natchaug State Forest consists of approximately 12,000 acres providing diverse wildlife habitats. Most of the Natchaug State Forest is located north of the Proposed Route, in the northern portions of the towns of Chaplin and Hampton, as well as in the Town of Eastford. The forest is regulated by the CT DEEP and provides hunting and fishing opportunities for visitors. CT DEEP stocks pheasant in certain areas of the forest, as well as trout in the Natchaug River.

Municipal and Private Wildlife Areas

In addition to the state-designated WMAs and forests, some of the towns in the Project area have identified wildlife areas. Several private land trusts and hunting / fishing groups also own property in the vicinity of the Proposed Route. These areas are discussed briefly below and illustrated on the Volume 9 maps.

As identified in its 2010 *Plan of Conservation and Development*, the Town of Lebanon has designated existing utility ROWs, including the existing CL&P transmission line ROWs originating from Card Street Substation, as protected open space.[34] The town has identified these corridors as open space because they are largely left "as is" with minimal structures developed, and therefore are important for wildlife. The Proposed Route is located within CL&P's existing transmission line ROW for approximately 0.6 mile within the Town of Lebanon.

In the Town of Mansfield, the Proposed Route is located in proximity to, but does not traverse, lands managed by Joshua's Tract Conservation and Historic Land Trust, Inc., including the Wolf Rock Nature

[34] Chester, P. 2010. Written communication regarding Town of Lebanon Protect Open Space with Philip S. Chester Town of Lebanon Planner, and Alison Milliman, AECOM. December 20, 2010.

Preserve and Joshua's Tract Wildlife Area. In the Town of Chaplin, the Proposed Route traverses approximately 2,900 feet of land owned by the Fin, Fur, and Feather Club, Inc., a private organization providing fishing, hunting, and shooting facilities for its members. Within a 1.1-mile segment of existing CL&P ROW in Hampton, the Proposed Route traverses property owned by the Bigelow Howard Valley Fish and Game Club. This privately-owned property is used for hunting and is located between Pudding Hill Road and Drain Street.

5.1.4 Land Uses and Scenic Resources

With the exception of the 1.4-mile segments in the towns of Mansfield and Chaplin, the Proposed Route would be aligned within CL&P's existing transmission line ROWs between Card Street Substation, Lake Road Switching Station, and the Connecticut/Rhode Island border. Lands in the general Project region are characterized by a variety of uses and types, including forest lands, agricultural areas, recreational areas, transportation corridors (state and local roadways), and residential, commercial, and industrial developments.

Within CL&P's existing ROWs, lands along and in the vicinity of the existing transmission lines are managed to promote shrub or similar low-growth vegetation, consistent with utility use. Lands encompassing the unmanaged portions of the ROWs are undeveloped and consist of forested, shrub, and agricultural or other open lands. Within these existing ROWs, developed land uses (e.g., buildings) are not permitted, pursuant to CL&P's easement agreements with landowners.

To identify and assess land uses along the ROWs, as well as existing and future land use plans and conditions in the Project vicinity, CL&P consulted existing published GIS resources; analyzed aerial photography and maps; examined federal, state, local, and regional land-use plans (including data concerning federal- and state–designated heritage areas); and reviewed data concerning public and private recreational resources, including the Connecticut Forest and Parks Association's (CFPA's) blue-blazed trail system (as defined in the CFPA's *Connecticut Walk Book East (The Guide to the Blue-Blazed Hiking*

Trails of Eastern Connecticut. 2005, 19th Edition) and the Joshua's Tract Conservation and Historic Trust's *Joshua's Tract Walk Book* (2005, 4th Edition). In addition to Joshua's Tract Conservation and Historic Trust, Inc. (which owns properties in Lebanon, Coventry, Columbia, Mansfield, Chaplin, and Hampton), CL&P conducted research to identify parcels preserved by other land trusts in the Project region, including Wolf Den Land Trust (Brooklyn, Hampton, and Killingly) and Wyndham Land Trust (Brooklyn, Pomfret, Killingly, Putnam, and Thompson).

CL&P also researched the location of the Project in relation to Connecticut Heritage Areas, Connecticut State Department of Transportation (ConnDOT) scenic lands, state parks and forests, and protected rivers. Whereas no ConnDOT scenic lands[35] are located in the vicinity of the Proposed Route, the Proposed Route does traverse the Quinebaug-Shetucket Rivers Valley National Heritage Corridor[36], which is designated as such by both the federal and state governments. This heritage corridor encompasses 10 of the 11 towns along the Proposed Route.

The following subsections describe existing land uses along the Proposed Route, as well as settled areas, public open space and recreational areas, statutory facilities, and designated protected and scenic resources.

5.1.4.1 Existing Land Uses

The Proposed Route would commence at CL&P's existing Card Street Substation in the Town of Lebanon, and would extend generally north-northeast across portions of 11 towns before interconnecting at the Connecticut/Rhode Island border to National Grid's proposed 345-kV transmission line. The route

[35] ConnDOT scenic lands are roadside properties, located primarily outside of highway ROWs, which were purchased at least in part with federal Highway Beautification Act (1965) funds in order to control the proliferation of billboards and other unsightly views along federal highways. Two of the 33 parcels of scenic lands are located in the Town of Killingly, along Interstate 395. However, these parcels are located more than 1 mile south of the Proposed Route (refer to the Volume 8 *Visual Resource Analysis*).

[36] This heritage corridor also is referred to as The Last Green Valley.

would be aligned along existing ROWs that traverse or border a variety of land uses, as depicted on the maps in Volumes 9 and 11.

Almost the entire length of the Proposed Route extends along existing CL&P ROWs. Approximately 5 miles of the 36.8-mile Proposed Route traverses CL&P-owned property, whereas 1.4 miles crosses lands in the Mansfield Hollow area that are owned by the USACE (where CL&P's Proposed Configuration would involve 11 acres of additional easement in order to collocate the new 345-kV line adjacent to the existing 345-kV line using matching structure types).

The remainder of the Proposed Route is located within CL&P ROWs consisting of easements on private properties. Table 5-12 summarizes the length of the Proposed Route and the CL&P-owned property (length) traversed, by town. Table 5-13 presents the distance that the Proposed Route traverses, by land use type within each town.

Table 5-12: Approximate Distance Traversed by Proposed Route, by Town and through CL&P-owned Property

Town	Approximate Distance Traversed (miles)	
	ROW	CL&P-owned land
Lebanon	0.6	0.3
Columbia	1.7	0.2
Coventry	1.2	0.5
Mansfield	6.4	0.9
Chaplin	3.3	0
Hampton	4.3	0
Brooklyn	7.2	1.0
Pomfret	1.7	0.2
Killingly	3.0	1.0
Putnam	5.6	0.6
Thompson	1.8	0.3
Total	**36.8**	**5.0**

Table 5-13: Approximate Distance Each Land Use Type is Traversed by Proposed Route, by Town

Town	Land Use Type Traversed[1] (feet)										
	Agricultural[1]	Commercial/ Industrial[1]	House/Yard[1]	Open Field – Shrub Land[1]	Open Water[2]	Emergent Wetlands[2]	Forested Wetlands[2]	Scrub-Shrub Wetlands[2]	Right-of-Way	State Wetlands[2]	Upland Forest
Lebanon	0	122	0	1,601	14	0	0	1,083	0	156	0
Columbia	0	0	0	6,799	59	0	192	1,826	168	0	0
Coventry	670	0	262	2,446	113	340	464	84	451	0	1,634
Mansfield	3,440	0	14	9,325	679	8	2,557	361	505	0	16,648
Chaplin	419	0	731	9,325	1,958	84	2,318	199	86	0	6,312
Hampton	1,005	0	329	5,327	270	0	4,530	898	203	0	10,867
Brooklyn	605	0	160	4,342	435	1,984	3,755	1,958	470	0	8,329
Pomfret	3,132	0	0	20,451	107	0	308	464	46	196	1,836
Killingly	456	1,393	226	2,789	168	0	343	699	423	949	0
Putnam	2,202	1,813	255	10,969	534	10	4,960	641	510	0	6,527
Thompson	0	0	68	12,490	0	1,064	89	41	96	0	2,214
Total (feet)	**11,930**	**3,327**	**2,045**	**82,824**	**4,336**	**3,491**	**19,518**	**8,255**	**2,959**	**1,301**	**54,367**
Total (miles)[3]	**2.3**	**0.6**	**0.4**	**15.7**	**0.8**	**0.7**	**3.4**	**1.6**	**0.6**	**0.2**	**10.3**

[1] Land Use type based on town zoning data, not field investigations of the Proposed Route.
[2] Land Use type is an estimate and may not be consistent with actual distance traversed by the Proposed Project based on field observations and field data for wetland boundaries (Volume 2).
[3] Total not exact due to rounding.

The following summarizes the primary land-use patterns, by town, along and in the vicinity of the Proposed Route.

Town of Lebanon

From the Card Street Substation, the Proposed Route would extend for approximately 0.6 mile through the northeastern corner of the Town of Lebanon, an area that is predominantly forestland interspersed with rural residences. In Lebanon, the Proposed Route would be aligned within CL&P's existing ROW, between two overhead transmission lines (i.e., CL&P's 330 Line and a double-circuit 69-kV line; refer to XS-1 in Section 3, Appendix 3A of this Volume). Because of the existing transmission lines, most of the land within the ROW is managed and consists of undeveloped open fields and scrub-shrub land.

Approximately 430 feet southeast of the Tenmile River (which forms the boundary between Lebanon and the Town of Columbia), the Proposed Route crosses the Airline State Park Trail (Southern Section). The Airline State Park Trail is an approximately 50-mile-long former railroad corridor presently managed by the CT DEEP and used for recreational purposes (hiking, biking, horseback riding, etc.). The trail extends through portions of 11 municipalities in central-eastern Connecticut, including Lebanon, Columbia, Windham, Chaplin, Hampton, Putnam, Pomfret, and Thompson.

One historic site, the Bridge over Tenmile River, as identified in the Town of Lebanon *Plan of Conservation and Development*, is located at the Columbia/Lebanon boundary, approximately 3,000 feet southwest of the Proposed Route crossing of this river.

Town of Columbia

The Proposed Route traverses approximately 1.7 miles through the northeastern portion of the Town of Columbia, between the Tenmile and Hop rivers. Land uses in the vicinity of the Proposed Route include a mix of forestland, scattered rural residences, and some agricultural land. Commercial land uses are located along Willimantic Road (State Route 66). Land uses within the existing CL&P ROW (where the proposed 345-kV line would be situated between the existing 330 Line and the 69-kV line, refer to XS-1 in Appendix 3A and the Volume 9 maps) include undeveloped open fields and scrub-shrub land. The areas adjacent to the existing ROW are predominantly forestland, with some residential areas.

The Tenmile Mill historic site, as identified in the Town of Columbia's *Plan of Conservation and Development*, is located approximately 1,000 feet south of the Proposed Route, along the west bank of the Tenmile River. Three parcels of privately owned open space (property owned by a land trust or protected by deed restrictions) are located near the Proposed Route: one parcel is located approximately 0.6 mile north of the Proposed Route toward the Windham/Columbia border; Potter Meadow, a 34-acre preserve owned by Joshua's Tract Conservation and Historic Trust and located adjacent to the Willimantic and

Tenmile Rivers, is situated approximately 0.2 mile north of the Proposed Route off Commerce Park Drive; and one parcel is located approximately 0.5 mile east of the Proposed Route just south of Willimantic Road.

In Columbia, the Proposed Route crosses one town-identified priority wetland[37] just south of the Hop River (wetland W20-24). One new 345-kV line structure would be located in this wetland (refer to mapsheet 3 of 40 in Volume 9 and mapsheets 8 and 9 of 134 in Volume 11 and to the *Inventory and Delineation of Wetland and Waterways Report* in Volume 2 for information concerning this wetland). Columbia identifies priority wetlands as those demonstrating the highest scores for such characteristics as wildlife habitat, ecological integrity (unspoiled), and ability to recharge groundwater supplies.

Town of Coventry

The Proposed Route extends northeast from Columbia, crossing approximately 1.2 miles through the southwestern corner of the Town of Coventry, from the Hop River (which forms the boundary with Columbia) to the Willimantic River (which demarcates Coventry's border with the Town of Mansfield). Along the southern portion of the Proposed Route in Coventry (i.e., from the Town of Columbia boundary to just north of U.S. Route 6 at CL&P's Babcock Hill Junction), the new 345-kV transmission line would be aligned between CL&P's existing 330 Line and the 69-kV double-circuit lines. At Babcock Hill Junction, the Proposed Route extends to the north-northeast within CL&P's existing ROW; in this area, the new 345-kV line would be located parallel to the existing 330 Line within an un-managed portion of the ROW.

Lands in the vicinity of the ROW in Coventry consist predominantly of rural residences, agricultural land, and forest land. Land uses within the existing ROW include forest, undeveloped shrub land, and agricultural land. The only designated recreational or open space land uses traversed by the Proposed

[37] Priority wetlands demonstrate the highest scores for such characteristics as wildlife habitat, ecological integrity (unspoiled), and ability to recharge groundwater supplies (*Plan of Conservation and Development 2006*, Town of Columbia, Connecticut).

Route in Coventry are the Hop River State Park Trail, just north of the Hop River crossing, and an undeveloped parcel of town open space adjacent to Flanders River Road. The approximately 15-mile Hop River State Park Trail, which is managed by CT DEEP, is a former railroad corridor that extends along the Hop River in the towns of Bolton, Coventry, Andover, Columbia, and Windham, providing recreational opportunities for hikers, bikers, and equestrians.

Town of Mansfield

The Proposed Route traverses 6.4 miles across the southern portion of the Town of Mansfield, following CL&P's existing ROWs through areas that are predominantly forested with some rural residences, intermixed with concentrations of agricultural land. In the southeastern portion of the town, the Proposed Route extends for approximately 1 mile through Mansfield Hollow State Park, across Mansfield Hollow Lake, and through the Mansfield Hollow WMA. The state park and lake are used for recreational boating and picnic activities, as well as for a variety of other outdoor activities (e.g., hiking, ice fishing, and bird watching); in addition, hunting and dog training are permitted in the WMA.

In Mansfield, the Proposed Route would be aligned adjacent to the existing 330 Line, principally within presently unmanaged portions of CL&P's existing ROW. Along the 0.9-mile segment within the state park and WMA, CL&P proposes to acquire an additional 55-foot-wide easement from the USACE in order to expand the existing 150-foot-wide ROW. This proposed ROW expansion would encompass approximately 5.2 acres of land, most of which is presently forested upland.[38]

In addition to the Mansfield Hollow State Park and WMA, the Proposed Route crosses the following recreational land uses in Mansfield: the Highland Ridge Driving Range, which the route traverses adjacent to State Route 32 (Stafford Road), the CFPA's Nipmuck Trail (West Branch); the Mansfield Hollow Dam Levee Trail, an asphalt-paved pathway located on top of the levee; the Red Trail, a hiking

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[38] This land-use acreage estimate excludes the 600-foot span of Mansfield Hollow Lake. Refer to Section 10 for a discussion of land uses along the other two configuration options identified for the Mansfield Hollow area.

trail located on the west side of Mansfield Hollow Lake within the State Park; and the eastern branch of the Nipmuck Trail, located east of Mansfield Hollow Lake within the WMA.

According to the Town of Mansfield 2006 *Plan of Conservation and Development*, four scenic vistas are located at Mansfield Hollow Lake, two looking south along the southeastern portion of the lake (approximately 400 feet east of the Proposed Route), and two located at Bassetts Bridge (one looking north and one south) crossing the center of the lake (approximately 2,000 feet north of the Proposed Route). Two scenic vistas, with a view north, are located to the north of Pleasant Valley Road (approximately 2,500 feet and 3,000 feet south of the Proposed Route) and one with a view south is located along Stearns Road (approximately 1,500 feet north of the Proposed Route). There is a scenic vista looking west located at Wolf Rock south of Crane Hill Road (approximately 3,000 feet north of the Proposed Route) and one looking east from Storrs Road between Cemetery Road and Bassetts Bridge Road (approximately 2,000 feet north of the Proposed Route).

As illustrated on the Volume 9 maps, the Proposed Route also crosses or is in proximity to town open space and parcels owned by Joshua's Tract Conservation and Historic Trust, Inc., a local non-profit organization that owns, or protects by easement, more than 4,000 acres of land, making the trust the fourth largest land trust in Connecticut. Winfred Acres, owned by the Joshua's Tract Conservation & Historic Land Trust, Inc., is located along Thornbush Road, approximately 800 feet southeast of the Proposed Route. The trust also owns several other parcels near, but not traversed by, the Proposed Route; these include Wolf Rock Nature Preserve (a 94.5-acre parcel located approximately 0.2 mile north of the route near Sawmill Brook), as well as the Pond Lot, a 10-acre tract located approximately 0.3 mile north of the Proposed Route in Mansfield Center (north of Cemetery Road).

Town of Chaplin

The Proposed Route would traverse 3.3 miles through the southern portion of the Town of Chaplin. Predominant land uses in the vicinity include forest land and rural residences. Commercial areas are located along Willimantic Road (U.S. Route 6), which extends through the southern portion of the town. State forest, wildlife areas, and parkland are also located throughout the area. With the exception of the approximately 0.5-mile segment through the Mansfield Hollow WMA, the Proposed Route would be aligned within CL&P's existing ROW, which consists of undeveloped forest, open field, and shrub land. The areas adjacent to the existing ROW are predominantly forest land, with some residences.

Within the 0.5-mile WMA segment, which encompasses the Natchaug River, CL&P proposes to expand the ROW to the north by acquiring an additional 85-foot-wide easement from the USACE. This ROW expansion would encompass approximately 5.2 acres of forested upland and forested wetland. There is no existing public access to this undeveloped WMA segment.

Within Chaplin, the Proposed Route also crosses a portion of the Natchaug State Forest and traverses approximately 2,900 feet of land owned by the Fin, Fur, and Feather Club, Inc. In addition, the Airline State Park Trail (Northern Section) parallels and is located approximately 200 feet south of the Proposed Route for approximately 0.8 mile.

Town of Hampton

The Proposed Route would extend 4.3 miles through the south-central portion of the Town of Hampton. Land uses in the vicinity predominantly include undeveloped forest with some scattered agricultural land and rural residences. Land uses within CL&P's existing ROW, along which the Proposed Route would be aligned, primarily include undeveloped forest, open space, and some agricultural land. Forest land is predominant in the areas adjacent to the ROW, with a few residences and some agricultural land as well.

In Hampton, the Proposed Route crosses the Airline State Park Trail (Northern Section) and Bigelow Howard Valley Fish and Game Club. The James L. Goodwin State Forest is located approximately 1,200 feet north of the route, across U.S. Route 6. Pine Acres Lake also is located over 3,000 feet north of the Proposed Route. A public boat launch is located at the lake and provides recreational boating opportunities.

A town-identified scenic vista (with views north and southeast) is located south of the existing ROW near Parker Road and State Route 97. The Quinebaug-Shetucket Heritage Corridor, Inc. also identifies State Route 97, which the Proposed Route would traverse, as a scenic rural driving route. CL&P's ROW crosses State Route 97 perpendicularly; due to dense surrounding forest land and undulating topography, views of the ROW from the road are limited to the point of crossing.

Town of Brooklyn

The Proposed Route would traverse approximately 7.2 miles east-northeast through the Town of Brooklyn, crossing areas that are predominantly undeveloped forestland, interspersed with rural residences and agricultural land uses. Residential and commercial developments are more concentrated in the eastern portion of the town, in and around the Brooklyn town center and near the communities of East Brooklyn and Danielson. The Proposed Route is generally located north and northwest of these more developed areas. There is also a greater concentration of agricultural land in the eastern portion of the Town of Brooklyn.

Through Brooklyn, the new 345-kV transmission line would be aligned within CL&P's existing ROW, north or west of the existing 330 Line. At Day Street Junction in the eastern portion of the town, the CL&P's existing 345-kV line is joined by two 115-kV lines. In this area, the proposed 345-kV line would extend north along CL&P's existing ROW, and would be located west of both the existing 330 Line (345-kV) and the two 115-kV lines.

In Brooklyn, the Proposed Route would be aligned north of and parallel to the 330 Line across Connecticut State Route 169, a National Scenic Byway. Three scenic vistas designated by the Town of Brooklyn are located in proximity to the Proposed Route. These are Tatnic Hill (with views northeast and southeast) and Gray Mare Hill (with a view southeast) located south of the ROW, and one scenic vista off Barrett Hill Road (with a view southeast) located north of the Proposed Route.[39]

The Proposed Route also crosses the Milo Appley Conservation Showcase property adjacent to the Eastern Connecticut Conservation District, located between Laurel Hill Road and Wolf Den Road. This area includes several trails that extend southeast of the ROW. East of State Route 169, the Proposed Route is located in the vicinity of two privately-owned open space parcels. Near Darby Road, the Proposed Route traverses a portion of the Wolf Den Land Trust's White Brook Sanctuary property. North of Day Street Junction, the Proposed Route extends across a portion of a large tract of CL&P-owned land that abuts the Quinebaug River and includes public hiking / recreational use trails (referred to as the Quinebaug River Trails).

Town of Pomfret

The Proposed Route would traverse 1.7 miles through the southeastern corner of the Town of Pomfret. Land uses along and in the vicinity of the ROW include agricultural, open field / shrub, and forest land. In addition, the ROW is located west of and parallel to the Quinebaug River. Adjacent to the Quinebaug River where the ROW crosses Killingly Road (State Route 101), the Town of Pomfret has developed a canoe / kayak boat launch and parking area on CL&P-owned property. Through Pomfret, the Proposed Route is located within the western portion of CL&P's ROW, adjacent to the existing 345-kV line and two 115-kV circuits.

[39] Town of Brooklyn 2010 Plan of Conservation and Development

Towns of Killingly and Putnam[40]

From Pomfret, the Proposed Route would cross the Quinebaug River into the Town of Killingly. Following CL&P's existing ROW through Killingly and the Town of Putnam, the route then would span the river twice more, each time crossing the boundary between these two towns.

From the first Quinebaug River crossing at the boundary with the Town of Pomfret, the route would traverse approximately 1.9 miles northeast through Killingly before re-crossing the river into the Town of Putnam. The Proposed Route would extend for approximately 0.8 mile through Putnam, and then would cross the Quinebaug River a third time, reentering Killingly. The route would traverse the northwestern corner of Killingly for approximately 1.1 mile, and then would continue northeast, crossing back into and traversing Putnam for approximately 4.9 miles.

Through Killingly and the shorter segment through Putnam, predominant land uses in the vicinity of the Proposed Route include forest land and agricultural land, as well as commercial and industrial land uses. Commercial/industrial land uses include warehouse and distribution facilities, as well as several quarries. As the Proposed Route continues through Putnam, it extends through areas characterized by a mix of forest land, agricultural land, and rural residences.

Through Killingly and Putnam between the first Quinebaug River crossing (directly north of State Route 101) and Killingly Substation, the new 345-kV line would be aligned in the middle of CL&P's existing ROW, between the existing 345-kV transmission line and two 115-kV lines or (along the segment from Lake Road Junction to Lake Road Switching Station) between two 345-kV lines. North of Killingly Substation, through the remainder of Killingly and through Putnam to Heritage Road, the new 345-kV line also would be aligned in the center of CL&P's existing ROW, west of and adjacent to the existing 345-kV line and east of an electric distribution line. Land uses within the existing ROW include open

[40] This subsection groups the description of land uses along the Proposed Route in the towns of Killingly and Putnam because the ROW crosses these town boundaries in several different locations.

field and shrub land, with some agricultural land. Undeveloped forested areas are located along the edges of the ROW and, in some locations, within the middle of the ROW. The ROW also extends across one of the quarries in the Town of Putnam. Adjacent land uses include forest land, as well as some rural residences, agricultural land, and commercial/industrial land uses.

In addition, a large subdivision (Clover Brook Estates) has been proposed, along both sides of the ROW in Putnam, south of State Route 12. Although this subdivision has been planned for several years, according to the Town of Putnam Planning Department, as of Summer 2011, the Clover Brook Estates project was on hold.

The Proposed Route is located near but does not traverse several parcels conserved by the Wyndham Land Trust, Inc. The land trust, which preserves property in the northeast corner of Connecticut, owns approximately 30 parcels, totaling 1,200 acres. In Killingly, the ROW is approximately 500 feet east of the land trust's Dunn Preserve, a 32-acre property accessible from Lake Road and located along the east bank of the Quinebaug River. In Putnam, the ROW is located approximately 200 feet southeast of the land trust's Chaffee Preserve, a 29-acre parcel accessible via U.S. Route 44.

In Putnam, the Proposed Route follows CL&P's ROW across several town-designated "greenbelt" protection areas, which are characterized by streams, wetlands, or floodplains. Specifically, the ROW extends across greenbelt protection areas located along the Quinebaug River at the Putnam/Killingly border, as well as associated with wetlands and streams near LaBonte Pond south of State Route 12 (e.g., S20-60); wetland W20-189 and stream S20-61 / wetland W20-191 located west and east of Liberty Highway (State Route 21); wetland 20-198 / stream S20-63 (Munson Brook); and wetland W20-200 / W20-201 and stream S20-64 (Fivemile River). The areas designated for greenbelt protection are currently traversed by the existing CL&P transmission lines and ROWs.

Town of Thompson

The Proposed Route traverses 1.9 miles through the southeast corner of the Town of Thompson before interconnecting to the proposed National Grid facilities at the Connecticut / Rhode Island border. The ROW extends through portions of the town consisting primarily of undeveloped forest, with some rural residences. The existing ROW is characterized principally by forest and open field / shrub lands. Forested areas dominate land use-patterns near the ROW. Quaddick State Park is located approximately 0.8 mile north of the ROW along the east shore at the south end of Quaddick Reservoir. Quaddick State Forest is located approximately 1 mile north of the ROW at the north end of Quaddick Reservoir.

In Thompson, the Proposed Route follows CL&P's existing ROW across protected land owned and managed by the Wyndham Land Trust (in cooperation with The Nature Conservancy). Barker Preserve consists of 41 acres of wetland and upland buffer at Lower Pond, south of Quaddick Road.[41] The Proposed Route traverses a portion of this protected area approximately 0.4 mile southeast of Lower Pond. Lower Pond is recognized by the CT NDDB as one of the state's best examples of Atlantic white cedar swamp, and contains habitat for several significant animal and plant species. The area has also been selected as a priority site in The Nature Conservancy's Lower New England Ecoregional Plan. The Plan is intended to ensure the long-term viability of all native species and natural communities and to sustain the landscape configurations and ecological processes.

The Proposed Route also traverses approximately 1,800 feet of the Wyndham Land Trust's Tamler Preserve, a 79.4-acre parcel located adjacent to Elmwood Hill Road.[42]

[41] http://www.wyndhamlandtrust.org/preserves/preserves_barker.html
[42] http://www.wyndhamlandtrust.org/preserves/preserves_tamler.html

5.1.4.2 Settled Areas[43]

Although the Proposed Route is located predominantly in rural areas, homes have been developed in some places along CL&P's existing ROWs. Settled areas are generally located along public roads near the Proposed Route (i.e., within 200 to 400 feet of the Proposed Route centerline) in the following towns: Mansfield (Stafford Road, Highland Road, Storrs Road, Hawthorne Lane), Chaplin (Willimantic Road), Brooklyn (Windham Road, U.S. Route 6, Darby Road, and Church Street), Pomfret (Killingly Road), Killingly (Lake Road), Putnam (Elvira Heights), and Thompson (Elmwood Hill Road).

5.1.4.3 Statutory Facilities

Connecticut General Statutes Section 16-50p(i) designates a group of land uses (for conciseness, collectively called "Statutory Facilities") that the Council must consider in its review of new electric transmission lines. These are, in particular:

- Private or public schools
- Licensed child day-care facilities
- Licensed youth camps
- Public playgrounds
- Residential areas

"Residential areas" is construed to mean developed "neighborhoods," not residentially zoned land or sparsely settled rural or semi-rural areas.

Connecticut General Statutes Section 16-50p(i) establishes a rebuttable presumption that electric transmission lines with a voltage of 345 kV or greater, shall be constructed underground if they are "adjacent to" Statutory Facilities. This presumption may be overcome by a demonstration that it is

[43] Settled areas in this section could be considered a "Statutory Facility" as defined by Connecticut General Statutes Section 16-50p(i).

infeasible to bury the lines for technical or economic reasons. The Council may, in such a case, approve overhead construction of a 345-kV transmission line adjacent to Statutory Facilities, provided it would be contained within a buffer zone adequate to protect public health and safety. A ROW providing clearance requirements consistent with generally applicable safety standards may qualify as such a buffer zone.

A review of public records indicates the Proposed Route would be located within 500 feet of one school, and several licensed residential child day-are facilities. These schools and day-are facilities are as follows:

- Mount Hope Montessori School, Bassetts Bridge Road, Mansfield
- Come Play With Me Day Care, Storrs Road, Mansfield
- Green Dragon Day Care, Bassetts Bridge Road, Mansfield
- Residential day care, Church Street, Brooklyn
- Residential day care, Hickory Lane, Brooklyn[44]

Based on a review of existing data, no playgrounds or youth camps appear to be located adjacent to the Proposed Route.

The Council may or may not consider one or more of the groups of homes within the vicinity of the Proposed Route to be sufficiently dense and integral to qualify as a "neighborhood" and therefore as a statutory "residential area." The Council may also not consider any home groupings that may so qualify as neighborhoods as being "adjacent" to the proposed 345-kV line. CL&P has made a tentative determination that these groups of homes would not so qualify as adjacent residential areas. Nevertheless, pursuant to the Council's EMF Best Management Practices for the Construction of Electric

[44] The residential day care is located on Hickory Lane, approximately 625 feet north of the Proposed Route centerline, at a distance where magnetic fields associated with the line would be at background levels, regardless of the line design used. Accordingly, it was not considered to be "adjacent to" the Proposed Route.

Transmission Lines in Connecticut, CL&P included several areas (i.e., "focus areas") where homes are grouped in its Field Management Design Plan, found in Section 7, Appendix 7B.

5.1.4.4 Public Forests, Parks, Open Space, Recreational / Public Trust Lands, and Trails

As discussed briefly in Section 5.1.4.1, the Proposed Route traverses or is located near various forests, parks, open space lands, recreational areas (including trails), and public trust lands. These areas are described below, summarized in Table 5-14 (located at the end of this subsection), and illustrated on the maps in Volume 9 and Volume 11.

- **Quinebaug and Shetucket Rivers Valley (The Last Green Valley) National Heritage Corridor**. In 1994, Congress designated the Quinebaug and Shetucket Rivers Valley a National Heritage Corridor, recognizing the region as a unique national resource. In 1999, Congress enlarged the heritage corridor to include Quinebaug and Shetucket River Valley towns in both Massachusetts and Connecticut. As a result, the heritage corridor now encompasses 35 municipalities (26 in Connecticut). In 2009, Congress reauthorized the heritage corridor designation through September 30, 2015. The heritage corridor is managed by a non-profit organization, The Last Green Valley, Inc. (TLGV).[45] According to the National Park Service (NPS), the National Heritage Corridor encompasses approximately 695,000 acres of land in northeastern Connecticut and south-central Massachusetts. Within the National Heritage Corridor, citizens, businesses, nonprofit cultural and environmental organizations, local and state governments, and the NPS work together to preserve the region's cultural, historical, and natural heritage (NPS 2006).

  Pursuant to Connecticut Public Act 09-221, state agencies, departments, boards and commissions are encouraged to consider Connecticut's Heritage Areas when developing planning documents and to partner with the managing entities on projects concerning, but not limited to, environmental protection, heritage resource preservation, recreation, tourism and trail development. Connecticut's designated Quinebaug-Shetucket Rivers Valley National Heritage Corridor corresponds to the Connecticut portion of the nationally-designated heritage corridor. The heritage corridor encompasses the entire towns of Lebanon, Coventry, Mansfield, Chaplin, Hampton, Brooklyn, Pomfret, Killingly, Putnam, and Thompson. Thus, along the Proposed Route, only the Town of Columbia is located outside of the designated heritage corridor.

- **Airline State Park Trail.** The Airline State Park Trail, which is managed by CT DEEP, is a 50-mile multi-use trail following the corridor of the former Airline Railroad. It was declared a

[45] The Quinebaug and Shetucket Rivers Valley of northeastern Connecticut and south-central Massachusetts also is referred to as "The Last Green Valley" in the sprawling metropolitan Boston-to-Washington corridor. This designation was coined because at night, the region appears distinctively dark amid the urban and suburban glow when viewed from satellites or aircraft. In the daytime, the green fields and forests confirm the rural character of the 1,085-square-mile area defined by the Quinebaug and Shetucket Rivers systems and the rugged hills that surround them. Forest and farmland make up approximately 78% of its 695,000-acres.

national recreational trail in 2001 and provides hiking, biking and horseback riding opportunities. The trail stretches across 11 towns in eastern Connecticut, extending from the Town of East Hampton to the Town of Thompson. The Proposed Route crosses the trail twice – once in Lebanon and once in Hampton.

- **Hop River State Park Trail**. The Hop River State Park Trail, which is managed by CT DEEP, is approximately 15 miles long, extending from the Andover town line to the Willimantic River in the Town of Windham. The trail, which is aligned along the Hop River through the towns of Coventry and Columbia, provides opportunities for hiking, biking, horseback riding, and skiing. The Proposed Route crosses this trail in the Town of Coventry.

- **Highland Ridge Driving Range**. The Highland Ridge Driving Range, which the Proposed Route crosses, is a golf driving range located on Stafford Road in the Town of Mansfield.

- **Mansfield Hollow State Park and WMA**. Mansfield Hollow State Park and WMA, which are owned by the federal government (USACE) but managed by CT DEEP, offer a variety of recreational opportunities, including fishing, hiking, biking, and picnicking, as well as – in the WMA – hunting and dog training. Mansfield Hollow Lake, located within the park, is the result of the dam built by the USACE to control flooding in the Thames River Basin. The lake encompasses approximately 460 acres and offers public boating and fishing activities. The Proposed Route follows CL&P's existing ROW across approximately 0.8 mile of the park and 0.1 mile of the WMA within the Town of Mansfield, and approximately 0.5 mile of the WMA in the Town of Chaplin. Because CL&P's existing ROW across these federally-owned properties is only 150 feet wide, CL&P proposes to acquire additional easements from the USACE in order to expand the ROW by 55 feet through Mansfield Hollow State Park and WMA in the Town of Mansfield and by 85 feet through the WMA in the Town of Chaplin, thereby allowing the development of the new 345-kV transmission line adjacent to and with similar structure types as the existing 330 Line. This proposed ROW expansion would involve the acquisition of an estimated 11 acres of additional easement from the USACE. (Refer to Section 10 for details regarding other configuration options for aligning the new 345-kV line across these properties.)

- **Nipmuck Trail**. The 14-mile Nipmuck Trail is part of the CFPA's Blue Blazed Hiking Trail, a system of 800 miles of trails. The Proposed Route crosses two branches of the trail in the Town of Mansfield. The western branch of the trail crosses the ROW approximately 9.3 miles west of State Route 195 and 8.8 miles east of Mansfield City Road, while the eastern branch of the trail is traversed within the Mansfield Hollow WMA on the east side of Mansfield Hollow Lake.

- **Natchaug State Forest.** The Natchaug State Forest encompasses several thousand acres, with the principal recreation area located approximately 5 miles north of the Proposed Route in the Town of Eastford. This portion of the state forest is traversed by the Natchaug River, which is popular for fishing and is also designated a "Trout Park" fishing area by the CT DEEP. Several isolated parcels of the Natchaug State Forest are located in other northeast Connecticut towns. The Proposed Route crosses a small portion one such Natchaug State Forest parcel in the Town of Chaplin (near the Airline State Park Trail, Northern Section), and is located near other isolated state forest parcels in both Chaplin and the Town of Putnam.

- **Bigelow-Howard Valley Fish & Game Club**. The privately-owned Bigelow-Howard Valley Fish and Game Club lands are crossed by the Proposed Route in the Town of Hampton. This land is located between Pudding Hill Road and Drain Street.

- **Natchaug Trail**. The southern terminus of the Natchaug Trail (a CFPA Blue Blazed Hiking Trail) is located approximately 2,500 feet north of the Proposed Route in the Town of Hampton. The Proposed Route does not cross the Natchaug Trail.

- **State Route 169**. State Route 169 is identified as a National Scenic Byway. The National Scenic Byways Program is part of the U.S. Department of Transportation, Federal Highway Administration. Under the program, the U.S. Secretary of Transportation recognizes certain roads as National Scenic Byways or All-American Roads based on their archaeological, cultural, historic, natural, recreational, and scenic qualities. There are 125 such designated Byways in 44 states. The Proposed Route crosses State Route 169 in the Town of Brooklyn.

- **Quinebaug River Trail**. This trail is located on CL&P-owned land in the Town of Brooklyn near the Brooklyn Substation and Day Street Junction. The trail extends southeast of, and does not cross, the Proposed Route.

- **Tracey Road Trail**. The Tracey Road Trail is a paved sidewalk-type urban trail, identified by both CT DEEP and ConnDOT as a public trail, that extends adjacent to Tracey Road in Killingly and Park Road in Putnam. The ROW spans the trail along Park Road.

In addition, the Proposed Route traverses several areas of protected land (i.e. open space, greenway protection) in the towns of Coventry, Mansfield, Chaplin, Hampton, Brooklyn, Pomfret, Putnam, and Thompson. According to Connecticut General Statutes Section 23-100, a "greenway" means a corridor of open space that may protect natural resources, preserve scenic landscapes and historical resources or offer opportunities for recreation or non-motorized transportation; may connect existing protected areas and provide access to the outdoors; may be located along a defining natural feature, such as a waterway, along a man-made corridor, including an unused ROW, traditional trail routes or historic barge canals; or may be a greenspace along a highway or around a village. Open spaces are typically valuable for recreation, forestry, fishing, conservation of wildlife or natural resources; contributes to a prime natural feature of the state's landscape; protects habitat for native plant or animal species listed as threatened or endangered or of special concern; protects a relatively undisturbed outstanding example of a native ecological community which is now uncommon; enhances and conserves water quality of the state's lakes, rivers and coastal water; preserves local agricultural heritage; or protects land which is eligible to be classified as Class I land or Class II land after acquisition.

The Proposed Route crosses several state-designated greenways. The Willimantic River, which was designated as a Connecticut Greenway in 2003, extends through nine towns along the 25-mile length of the river. The Proposed Route crosses the river at the boundary of the towns of Coventry and Mansfield. The greenway is intended to link existing open spaces and extend hiking trails and bicycle routes along the river. The Hop River State Park Trail, Airline State Park Trail, Natchaug River, and Fivemile River also are state-designated greenways.

Table 5-14: Public Forest, Parks, Open Space, Land-Trust Parcels, and Trails along and in the vicinity of the Proposed Route

Municipality	Proximity to Route	Recreational/Scenic/Open Space Feature (Refer to Volume 9 maps for parcel location)
Lebanon	Crosses	Airline State Park Trail (Southern Section)
Columbia	1,600 feet	Joshua’s Tract Conservation & Historic Trust, Inc, (1 Parcel North of Willimantic Road)
Coventry	Crosses	Hop River State Park Trail
Coventry	Crosses	Town Open Space (Flanders River Road)
Mansfield	800 feet	Joshua’s Tract Conservation & Historic Trust, Inc. (1 Parcel west of Thornbush Road)
Mansfield	1,500 feet	Town Open Space (Thornbush Road)
Mansfield	Crosses	Highland Ridge Driving Range
Mansfield	200 feet	Town Open Space (Stafford Road)
Mansfield	Crosses	Town Open Space (Highland Road)
Mansfield	Crosses	Nipmuck Trail, West Branch
Mansfield	350 feet	Town Open Space (Saw Mill Brook Lane)
Mansfield	1,300 feet	Town Open Space (Jacobs Hill Road)
Mansfield	1,800 feet	Joshua’s Tract Conservation & Historic Trust, Inc. (Jacob Hill Preserve)
Mansfield	1,020 feet	Joshua’s Tract Conservation & and Historic Trust, Inc. (Wolf Rock Nature Preserve)
Mansfield	1,200 feet	Joshua’s Trust Trail
Mansfield	150 feet	Town Open Space (Storrs and Bassetts Bridge Road)

Table 5-14: Public Forest, Parks, Open Space, Land-Trust Parcels, and Trails along and in the vicinity of the Proposed Route

Municipality	Proximity to Route	Recreational/Scenic/Open Space Feature (Refer to Volume 9 maps for parcel location)
Mansfield	800 feet	Joshua's Tract Conservation & Historic Trust, Inc. Wildlife Area (Adjacent to Mansfield Hollow WMA – north of Proposed Route)
Mansfield	Crosses	Mansfield Hollow State Park & WMA
Mansfield	Crosses	Mansfield Hollow Dam Levee Trail (within Mansfield Hollow State Park)
Mansfield	Crosses	The Red Trail (within Mansfield Hollow State Park)
Mansfield	1,400 feet	Mansfield Hollow Lake Picnic Area
Mansfield	2,000 feet	Mansfield Hollow Lake Boat Ramp
Mansfield	2,000 feet	Town Designated Scenic Vistas[1]
Mansfield	Crosses	Nipmuck Trail, East Branch
Chaplin	Crosses	Mansfield Hollow WMA / Natchaug River (greenway)
Chaplin	200 feet	Natchaug State Forest
Chaplin	Crosses	Fin, Fur and Feather Club
Chaplin	1,200 feet	Natchaug State Forest Trails
Chaplin	Crosses	Natchaug State Forest
Chaplin	200 feet	Airline State Park Trail, Northern Section (parallels)
Hampton	Crosses	Airline State Park Trail (Northern Section)
Hampton	Crosses	Bigelow Howard Valley Fish & Game Club
Hampton	550 feet	South Cemetery
Hampton	1,200 feet	James L. Goodwin State Forest
Hampton	1,100 feet	Little River Wildlife Area
Hampton	1,200 feet	Natchaug Trail
Brooklyn	Crosses	State Route 169
Brooklyn	Crosses	Milo Appley Conservation Showcase and Trails - Eastern CT Conservation District[2]
Brooklyn	1,200 feet	Williams / Ferguson Sanctuary - Wolf Den Land Trust[2]
Brooklyn	Crosses	Steven Townsend Trust, Inc.
Brooklyn	400 feet	Colonel Daniel Putnam Association, Inc.
Brooklyn	Crosses	Wolf Den Land Trust White Brook Sanctuary
Brooklyn	2,750 feet	Donald Francis Recreation Park Trail - Town of Brooklyn[2]
Brooklyn	500 to 800 feet	Town Designated Scenic Vistas (Gray Mare Hill and Barrett Hill Road)[3]
Brooklyn	800 feet	Brooklyn Tennis Club
Brooklyn	Adjacent	Quinebaug River Trail

Table 5-14: Public Forest, Parks, Open Space, Land-Trust Parcels, and Trails along and in the vicinity of the Proposed Route

Municipality	Proximity to Route	Recreational/Scenic/Open Space Feature (Refer to Volume 9 maps for parcel location)
Pomfret	Crosses	Town Open Space (near Quinebaug River)
Pomfret	Adjacent	Town Canoe / Kayak Boat Launch
Pomfret	1,500 feet	Wyndham Land Trust (Lyon Preserve)
Killingly	1,800 feet	Town Open Space (near Quinebaug River)
Killingly	Adjacent	Town Open Space (near Quinebaug River)
Killingly	900 feet	Goodyear School
Killingly	1.3 miles	ConnDOT scenic parcels along Interstate 395
Killingly	700 feet	Dunn Preserve – Windham Land Trust
Killingly	100 feet	Open Space - Alexander’s Lake Conservation and Rentals, Inc.
Killingly	200 feet	Existing Preserved Open Space
Killingly	1,000 feet	Town Open Space (Louisa Viens Drive)
Killingly	2,000 feet	Town Open Space (State Route 12)
Putnam	2,000 feet	Natchaug State Forest
Putnam	1,500 feet	Town Open Space (River Road)
Putnam	Crosses	Tracey Road Trail
Putnam	800 feet	Quaddick State Forest parcel
Putnam	400 feet	Chaffee Preserve – Wyndham Land Trust (U.S. Route 44)
Putnam	Crosses	Town of Putnam Greenbelt Protection Areas
Putnam	Crosses	Town Open Space (Fox Road)
Putnam	1,100 feet	Munyan Cemetery
Thompson	Crosses	Backer Preserve – Wyndham Land Trust (Lower Pond area) and The Nature Conservancy, Inc.
Thompson	Crosses	Tamler Preserve – Wyndham Land Trust (includes trail, not crossed)
Thompson	1,100 feet	Quaddick Reservoir
Thompson	4,000 feet	Quaddick State Park
Thompson	6,500 feet	Quaddick State Forest

Source: CTDEP, Office of Information Management, GIS Data Guide DEP Property, November 2002. Connecticut Office of Policy and Management, and CTDEP Office of Information Management, GIS Data Guide Municipal and Private Open Space, 1997.

[1] Scenic vistas identified in the Mansfield Connecticut 1993 *Plan of Development* (http://www.mansfieldct.gov/filestorage/1904/1932/2043/plan_of_development_1993.pdf).
[2] Names according to the Town of Brooklyn website (http://www.brooklynct.org/anm/templates/?a=428&z=17).
[3]Scenic vistas identified in the 2011 Town of Brooklyn *Plan of Conservation and Development* (http://www.brooklynct.org/anm/articlefiles/1965-POCD%20Draft.pdf).

5.1.4.5 Protected and Scenic Resources

As described in this section and illustrated on the Volume 9 maps, the proposed 345-kV transmission lines would follow CL&P’s existing ROWs across or near various areas that have scenic attributes, such as established recreational trails (e.g., Airline State Park Trail, Hop River State Park Trail, the CFPA’s Nipmuck Trail); Mansfield Hollow State Park and WMA; Mansfield Hollow Dam; State Route 169 (a designated National Scenic Byway); and other recreational, open space, and historic sites. The Airline State Park Trail, Hop River State Park Trail, and Quinebaug River Water Trail also are part of the East Coast Greenway, which upon completion will provide a 3,000-mile trail linking 15 eastern U.S. states and Washington, D.C. Through all of these areas, the proposed 345-kV lines would be located adjacent to CL&P’s existing 345-kV lines and – along certain ROW segments – also adjacent to other CL&P overhead transmission and distribution lines.

Ten of the 11 towns traversed by the Proposed Route also are within the Quinebaug and Shetucket Rivers Valley National Heritage Corridor. Along the Proposed Route, only the Town of Columbia is located outside the National Heritage Corridor. The Quinebaug and Shetucket Rivers Valley National Heritage Corridor also is one of two Connecticut heritage areas as designated in July 2009 pursuant to state Public Act No. 09-221. As detailed in Public Act No. 09-221, a heritage area is defined as a place within Connecticut that has historic, recreational, cultural, natural, and scenic resources that form an important part of the state’s heritage. State agencies must take the resources of the national heritage areas into consideration in planning and project decision-making.

On December 23, 2009, the Council issued a memorandum to routine applicants / participants concerning, among other issues, the consideration of scenic quality and the aesthetic attributes of land that might be affected by projects under the Council’s jurisdiction. In the same memorandum, the Council advised applicants to use photographs of aesthetic areas, particularly for use in photo-simulations, which depict "leaf off" conditions. In the absence of deciduous vegetative screening, such "leaf off" conditions would tend to represent "worst case" (or maximum) views of potential project facilities.

Pursuant to the Council's specifications for visual resource analyses, CL&P conducted research to identify designated scenic, recreational, open space, and historic properties (collectively referred to herein as the "visual sites") crossed by or in the vicinity of the Proposed Route. These sites were identified based on the review of Project mapping, data contained in land use sections of town plans, Internet research, and other published information such as the CFPA's *Walk Book East* and the Joshua's Tract Conservation and Historic Trust Inc.'s *Joshua's Tract Walk Book*. In general, sites within approximately 1.5 miles of the Proposed Route were identified for further evaluation.

Field inspections were conducted of each of the identified potential visual sites. The objectives of the field inspections were to:

- Assess the relationship of each potential visual site to the existing CL&P ROWs.
- Determine whether CL&P's existing overhead transmission lines are visible from each potential site.
- Photo-document views, as applicable, of the existing transmission lines from the visual sites. Sites that were determined to be too geographically remote from the ROWs or from which views of the overhead transmission lines were blocked by intervening topography, vegetation, or land uses, were typically not photographed.

Initial field inspections were conducted in early April 2010, with follow-up field visits performed in December 2010, as well as in March and April 2011. All of the field visits were performed on clear, sunny days, during deciduous forest "leaf off" seasons. Thus, the field inspections were conducted under conditions during which the existing overhead transmission lines would be most visible.

In May, June, and August 2011, CL&P conducted follow-up field visits to assess and photo-document conditions at the same sites when deciduous forest vegetation was leafed out. In general, such "leaves on" conditions are representative of the spring through fall seasons when public use of most of the designated recreational or scenic areas near the ROWs can be expected to be highest.

Table 5-15 (located at the end of this section) identifies the sites from which the existing CL&P transmission lines are visible during "leaf off" and "leaf on" conditions, based on the 2010-2011 field inspections. In most cases, long views of the existing transmission lines from sites remote from the ROWs were found to be precluded by intervening topography, vegetation, and land uses. For each site with views of the existing transmission line, the table identifies its location in relation to the existing CL&P ROWs and summarizes its known aesthetic, recreational, or cultural attributes. Overall, the primary scenic areas from which the existing transmission lines are visible include the Airline State Park Trail (two locations), Hop River Trail, Nipmuck Trail (West and East Branches), Mansfield Hollow Dam and levee system in the towns of Mansfield and Windham, Mansfield Hollow State Park and WMA, and State Route 169 in Brooklyn (a National Scenic Byway).

5.1.5 Federal, State, and Local Use Plans/Future Land-Use Development

CL&P consulted with the municipalities along the Proposed Route and has compiled available information concerning state, local, and regional land-use plans. In addition to Connecticut's *Conservation and Development Policies Plan*, each municipality along the Proposed Route has established municipal land-use plans, all having goals and objectives consistent with the operation of transmission lines within the Proposed Route. In addition, the future land-use and planning objectives of the Windham Regional Council of Governments (WINCOG) and the Northeastern Connecticut Council of Governments (NECCOG), the regional planning agencies encompassing the Project area, are also consistent with the Project.

5.1.5.1 State and Regional Plans

WINCOG's mission is to plan for the future of the region, both physical and economic, providing a forum for inter-municipal discussion and decision-making, and helping towns implement their planning goals by providing information and assistance. Based upon the information provided in the *Windham Region Land Use Plan* (2010), the WINCOG seeks, in part, to promote coordinated land development of the planning region with the greatest efficiency and economy for the welfare and prosperity of its citizens. NECCOG's mission is to serve as a forum identifying, studying, and solving regional issues; developing policies and initiating actions of mutual benefit to member towns; promoting cooperative arrangements and coordinated action; coordinating and carrying out comprehensive regional planning; and providing technical assistance to members.

CL&P has also reviewed the *Conservation and Development Policies Plan for Connecticut 2005 - 2010* (*C&D Plan*), prepared by the Connecticut Office of Policy and Management for information relating to the State's growth.[46] The objective of the *C&D Plan* is to guide and balance response to human, environmental, and economic needs in a manner best suiting Connecticut's future.

Based on the general planning information provided in the *C&D Plan*, the Project is consistent with the overall goals and objectives of the *C&D Plan* and serves a public need by providing reliable transmission of electricity. As stated in the *C&D Plan*, "The ability to redevelop Connecticut's Regional Centers requires that existing infrastructure be maintained and updated to support compact urban development. This holds true and is particularly relevant regarding electric capacity and delivery systems" (p. 22). Regional Centers within the towns of Windham and Killingly are located in the area of the Proposed Route. However, neither of these centers is traversed by the Proposed Route.

[46] Recent amendments to state statutes have delayed the revision process for the *Conservation and Development Policies Plan for Connecticut*. The current State C&D Plan, which was adopted in 2005, will remain in effect until the 2013 legislative session, when the General Assembly is scheduled to vote on adopting the next plan revision.

5.1.5.2 Local Land-Use Plans

All of the 11 towns traversed by the Proposed Route have established land use plans. Table 5-16 identifies the local land-use plans obtained and reviewed to assess the consistency of the proposed Project with existing and future land-use goals.

Table 5-16: Summary of Local Land-Use Plans

Municipality	Land-Use Plan Reviewed (Date of Plan)	Goals
Lebanon	Plan of Conservation and Development (December 2010)	Guide land-use management, community facilities development, parks and recreation, open space and environmental resource conservation, transportation and traffic improvement, historic preservation and community character.
Columbia	Plan of Conservation and Development (2006)	Guide growth in order to protect rural character and natural resources, encourage economic development and open space protection to help maintain balance between growing service needs and the mil rate, and remain sensitive to citizen concerns regarding quality of life.
Coventry	Plan of Conservation and Development (May 2010)	Guide the town's future physical growth and to give direction to both public and private development. Goals focus on community character; the economic base; environmental, aesthetic and historical resources; conservation and open space; housing; transportation; recreation; municipal facilities; and human services.
Mansfield	Plan of Conservation and Development (April 2006)	Strengthen and encourage an orderly and energy-efficient pattern of development; conserve and preserve natural, historic, agricultural and scenic resources; strengthen and encourage a mix of housing opportunities; and strengthen and encourage a sense of neighborhood and community.
Chaplin	Plan of Conservation and Development (June 2010); Route 6 Corridor Management Plan (adopted in 2000, included as part of the Plan of Conservation and Development June 2010)	Direct change in a manner that preserves the town's most valuable assets and provides long term benefits to the community. Guide the future use and development of the Route 6 corridor while promoting a balance of conservation.
Hampton	Plan of Conservation and Development (January 2007)	Recommend the best use of the town's lands for residential, recreational, commercial, industrial, conservation and other purposes, and the most desirable density of population.
Brooklyn	Plan of Conservation and Development (April 2011)	Guide open space, conservation, and natural resource protection decisions. Provide recommendations in the areas of agriculture, economic development, education, finance, governance and administration, historic preservation, housing, infrastructure, municipal facilities, open space and conservation, parks and recreation, public safety, and the Route 169 corridor.
Brooklyn	An Open Space and Conservation Plan (1993)	Inventory of natural resources designed to guide the town's future development with the ultimate goal of balancing economic development and environmental protection.
Pomfret	Conservation Plan (June 2002)	Inventory and conserve Pomfret's natural resources and open spaces; distinguish suitable areas for development from areas meriting various levels of long-term protection. The goal of the Plan is to achieve the right balance among economic development, environmental protection, and quality of life.

Table 5-16: Summary of Local Land-Use Plans

Municipality	Land-Use Plan Reviewed (Date of Plan)	Goals
Killingly	Plan of Conservation and Development (May 2010)	Provide a broad context or blueprint for decision making that fosters a healthy environment, a thriving economy, and a high quality of life for all residents. It balances population, housing, and employment growth with habitat preservation, agriculture, open space, and infrastructure needs.
	Plan of Conservation and Open Space	Promote development, conservation, supervision and responsible management of all natural resources within the Town of Killingly; provide methodologies for the implementation of protection and maintenance of these natural resources including developing aggressive strategies to find the funding to meet the town's goals.
Putnam	Planning on Putnam, Plan of Conservation and Development (August 2005)	State policies, goals and standards for physical and economic development; promote coordinated development and general welfare and prosperity; and recommend the most desirable uses of land. Maintain a balance between economic growth while maintaining the town's rural character and natural resources.
Thompson	Plan of Conservation and Development (November 2009)	Guide the town's future growth, resource's management and public investment policies.
	Conservation Commission Conservation & Open Space Plan (December 2005)	Guide town's future growth while protecting and preserving the town's natural and cultural resources.

5.1.6 Transportation Systems and Utility Crossings

As listed in Table 5-17 (located at the end of this subsection) and shown on the maps in Volume 9, the road transportation network in the vicinity of the Proposed Route is well developed and consists of a variety of federal, state, and local roads. Principal roads include Interstate 395; U.S. Routes 6 and 44; State Routes 12, 21 (Liberty Highway) 32, 66, 97, 101, 169 and 195. State Route 169 has been designated a National Scenic Byway.

Two public general aviation airports are located in the area (Windham and Danielson). The Windham Airport is located in the Town of Windham, approximately 0.7 mile south of the Proposed Route. The airport is situated directly south of Mansfield Hollow Lake and the Mansfield Hollow WMA, and is east of Willimantic Reservoir and north of U.S. Route 6. The Danielson Airport, a public airport serving small general aviation aircraft, is located in the Town of Killingly, adjacent to the Quinebaug River. The airport is situated across the river from and approximately 0.5 mile east of the segment of the Proposed Route that extends through the northeast corner of the Town of Brooklyn.

Any construction activities along the Proposed Route within 10,000 feet of general aviation airports would trigger a review by the FAA. As discussed in Section 3.1.2, CL&P is currently coordinating with the FAA regarding the review of the Project.

The New England Central and Providence and Worcester railroads are also crossed by the Proposed Route. The New England Central Railroad (NECR) operates a short stretch of railroad track that traverses the Town of Mansfield west of Stafford Road (State Route 32) and adjacent to the Willimantic River. The NECR is part of a rail line that extends from New London north into Canada. The line is used primarily for freight traffic.

The Providence and Worcester Railroad operates a rail line that extends through the Town of Killingly east of Interstate 395. The line is used for freight rail services.

The existing 345-kV transmission facilities cross several natural gas transmission pipelines, existing distribution pipelines, water lines, storm water sewers, and sanitary sewers. With the exception of the natural gas transmission pipelines, these utilities are mostly constructed along existing roadways. All of these utility lines are spanned by the existing overhead transmission lines and would be spanned by the proposed overhead transmission lines.

Table 5-17: Road Crossings – Proposed Route

Town	Road Name	Road Type
Columbia		
	Cards Mill Road	Local Road
	Old Willimantic Road	Local Road
	Willimantic Road (State Route 66)	Highway
Coventry		
	US Route 6	Major Highway
	Babcock Road	Local Road
	Flanders River Road	Local Road
Mansfield		
	Unnamed Road	Local Road
	Stafford Road (State Route 32)	Highway
	Highland Road	Local Road
	Mansfield City Road	Local Road
	Storrs Road (State Route 195)	Highway
	Bassetts Bridge Road	Local Road
	Bassetts Bridge Road	Local Road
	Unnamed Road	Local Road
	Bassetts Bridge Road	Local Road
	South Bedlam Road	Local Road
Chaplin		
	Willimantic Road (US Route 6)	Highway
	Chewink Road	Local Road
Hampton		
	Brook Road	Local Road
	Pudding Hill Road (State Route 97)	Highway
	Cemetery Road	Local Road
	Bigelow Road	Local Road
	Drain Street	Local Road
Brooklyn		
	Stetson Road	Local Road
	Windham Road	Local Road
	Hartford Road (US Route 6)	Highway

Table 5-17: Road Crossings – Proposed Route

Town	Road Name	Road Type
	Appell Road	Local Road
	Laurel Hill Road	Local Road
	Wolf Den Road	Local Road
	Costello Road	Local Road
	Pomfret Road (State Route 169)	Highway
	Church Street	Local Road
Pomfret		
	Killingly Road (State Route 101)	Highway
Killingly		
	Lake Road (two crossings)	Local Road
	Interstate 395	Major Highway
Putnam		
	Unnamed Road	Local Road
	Park Road	Local Road
	Killingly Avenue (State Route 12)	Highway
	Heritage Road	Local Road
	Toutellotte Road	Local Road
	Liberty Highway (State Route 21)	Highway
	Aldrich Road	Local Road
	Fox Road	Local Road
	Providence Pike (US Route 44)	Highway
Thompson		
	Quaddick Town Farm Road	Highway
	Elmwood Hill Road	Local Road

5.1.7 Cultural (Archaeological and Historic) Resources

5.1.7.1 Cultural Resources Overview

Cultural resources include buried archaeological sites, standing historic structures, or thematically-related groups of structures or other above-ground features. To be considered significant and eligible for listing on the National or State Registers of Historic Places (NRHP/SRHP), a cultural resource must exhibit physical integrity and contribute to American history, architecture, archaeology, technology, or culture; and must possess at least one of the following four criteria:

- Association with important historic events
- Association with important persons
- Distinctive design or physical characteristics
- Potential to provide important new information about prehistory or history

The proposed Project falls within the boundaries of the Quinebaug-Shetucket Rivers Valley National Heritage Corridor, which encompasses approximately 695,000 acres in northeastern Connecticut and south-central Massachusetts. The National Heritage Corridor Program is administered by the National Park Service (NPS) under the Department of the Interior. Locally, the Quinebaug-Shetucket Rivers Valley National Heritage Corridor is administered by the Quinebaug-Shetucket Heritage Corridor, Inc.[47] National Heritage Corridor cultural resources are subject to state protection under Connecticut Public Act 09-221 (passed in 2009) and to federal protection under the regulations of the Advisory Council on Historic Preservation (36 CFR § 800.5). Accordingly, protection criteria for National Heritage Corridor cultural resources are similar to those used for the NRHP/SRHP. The Quinebaug-Shetucket Heritage Corridor, Inc. must be consulted about any effects that the Project would have on cultural resources within the National Heritage Corridor. Similarly, CL&P will coordinate cultural resource reviews with the USACE, pursuant to the National Historic Preservation Act.

The Connecticut State Historic Preservation Officer (SHPO), a part of the Connecticut Commission on Culture and Tourism, Historic Preservation and Museum Division, is responsible for reviewing projects to ensure significant cultural resources will be protected or otherwise preserved. CL&P consulted with the SHPO regarding the studies required to identify and evaluate the known or potential significant cultural

[47] Quinebaug-Shetucket Heritage Corridor, Inc., 107 Providence Street, Putnam, CT 06260, p. 860.963.7226 f. 860.928.2189.

resources for the Project, and in 2008 prepared an *Historical and Archaeological Assessment* report (herein referred to as the *Cultural Resources Assessment or Assessment)* report for the Project, which was included in the August 2008 *Municipal Consultation Filing*. This 2008 *Assessment* is included in Volume 3.

The SHPO concurred with the scope of work for Project-related cultural resource investigations, based on similar studies completed for CL&P's recent Bethel-Norwalk, Middletown-Norwalk, and Greater Springfield Reliability transmission projects, and approved the *Cultural Resources Assessment* report. Consultation with the SHPO in December 2010 indicated that no resources adjacent to the Project have been listed or determined eligible for the NRHP/SRHP since the 2008 *Assessment* was completed.

Subsequent to the completion of the 2008 *Assessment*, reconnaissance archaeological fieldwork was performed along portions of the proposed Project area. Additional field investigations are ongoing. A summary of the cultural resource studies conducted subsequent to the completion of the 2008 *Assessment* is included in Volume 3.

CL&P is sensitive to Connecticut's cultural heritage and is committed to continuing to coordinate with the SHPO, the USACE, the National Heritage Corridor, and the Native American Tribes in protecting and mitigating potential effects to significant resources. Correspondence with the SHPO is included in Volume 4. CL&P is in the process of consulting with interested federally-recognized Native American tribes about Project cultural resources, in compliance with federal requirements.

5.1.7.2 Cultural Resources Assessment Methods and Results

As part of the initial Project planning effort, baseline information was compiled about the history and prehistory of the Project area, identifying the known cultural resources in the vicinity of the Proposed Route. Based on such information, CL&P's cultural resource consultants provided recommendations regarding the potential for locating as yet undiscovered resources during the development of the Project.

This information is included in the 2008 *Cultural Resources Assessment* report, which addresses both archaeological and historic resources.

The 2008 *Assessment* study was performed using methods consistent with the *Environmental Primer for Connecticut's Archaeological Resources* (1987). The assessment of visual resources on historic resources followed the guidelines in Connecticut General Statutes Section 16-50p(a)(4)(c) and the regulations of the Federal Advisory Council on Historic Preservation (36 CFR Section 800.5). The *Cultural Resources Assessment* report was prepared using both research and reconnaissance-level field investigations.

The *Cultural Resources Assessment* report is based on information obtained from the Office of State Archaeology, previously published technical studies of cultural resources, reviews of the NRHP and SRHP listings, the Historic American Engineering Record (HAER) Connecticut Inventory, and consultations with the SHPO and the Connecticut State Archaeologist. As is standard procedure for projects under SHPO review, the report does not provide exact locational information about buried archaeological sites in order to protect the integrity of such resources. The following summarizes the principal findings of the 2008 *Cultural Resources Assessment*.

Five known Native American archaeological sites have been reported within approximately 1 mile of the Proposed Route. One of these sites (State Site No. 112-8, located in the Town of Pomfret approximately 0.3 mile east of the Proposed Route) has been determined not eligible for the NRHP. In the Town of Mansfield, four archaeological sites, each with insufficient reported data to make a determination of eligibility for the NRHP, are located within approximately 300 feet of the centerline of the Proposed Route.

Based on environmental characteristics of reported Native American sites in the Project vicinity, the Proposed Route was classified as sensitive or not sensitive for possible unreported sites. Most sites in the Project vicinity and the larger region are found in undisturbed areas with well-drained soils, on slopes typically not exceeding 20% except where possible rockshelters are located. CL&P's cultural resource consultants conducted low-level helicopter inspection and selective ground inspection of the Proposed Route to identify potential rockshelter sites. Results of the archaeological sensitivity assessment found that approximately 64.2% of the Proposed Route appeared to be sensitive for possible Native American sites (refer to the cultural resource maps in the *Cultural Resources Assessment*).

The studies found that the Proposed Route generally appears to have limited sensitivity for significant Euro-American archaeological sites. Although 24 previously reported Euro-American sites have been identified within 1 mile of the route, none are listed or are eligible for listing on the SRHP or the NRHP. The closest reported site is a partly documented 19th century mill ruin on Stony Brook in Brooklyn, located about 400 feet east of the Proposed Route.

Two inactive former rail lines cross the Proposed Route in three places. The Air Line Railroad, completed in 1873, crosses the route as a flat track bed just west of Card Street Substation in Lebanon. The New York & New England Railroad, opened in 1872, crosses the route as a flat track bed north of U.S. Route 6 in Coventry, and as a cut through rock 25 to 30 feet deep east of South Brook Road in Hampton. The latter site has no well-defined engineering features, and, like the other two former railroad crossings, does not appear to be a potentially significant cultural resource. All three rail corridors are now used for hiking and related recreational uses as components of the Airline State Park and Hop River State Park trails.

Small undocumented possible domestic, commercial or recreational archaeological sites may exist along or near roads crossed by the route, including ruins of small structures probably associated with a former Boy Scout Camp (circa 1930 to 1960) south of U.S. Route 44 in Putnam.

A total of 12 significant above-ground historic architectural resources were identified within approximately 0.25 mile of the Proposed Route. Some of these resources are historic districts, containing multiple structures located at least partially within 0.25 mile of the Proposed Route; therefore, the total number of individual sites and structures within 0.25 mile is 21. These resources include:

- Flanders Road Bridge in Coventry
- Three Cemeteries, Mansfield Hollow Historic District, Mansfield Hollow Dam, Mansfield Center Historic District, and Mansfield Center Cemetery in Mansfield
- The Chewink Cemetery and Old Cemetery in Chaplin; South Cemetery in Hampton
- Brooklyn Green Historic District in Brooklyn
- Rogers Village in Killingly
- Munyan Cemetery in Putnam

Additional information about these and other resources is presented in the report in Volume 3. In addition to these resources, the Proposed Route crosses State Route 169 in Brooklyn, which has been designated a National Scenic Byway.

5.1.7.3 Archaeological Reconnaissance Methods and Results

Following the completion of the 2008 *Assessment*, CL&P's cultural resource consultants conducted subsurface archaeological reconnaissance investigations of sensitive Project areas that would be potentially affected by the development of the proposed transmission lines, including construction pads, construction roads, and forest clearing. These investigations, using methods consistent with the *Environmental Primer for Connecticut's Archaeological Resources*, were generally conducted within established CL&P ROWs, and as of September 2010, were performed on approximately 90% of the Project areas noted above.

Reconnaissance testing began with hand-excavated 50-centimeter-square shovel tests at intervals not exceeding 15 meters/50 feet, and included additional shovel tests at intervals of 2 to 4 meters to confirm the presence of sites potentially eligible for the NRHP/SRHP. Surface features, including foundations and unidentified human-built stone piles, walls or rings were also noted, mapped, and photographed.

Approximately 115 Native American archaeological sites have been located to date throughout the areas identified as sensitive in the 2008 *Assessment* study. The vast majority of these sites appear to represent short-term occupations near wetlands, streams, and rivers for seasonal hunting and gathering. Temporally-diagnostic projectile points and ceramic fragments indicate these occupations span almost the entire chronological range of Native American presence in the Project area region, although no sites can presently be attributed to any known tribes. Eligibility of the Native American sites to the NRHP/SRHP remains undetermined. Completion of reconnaissance investigations at some sites characterized by very limited initial finds may allow a determination that such sites are not eligible. Following standard procedure for projects under SHPO review, no locations of these or other resources discovered during the reconnaissance investigations are being provided to the public, to protect resource integrity. (Note, however, that upon request, landowners will be provided with information about the resources found on their property.)

Seven pre-20th-century Euro-American archaeological sites were located through surface inspection and/or subsurface testing, including at least one water-powered mill and one 18th- or 19th-century homestead. The functions of many of these sites remain undetermined, as does the potential eligibility of any of the sites to the NRHP/SRHP. At least five sites appear potentially eligible; completion of reconnaissance investigations at two sites with very limited initial finds may determine that these sites are not eligible. Poorly-preserved remains of the circa 1930-1960 Boy Scout Camp south of U.S. Route 44 in Putnam were located, and do not appear eligible.

Five unidentified human-built stone piles, walls, or rings were located, with considerable variations in size. The age, function, cultural affiliation, and eligibility of these features to the NRHP/SRHP remain undetermined; none appear to be field walls.

5.1.8 Air Quality

Ambient air quality is affected by pollutants emitted from both mobile sources (e.g., automobiles, trucks) and stationary sources (e.g., manufacturing facilities, power plants, and gasoline stations). In addition, naturally occurring pollutants, such as radon gas or emissions from forest fires, affect air quality. In addition to emissions from sources within the state, Connecticut's air quality is significantly affected by pollutants emitted in states located to the south and west, and then transported into Connecticut by prevailing winds. Ambient air quality in the state is monitored and evaluated by the CT DEEP. Air quality is assessed in terms of compliance with the National Ambient Air Quality Standards (NAAQS) for selected "criteria" pollutants, as well as conformance with regulations governing the release of toxic or hazardous air pollutants.

The state is currently designated as in attainment or is unclassified with respect to the NAAQS standards for five criteria air pollutants: particulate matter no greater than 10 micrometers in diameter (PM10), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and lead (Pb). The state is currently designated as being in non-attainment with the 8-hour NAAQS standard for ozone (O_3), and the 2006 24-hour $PM_{2.5}$ standard. Litchfield, New London, Tolland, and Windham counties are in conformance with all the NAAQS. Fairfield and New Haven counties are non-attainment for both the 8-hour ozone and 24-hour $PM_{2.5}$ standard. Middlesex County is non-attainment only for the 8-hour ozone standard.

The U.S. Environmental Protection Agency (EPA) has determined that carbon dioxide (CO_2) is a pollutant and has included CO_2 in its list of criteria pollutants. Areas of non-attainment have not yet been established for CO_2 or other greenhouse gases.

The CT DEEP maintains 26 air monitoring stations, located throughout the state, to collect ambient air quality data regarding concentrations of criteria pollutants. The stations closest to the Project area are located in the following municipalities: Hartford, East Hartford, Stafford, Mansfield[48], Middletown, Norwich, Groton, Madison, and New Haven.

Other air monitoring stations straddle the Project area, and may have representative air quality data. These monitors are located in Providence, and West Greenwich Rhode Island; and Ware and Worcester Massachusetts.

Table 5-18 summarizes the monitoring data considered most representative of ambient air quality from these monitoring sites. Data from the three most recent years available were used (generally 2006-2008). The table lists the maximum annual average concentrations in each year. The highest of the second-highest concentrations are listed for all short term averaging periods except for the 24-hour $PM_{2.5}$ and 8-hour ozone where the highest of the 2006-2008 98th percentile and the highest of the fourth highest concentration are listed respectively. All data were obtained from the EPA AIRDATA database (http://www.epa.gov/air/data/index.html).

[48] The Mansfield monitoring site is operated by the Connecticut Department of Transportation.

Table 5-18: Ambient Air Quality Concentrations

Pollutant	Monitor	Averaging Period	Concentration (μg/m^3)			NAAQS (μg/m^3)
			2006	2007	2008	
CO	McAuliffe Park, East Hartford, CT	1-hour	3,144	2,330	1,864	40,000
		8-hour	1,980	1,398	1,398	10,000
	76 Durrance S Providence, RI	1-hour	4891.85	5241.26	NA	40,000
		8-hour	2911.81	2911.81	NA	10,000
	Francis School E. Providence, RI	1-hour	2911.81	2096.51	1630.62	40,000
		8-hour	1863.56	1281.20	1048.25	10,000
NO_2(1)	West Alton Jones Campus, West Greenwich, RI	1-hour	26.79	15.31	11.48	191.3
		Annual	3.83	1.9	1.9	100
	Quabbin Summit Ware, MA	1-hour	80.37	65.06	70.80	191.3
		Annual	9.57	7.65	9.57	100
	Summer St, Worcester, MA	1-hour	99.50	107.15	141.60	191.3
		Annual	28.70	30.62	28.70	100
	Rockefeller Library Providence, RI	1-hour	103.33	133.94	114.81	191.3
		Annual	28.70	26.79	22.96	100
	Francis School E. Providence, RI	1-hour	51.66	51.66	59.32	191.3
		Annual	13.39	9.57	11.48	100
PM_{10}	McAuliffe Park, East Hartford, CT	24-hour	36	28	36	150
		Annual	16	16	14	50
	Quabbin St Ware, MA	24-hour	31	28	33	150
	Summer St Worcester, MA	24-hour	40	53	35	50
	#1 212 Prairie Ave. Providence, RI	24-hour	47	27	34	150
	#2 212 Prairie Ave Providence, RI	24-hour	48	27	34	50

Table 5-18: Ambient Air Quality Concentrations

Pollutant	Monitor	Averaging Period	Concentration (µg/m³) 2006	2007	2008	NAAQS (µg/m³)
$PM_{2.5}$ (2)	22 Court House St., Norwich, CT	24-hour	27.8			35
		Annual	10.27	10.07	10.39	15
	Mcauliffe Park East Hartford, CT	24-hour	38.5	45.8	32.3	35
		Annual	10.72	9.98	9.67	15
O_3 (3)	Route 190, Shenipsit State Forest, Tolland Co., CT	8-hour	177.7			147
	Quabbin St Ware, MA	8-hour	173.7			147(4)
	Worcester Airport Worcester, MA	8-hour	177.7			147(4)
	W. Alton Jones Campus West Greenwich, RI	8-hour	177.7			147(4)
	Francis School East Providence, RI	8-hour	157.7			147(4)
SO_2	85 High Street/McAuliffe Park, East Hartford, CT	1-hour(4)	NA	NA	NA	149.8
		3-hour	53.2	47.94	45.3	1300
		24-hour	32.04	32.0	34.6	365
		Annual	5.3	5.3	5.3	80
	Summer St Worcester, MA	1-hour(5)	66.6	69.2	47.9	149.8
		3-hour	53.2	42.6	45.3	1300
		24-hour	34.6	32.0	24.0	365

Table 5-18: Ambient Air Quality Concentrations

Pollutant	Monitor	Averaging Period	Concentration (µg/m³) 2006	2007	2008	NAAQS (µg/m³)
		Annual	8.0	10.7	5.3	80
Pb (5)	Shed Meadow and Bank Street, Waterbury, CT	Calendar quarter	0.02	0.01	0.01	1.5
	New Haven, CT	Calendar quarter	2010 Data Not Available			
	Kenmore Square, Boston, MA	Calendar quarter	0.01	0.01	0.02	
	212 Prairie Ave. Providence, RI	Calendar quarter	NA	0.02	0.02	

Source: http://www.epa.gov/air/data/index.html

(1) The three year average of the 98th percentile daily 1-hour maximum NO_2 concentration data is **not** the NAAQS.
(2) Short-term value is a three-year average of the 98th percentile concentration.
(3) Value is the maximum 4th highest high 8-hour average in 2006-2008. This is **not** the NAAQS value.
(4) Value is a three-year average of the 4th highest concentration.
(5) The three year average of the 99th percentile daily 1-hour maximum SO2 concentration data is not available. These are **not** the NAAQS values
(6) These are the closest lead monitors to the project area. The most recent data set for Waterbury, CT, was from 2000-2002; the New Haven, CT, data is only for 2010 and has not been released; for Providence, RI, the most recent data set was for 2001-2002.

As shown in Table 5-18, in comparison to the NAAQS, the ambient background concentrations are less than the standard for all pollutants and averaging periods with the exception of 8-hour ozone. All of the monitoring sites are within a non-attainment area for 8-hour ozone where the three-year average of the fourth highest daily maximum concentrations exceeds the standard of 147 µg/m³. However, the non-attainment area is considered to be moderate since the three-year average does not exceed 210 µg/m³.

5.1.9 Noise

Existing noise levels in the vicinity of the Proposed Route vary as a function of land use, and can be expected to range from sound levels typical of an urban environment to those typical of quiet, rural areas. Noise levels are also variable throughout the day, and are influenced by diverse factors such as vehicular traffic, commercial and industrial activities and outdoor activities typical of suburban environments. Table 5-19 lists typical sound levels associated with different types of environments and activities.

The State of Connecticut has noise regulations (RCSA §§ 22a-69-1 to 22a-69-7.4) identifying the sound limits that can be emitted within certain types of land uses. The state regulations define daytime vs. nighttime noise periods; classify noise zones based on land use; and identify noise standards for each zone. Table 5-20 summarizes Connecticut's noise zone standards, by emitter (source) and receptor (receiver) noise classification. In general, the regulations specify that noise emitters must not cause the emission of excessive noise beyond the boundaries of their noise zone so as to exceed the allowable noise levels on a receptor's land.

As illustrated in Table 5-20, the allowable noise levels vary by type of noise emitter and type of noise receptor. For example, an industrial noise emitter is allowed a 70 dBA (decibel, on the A-weighted scale) level on other industrial receptors, but only a 61 dBA (daytime) level on residential areas. Where multiple noise emitter/noise receptor types exist on the same property, the least restrictive limits apply.

Table 5-19: Representative Indoor and Outdoor Noise Levels

Outdoor Noise Levels	A-Weighted Sound Level (dBA)	Indoor Noise Levels
Jet aircraft take-off at 100 feet	+120	
Riveting machine at operator's position	+110	
Cut-off saw at operator's position	+100	
Elevated subway at 50 feet		
		Newspaper press
Automobile horn at 10 feet		
	+90	Industrial boiler room
Diesel truck at 50 feet		Food blender at 3 feet
Noisy urban daytime	+80	Garbage disposal at 3 feet
Diesel bus at 50 feet		
		Shouting at 3 feet
	+70	
Gas lawn mower at 100 feet		Vacuum cleaner at 10 feet
Quiet urban daytime	+60	Normal conversation at 5 - 10 feet
		Large business office
Quiet urban nighttime	+50	Open office area background level
Substation (transformer)	+43	
Quiet suburban nighttime		
	+40	Large conference room
		Small theater (background)
Quiet rural nighttime	+30	Soft whisper at 2 feet
		Bedroom at nighttime
	+20	Concert hall

Table 5-20: State of Connecticut Noise-Control Regulations by Emitter and Receptor Land-Use Classification

Noise Emitter Class	Noise Receptor Class			
	C: Industrial	**B: Generally Commercial**	**A: Residential Day**	**A: Residential Night**
C: Industrial	70 dBA	66 dBA	61 dBA	51 dBA
B: Generally Commercial	62 dBA	62 dBA	55 dBA	45 dBA
A: Residential	62 dBA	55 dBA	55 dBA	45 dBA

Definitions:
Day = 7:00 AM to 9:00 PM Monday – Saturday; 9:00 AM to 9:00 PM Sunday
Night = 9:00 PM to 7:00 AM Monday – Saturday; 9:00 PM to 9:00 AM Sunday

The regulation also prohibits the production of prominent, audible discrete tones. If a facility produces such sounds, the applicable limits in Table 5-20 are reduced by 5 dBA to offset the undesirable nature of tonal sound in the environment. The regulation defines prominent discrete tones on the basis of one-third octave band sound levels.

Construction noise is exempted under RCSA § 22a-69-1.8(h); therefore the noise limits presented in Table 5-20 do not apply to construction of this Project.

In accordance with Connecticut General Statutes Section 22a-73, municipalities also may adopt noise-control ordinances.[49] Such ordinances must be approved by the Commissioner of CT DEEP and be consistent with the state noise regulations.

[49] The towns of Mansfield and Thompson have noise ordinances that are similar to the Regulations for Control of Noise in the State of Connecticut.

5.2 SUBSTATIONS AND SWITCHING STATIONS

5.2.1 Card Street Substation

Card Street Substation is located in the northern portion of the Town of Lebanon. The existing substation occupies approximately 10 acres of a 150-acre site owned by CL&P. The proposed Project modifications to Card Street Substation, as illustrated on the preliminary plans in Volume 7 and discussed in Sections 1, 3, and 4, would be entirely within the existing station fence line.

5.2.1.1 Geology, Topography, and Soils

The elevation at Card Street Substation is approximately 350 NGVD. Surficial geology at the substation site consists of till. Bedrock geology consists of gray to dark-gray, medium-grained gneiss or schist associated with the Tatnic Hill Formation. Table 5-21 identifies the soil types mapped at CL&P's Card Street Substation property. None of these soils types are considered a prime farmland soil or farmland soils of statewide importance.

5.2.1.2 Water Resources

No streams are located on the substation property. Three wetlands were delineated during the 2008 through 2011 field surveys. These wetlands, which are depicted on the maps in Volume 9 and Volume 11 and discussed in the *Wetlands and Watercourse Delineation Report* (Volume 2), are W21-14 (a PFO wetland), W21-15 (a PFO wetland); and W21-16 (a PFO wetland).

Table 5-21: Soil Types: Card Street Substation

Map Unit Symbol	Parent Material	Hydric Soil	Depth to Bedrock (inches)	Depth to Water Table (feet)
17 Timakwa and Natchaug	Woody organic material over sandy and gravelly glaciofluvial deposits, and woody organic material over loamy alluvium and/or loamy glaciofluvial deposits and/or loamy till	Yes	>60 (Typical)	0.0-1.0
51B Sutton sandy loam, 2 to 8 % slopes, very stony	Coarse-loamy melt-out till derived from granite and/or schist and/or gneiss	No	>65 (Typical)	1.5-2.5
61B Canton and Charlton, 3 to 8 % slopes, very stony	Coarse-loamy over sandy and gravelly melt-out till derived from granite and/or schist and/or gneiss	No	>60 (Typical)	>6
73C Charlton-Chatfield complex, 3 to 15 % slopes, very rocky	Coarse-loamy melt-out till derived from granite and/or schist and/or gneiss	No	20-40	>6
307 Urban Land	Areas where native soil has been altered or obscured by urbanization and structures (e.g., buildings, paved areas, industrial areas)			

Source: USDA Natural Resources Conservation Service, Online Soil Surveys and Geographic Data of New London County, accessed 2009 and 2010, and United States Department of Agriculture, Natural Resources Conservation Service, 2008, Soil Survey of the State of Connecticut (ftp://ftp-fc.sc.egov.usda.gov/CT/soils/connecticut.pdf), accessed November 2010.

5.2.1.3 Biological Resources

The predominant vegetative communities in the vicinity of the substation consist of upland forest (deciduous hardwood), open field-shrub land, and forested wetlands. These vegetative communities can be expected to provide productive habitat for a variety of wildlife species. The wildlife species expected to occur in the vicinity of the Card Street Substation would be tolerant of regular disturbances caused by human activities, given the proximity to rural residences along Card Street and the development and regular maintenance that occurs at Card Street Substation and along the existing transmission line corridors.

According to the USFWS and CT NDDB, no federally- or state-listed vegetation or wildlife species are known to inhabit areas on or in the immediate vicinity of the Card Street Substation (USFWS and CT

NDDB correspondence, Volume 4). However, the USFWS has indicated that the New England cottontail (*Sylvilagus transitionalis*), a federal candidate species, occurs in the Town of Lebanon. According to the USFWS, the New England cottontail prefers early successional forests (typically less than 25 years old) with a dense shrub layer.[50] An open field-shrub-land vegetative community is being managed on the existing CL&P property in the vicinity of the substation and along the existing transmission line ROWs.

5.2.1.4 Existing and Future Land Uses, Recreational Areas, and Visual Resources

Card Street Substation is classified as commercial/industrial land. Lands surrounding Card Street Substation are zoned for rural residential and agricultural uses. The land uses in the vicinity of Card Street Substation include rural residences along Card Street, undeveloped forest, and transmission line ROWs (characterized by open (old) field-scrub land vegetation). Single-family rural residences are located along Card Street to the south and east of the substation property.

No Statutory Facilities are located in proximity to Card Street Substation. Similarly, the substation is not in the vicinity of any designated scenic or recreational resources.

The existing substation and associated transmission line structures are visible from Card Street and some of the residences along Card Street. Forest located on the south, east, and west sides of the existing fenced Card Street Substation provides some visual screening.

5.2.1.5 Transportation and Access

Access to the substation is via Card Street along the south side of the site.

5.2.1.6 Cultural (Archaeological and Historic) Resources

One reported Native American archaeological site is located within 1 mile of the substation. Most or all of the undeveloped CL&P property surrounding the substation appears to be sensitive for possible Native

[50] USFWS, 2006. New England Cottontail (*Sylvilagus transitionalis*). August 2006. http://www.fws.gov/northeast/pdf/necotton.fs.pdf (accessed December 2010).

American sites. However, there are no reported Euro-American archaeological sites within 1 mile of the substation property, and no significant historic resources reported within 0.25 mile. Further, the modifications to the substation would all be within the fenced area, which has already been disturbed by prior utility developments.

5.2.1.7 Air Quality

The state is currently designated as in attainment or is unclassified with respect to the NAAQS standards for five criteria air pollutants: particulate matter no greater than 10 micrometers in diameter (PM_{10}), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and lead (Pb). The state is currently designated as being in non-attainment with the 8-hour NAAQS standard for ozone (O_3), and the 2006 24-hour $PM_{2.5}$ standard. New London County, which includes the Town of Lebanon and the existing Card Street Substation, are in conformance with all the NAAQS.

5.2.1.8 Noise

The Card Street Substation is located within an area zoned for rural residential and agricultural uses. No other locally designated zoning districts are within 0.25 mile of the existing substation fence line. Noise-sensitive sites in proximity to the substation include scattered residences south and east of the substation. The nearest residences are located within approximately 400 feet of the existing substation fence line.

5.2.2 Lake Road Switching Station

Lake Road Switching Station is located in the northwestern portion of the Town of Killingly. The developed portion of the switching station occupies approximately 3 acres. The Lake Road Switching Station is located on an approximately 60-acre parcel of land owned by Lake Road Generating Company, L.P. The Lake Road Generating Station is also located on this parcel of land, south of the Lake Road Switching Station. The proposed modifications to Lake Road Switching Station, as illustrated on the preliminary plans in Volume 7 and discussed in Sections 1, 3, and 4, would be entirely within the existing switching station fence line.

5.2.2.1 Geology, Topography, and Soils

Lake Road Switching Station is located at an elevation of approximately 295 NGVD. The topography at the switching station has been modified to create a level base for the utility equipment. Surficial geology at the station site consists of till, gravel, and sand and gravel overlying sand, overlying fines. Bedrock geology consists of gray to dark-gray fine-grained, well-layered schist and granofels associated with the Quinebaug Formation and gray to dark-gray, medium grained gneiss or schist associated with the Tatnic Hill Formation.

Table 5-22 identifies the soil types found at Lake Road Switching Station; however, soils within the fenced area of the site have been disturbed and consist of gravel and fill material. None of the soils types found at or in the immediate vicinity of the Lake Road Switching Station are considered a prime farmland soil or farmland soil of statewide importance.

Table 5-22: Soil Types: Lake Road Switching Station

Map Unit Symbol	Parent Material	Hydric Soil	Depth to Bedrock (inches)	Depth to Water Table (feet)
52C Sutton fine sandy loam, 2 to 15 % slopes, extremely stony	Coarse-loamy melt-out till derived from granite and/or schist and/or gneiss	No	>65 (Typical)	1.5-2.5
62C Canton and Charlton soils, 3 to 15 % slopes, extremely stony	Coarse-loamy over sandy and gravelly melt-out till derived from granite and/or schist and/or gneiss	No	>60 (Typical)	>6
73C Charlton-Chatfield complex, 3 to 15 % slopes, very rocky	Coarse-loamy melt-out till derived from granite and/or schist and/or gneiss	No	20-40	>6

Source: USDA Natural Resources Conservation Service, Online Soil Surveys and Geographic Data of Windham County, accessed 2009, and United States Department of Agriculture, Natural Resources Conservation Service, 2008, Soil Survey of the State of Connecticut (ftp://ftp-fc.sc.egov.usda.gov/CT/soils/connecticut.pdf), accessed November 2010.

5.2.2.2 Water Resources

No water resources are located on or within 200 feet of Lake Road Switching Station; however, an approximately 0.6-acre storm-water detention basin is located south of the Lake Road Switching Station and west of the Lake Road Generating Station.

5.2.2.3 Biological Resources

The vegetative communities in the vicinity of the switching station consist principally of upland forest (mature mixed deciduous and coniferous forest) and open field-shrub land. A discussion of these habitats and the associated wildlife species is provided in Section 5.1.3.2. The proposed modifications to the Lake Road Switching Station would occur within the existing switching station fence line in a previously disturbed area that is presently graveled. The area within the fence line at the Lake Road Switching Station is either developed or regularly managed and does not support habitat suitable for wildlife.

Whereas there are no federally-listed species in the vicinity of the switching station, consultations with the CT NDDB indicate that two moth species are known to occur in the area. These are the barrens metarranthis moth (*Metarranthis apiciaria*) and the slender clearwing (*Hemaris gracilis*). The barrens metarranthis moth prefers barrens, shrub lands, and open woodlands. The slender clearwing prefers heathlands with lowbush blueberry and mountain laurel. During field surveys conducted in June 2008, both species were discovered along the existing CL&P transmission line ROW approximately 1,000 feet northwest of the Lake Road Switching Station. The proposed modifications at the Lake Road Switching Station are not expected to impact the barrens metarranthis moth or the slender clearwing.

5.2.2.4 Existing and Future Land Uses, Recreational Areas, and Visual Resources

Lake Road Switching Station sits on a parcel of land classified as commercial/industrial land use. Land uses surrounding the switching station include other commercial/industrial facilities (including the Lake Road Generating Station), transportation uses (Interstate 395), and transmission line ROWs. No Statutory Facilities are located in proximity to Lake Road Switching Station. The existing switching station is not visible from Interstate 395 or Lake Road. The proposed modifications at the Lake Road Switching Station are not expected to increase its visibility from public roads.

5.2.2.5 Transportation and Access

Access to the switching station is via Louisa Viens Drive, Old Trolly Road, and Lake Road, located south of the Lake Road Generating Station. Interstate 395 and the Providence & Worcester Railroad line, both of which extend north-to-south, are located approximately 300 feet and 500 feet east of the switching station, respectively.

5.2.2.6 Cultural (Archaeological and Historic) Resources

The proposed modifications at Lake Road Switching Station will occur within the station's fence line, in areas disturbed by previous construction. As a result, the areas proposed for the modifications are not sensitive for the location of intact archaeological resources. There are no known significant historic resources reported within 0.25 mile of the switching station.

5.2.2.7 Air Quality

The state is currently designated as in attainment or is unclassified with respect to the NAAQS standards for five criteria air pollutants: PM10, SO_2, NO_2, CO, and Pb. The state is currently designated as being in non-attainment with the 8-hour NAAQS standard for O_3, and the 2006 24-hour PM2.5 standard. Windham County, which includes the Town of Killingly and the existing Lake Road Switching Station, is in conformance with all the NAAQS.

5.2.2.8 Noise

Lake Road Switching Station is located in an industrially zoned area within the Town of Killingly. The closest residentially zoned area is located approximately 0.25 mile to the southeast of the station. The ambient sound environment is presently influenced by the operation of the Lake Road Generation Station, vehicular traffic along Interstate 395, and train movements along the Providence & Worcester Railroad tracks located to the east of Interstate 395. Because none of the new equipment proposed for installation at the switching station would result in increased noise emissions, CL&P did not perform any site-specific studies of ambient noise levels.

5.2.3 Killingly Substation

Killingly Substation is located in the northwest corner of the Town of Killingly, approximately 0.5 mile northeast of the Lake Road Switching Station. The developed portion of the substation occupies approximately 5.6 acres of a 29.4-acre site owned by CL&P.

The proposed modifications to Killingly Substation, as illustrated on the preliminary plans in Volume 7 and discussed in Sections 1, 3, and 4, would be located entirely within the existing substation fence line. Killingly Substation and the surrounding area are zoned for industrial land uses. One residence is located approximately 700 feet east of Killingly Substation, along the west side of Tracy Road. Other land uses in the vicinity of Killingly Substation include warehouses, a railroad corridor, and Interstate 395.

5.2.3.1 Geology, Topography, and Soils

The elevation at Killingly Substation is approximately 280 NGVD. Surficial geology at the substation site consists of sand and gravel overlying sand, overlying fines and till. Bedrock geology consists of gray to dark-gray, medium-grained well-layered gneiss or gray, fine-grained, well-layered schist and granofels associated with the Quinebaug Formation. Table 5-23 identifies the soil types found within Killingly Substation property; however, soils within the fenced area of Killingly Substation have been disturbed and consist of gravel and fill material.

Table 5-23: Soil Types: Killingly Substation

Map Unit Symbol	Parent Material	Hydric Soil	Depth to Bedrock (inches)	Depth to Water Table (feet)
23A** Sudbury sandy loam, 0 to 5 % slopes	Sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss, and coarse-loamy eolian deposits over sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>60 (Typical)	1.5-3.0
34A** Merrimac sandy loam, 0 to 3 % slopes	Sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>60 (Typical)	>6
38C* Hinkley gravelly sandy loam, 3 to 15 % slopes	Sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>60 (Typical)	>6
38E Hinkley gravelly sandy loam, 15 to 45 % slopes	Sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	>60 (Typical)	>6

Source: USDA Natural Resources Conservation Service, Online Soil Surveys and Geographic Data of Windham County, accessed 2009, and United States Department of Agriculture, Natural Resources Conservation Service, 2008, Soil Survey of the State of Connecticut (ftp://ftp-fc.sc.egov.usda.gov/CT/soils/connecticut.pdf), accessed November 2010.

* Soils classified as Farmland Soils of Statewide Importance.
(http://www.cteco.uconn.edu/guides/resource/CT_ECO_Resource_Guide_Soils_Farmland.pdf, Accessed November 2010)

** Soils classified as Prime Farmland Soils.

5.2.3.2 Water Resources

No water resources are located on or within 200 feet of the Killingly Substation; however, an approximately 1.3-acre storm water detention basin is located along the east side of the substation, on an adjacent property that includes a warehouse distribution center.

5.2.3.3 Biological Resources

The vegetative communities in the vicinity of the substation include upland forest (deciduous hardwood) and open-field-shrub-land. A discussion of these habitats and associated wildlife species is provided in Section 5.1.3. The area within the fence line at the Killingly Substation is developed and regularly managed for utility use and does not support habitat suitable for wildlife. The proposed modifications to

Killingly Substation would occur within the existing substation fence line, in graveled areas previously disturbed by station development.

As illustrated on the Volume 9 maps (refer to maps 31 and 32 of 40), the station is located within the radius of a previously reported location of state-listed invertebrate species (Lepidoptera; moths, butterflies), as identified from CT NDDB records. During field surveys conducted along the ROWs as part of the planning for the proposed Project, CL&P consultants (UCONN CCB) observed, and subsequently reported to CT NDDB, these listed species. However, according to UCONN CCB, although the listed species were observed along the ROWs in the vicinity of the substation, the developed station site does not provide suitable host plant habitat for these invertebrates.

5.2.3.4 Existing and Future Land Uses, Recreational Areas, and Visual Resources

Killingly Substation is located along CL&P's existing ROW, on CL&P-owned property. The station is within an industrially zoned area. Land uses in the vicinity of the substation include CL&P's Tracy Substation, Interstate 395, commercial / industrial facilities, undeveloped forest, railroad ROW, and transmission line ROW. No Statutory Facilities or designated scenic resources are located in proximity to Killingly Substation. The closest residence, a single-family residence, is located approximately 700 feet east of Killingly Substation, along the west side of Tracy Road. Warehouse facilities are located north and south of the residence.

The existing substation is not visible from Tracy Road because of the existing wooded areas and the warehouse facilities east of the substation. Tracey Road Trail, a 1-mile paved trail suitable for walking/hiking and biking, extends along the east side of Tracy Road between Attawaugan Crossing Road (south of Interstate 395) and the Killingly / Putnam town border. The substation is not visible from this trail, which is identified on ConnDOT and CT DEEP trail maps, due to intervening vegetation, topography, and land development.

5.2.3.5 Transportation and Access

Access to the substation is along the transmission line ROW / CL&P property via Park Road / Tracy Road, located to the north of the site. (Note: Tracy Road originates in Killingly and becomes Park Road at the Putnam border.)

5.2.3.6 Cultural (Archaeological and Historic) Resources

The proposed modifications at Killingly Substation would be limited to existing, previously disturbed portions of the developed site. As a result, the area is not sensitive for intact archaeological resources. A review of historical records indicates there are no known significant historic resources reported within 0.25 mile of the substation.

5.2.3.7 Air Quality

The state is currently designated as in attainment or is unclassified with respect to the NAAQS standards for five criteria air pollutants: PM10, SO_2, NO_2, CO, and Pb. The state is currently designated as being in non-attainment with the 8-hour NAAQS standard for O_3, and the 2006 24-hour $PM_{2.5}$ standard. Windham County, which includes the Town of Killingly and the existing Killingly Substation, is in conformance with all the NAAQS.

5.2.3.8 Noise

Killingly Substation is located in an industrial zoned area. The closest residentially zoned area is located approximately 0.25 mile east of the existing substation. The ambient sound environment is presently influenced by the operations at the existing warehouse facilities, rail traffic along the Providence & Worcester Railroad tracks that extend along the western boundary of the substation and by vehicle traffic along both Tracy / Park roads and the Interstate 395. Because none of the new equipment proposed for installation at the substation would result in increased noise emissions, CL&P did not perform any site-specific studies of ambient noise levels.

Table 5-1
Soils and Soil Characteristics
along the Proposed Route

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Table 5-1: Soils and Soil Characteristics along the Proposed Route

USDA Soil Map Unit Name and Symbol	Parent Material	Hydric Soil	Erosion Factor[1]	Depth to Bedrock (inches)	Depth to Water Table (feet)
2* Ridgebury fine sandy loam	Coarse-loamy lodgment till derived from granite and/or schist and/or gneiss	Yes	0.15	>60 (Typical)	0.0-0.5
3 Ridgebury, Leicester, Whitman	Coarse-loamy lodgment till derived from granite and/or schist and/or gneiss	Yes	0.15	>60 (Typical)	0.0-1.5
13* Walpole sandy loam	Sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	Yes	--	>65 (Typical)	0.0-1.0
15 Scarboro muck	Sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	Yes	--	>72 (Typical)	0.0-1.0
17 Timakwa and Natchaug	Woody organic material over sandy and gravelly glaciofluvial deposits, and woody organic material over loamy alluvium and/or loamy glaciofluvial deposits and/or loamy till	Yes	--	>60 (Typical)	0.0-1.0
21A** Ninigret and Tisbury, 0 to 5 % slopes	Coarse-loamy eolian deposits over sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	0.43	>60 (Typical)	1.5-2.5
23A** Sudbury sandy loam, 0 to 5 % slopes	Sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss, and coarse-loamy eolian deposits over sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	--	>60 (Typical)	1.5-3.0
29A** Agawam fine sandy loam, 0 to 3 % slopes	Coarse-loamy eolian deposits over sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	0.28	>60 (Typical)	>6
29B** Agawam fine sandy loam, 3 to 8 % slopes	Coarse-loamy eolian deposits over sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	0.29	>60 (Typical)	>6
32A** Haven and Enfield soils, 0 to 3 % slopes	Coarse-loamy and coarse-silty eolian deposits over sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	0.32	>60 (Typical)	>6
34A** Merrimac sandy loam, 0 to 3 % slopes	Sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	0.24	>60 (Typical)	>6

Table 5-1: Soils and Soil Characteristics along the Proposed Route

USDA Soil Map Unit Name and Symbol	Parent Material	Hydric Soil	Erosion Factor[1]	Depth to Bedrock (inches)	Depth to Water Table (feet)
34B** Merrimac sandy loam, 3 to 8 % slopes	Sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	0.24	>60 (Typical)	>6
38A* Hinckley gravelly sandy loam, 0 to 3 % slopes	Sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	0.15	>60 (Typical)	>6
38C* Hinckley gravelly sandy loam, 3 to 15 % slopes	Sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	0.15	>60 (Typical)	>6
38E Hinckley gravelly sandy loam, 15 to 45 % slopes	Sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss	No	0.15	>60 (Typical)	>6
45A** Woodbridge fine sandy loam, 0 to 3 % slopes	Coarse-loamy lodgment till derived from granite and/or schist and/or gneiss	No	0.17	>65 (Typical)	1.5-2.5
45B** Woodbridge fine sandy loam, 3 to 8 % slopes	Coarse-loamy lodgment till derived from granite and/or schist and/or gneiss	No	0.17	>65 (Typical)	1.5-2.5
46B Woodbridge fine sandy loam, 2 to 8 % slopes, very stony	Coarse-loamy lodgment till derived from granite and/or schist and/or gneiss	No	0.15	>65 (Typical)	1.5-2.5
46C Woodbridge fine sandy loam, 8 to 15 % slopes, very stony	Coarse-loamy lodgment till derived from granite and/or schist and/or gneiss	No	0.15	>65 (Typical)	1.5-2.5
47C Woodbridge fine sandy loam, 2 to 15 % slopes, extremely stony	Coarse-loamy lodgment till derived from granite and/or schist and/or gneiss	No	0.10	>65 (Typical)	1.5-2.5
50A** Sutton fine sandy loam, 0 to 3 % slopes	Coarse-loamy melt-out till derived from granite and/or schist and/or gneiss	No	0.15	>65 (Typical)	1.5-2.5
50B** Sutton fine sandy loam, 3 to 8 % slopes	Coarse-loamy melt-out till derived from granite and/or schist and/or gneiss	No	0.15	>65 (Typical)	1.5-2.5

Table 5-1: Soils and Soil Characteristics along the Proposed Route

USDA Soil Map Unit Name and Symbol	Parent Material	Hydric Soil	Erosion Factor[1]	Depth to Bedrock (inches)	Depth to Water Table (feet)
51B Sutton sandy loam, 2 to 8 % slopes, very stony	Coarse-loamy melt-out till derived from granite and/or schist and/or gneiss	No	0.15	>65 (Typical)	1.5-2.5
52C Sutton fine sandy loam, 2 to 15 % slopes, extremely stony	Coarse-loamy melt-out till derived from granite and/or schist and/or gneiss	No	0.15	>65 (Typical)	1.5-2.5
58B Gloucester gravelly sandy loam, 3 to 8 %, very stony	Sandy and gravelly melt-out till derived from granite and/or schist and/or gneiss	No	0.17	>60 (Typical)	>6
58C Gloucester gravelly sandy loam, 8 to 15 %, very stony	Sandy and gravelly melt-out till derived from granite and/or schist and/or gneiss	No	0.17	>60 (Typical)	>6
59C Gloucester gravelly sandy loam, 3 to 15 %, extremely stony	Sandy and gravelly melt-out till derived from granite and/or schist and/or gneiss	No	0.17	>60 (Typical)	>6
60B** Canton and Charlton, 3 to 8 % slopes	Coarse-loamy over sandy and gravelly melt-out till derived from granite and/or schist and/or gneiss	No	0.17	>60 (Typical)	>6
60C* Canton and Charlton, 8 to 15 % slopes	Coarse-loamy over sandy and gravelly melt-out till derived from granite and/or schist and/or gneiss	No	0.17	>60 (Typical)	>6
61B Canton and Charlton, 3 to 8 % slopes, very stony	Coarse-loamy over sandy and gravelly melt-out till derived from granite and/or schist and/or gneiss	No	0.17	>60 (Typical)	>6
61C Canton and Charlton, 8 to 15 % slopes, very stony	Coarse-loamy over sandy and gravelly melt-out till derived from granite and/or schist and/or gneiss	No	0.17	>60 (Typical)	>6
62C Canton and Charlton, 3 to 15 % slopes, extremely stony	Coarse-loamy over sandy and gravelly melt-out till derived from granite and/or schist and/or gneiss	No	0.17	>60 (Typical)	>6

Table 5-1: Soils and Soil Characteristics along the Proposed Route

USDA Soil Map Unit Name and Symbol	Parent Material	Hydric Soil	Erosion Factor[1]	Depth to Bedrock (inches)	Depth to Water Table (feet)
62D Canton and Charlton, 15 to 35 % slopes, extremely stony	Coarse-loamy over sandy and gravelly melt-out till derived from granite and/or schist and/or gneiss	No	0.17	>60 (Typical)	>6
73C Charlton-Chatfield complex, 3 to 15 % slopes, very rocky	Coarse-loamy melt-out till derived from granite and/or schist and/or gneiss	No	0.17	20-40	>6
73E Charlton-Chatfield complex, 15 to 45 % slopes, very rocky	Coarse-loamy melt-out till derived from granite and/or schist and/or gneiss	No	0.17	20-40	>6
75C Hollis-Chatfield-rock outcrop complex, 3 to 15 % slopes	Loamy melt-out till derived from granite and/or schist and/or gneiss	No	0.05	0-20	>6
75E Hollis-Chatfield-rock outcrop complex, 15 to 45 % slopes	Loamy melt-out till derived from granite and/or schist and/or gneiss	No	0.05	0-20	>6
76E Rock outcrop-Hollis complex, 3 to 45 % slopes	Loamy melt-out till derived from granite and/or schist and/or gneiss	No	--	0-20	>6
84B** Paxton and Montauk fine sandy loam, 3 to 8 % slopes	Coarse-loamy lodgment till derived from granite and/or coarse-loamy lodgment till derived from gneiss and/or coarse-loamy lodgment till derived from gneiss and/or coarse-loamy lodgment till derived from granite	No	0.20	>60 (Typical)	1.5-2.5
85B Paxton and Montauk fine sandy loam, 3 to 8 % slopes, very stony	Coarse-loamy lodgment till derived from granite and/or coarse-loamy lodgment till derived from gneiss and/or coarse-loamy lodgment till derived from gneiss and/or coarse-loamy lodgment till derived from granite	No	0.20	>60 (Typical)	1.5-2.5

Table 5-1: Soils and Soil Characteristics along the Proposed Route

USDA Soil Map Unit Name and Symbol	Parent Material	Hydric Soil	Erosion Factor[1]	Depth to Bedrock (inches)	Depth to Water Table (feet)
85C Paxton and Montauk fine sandy loam, 8 to 15 % slopes, very stony	Coarse-loamy lodgment till derived from granite and/or coarse-loamy lodgment till derived from gneiss and/or coarse-loamy lodgment till derived from gneiss and/or coarse-loamy lodgment till derived from granite	No	0.20	>60 (Typical)	1.5-2.5
86C Paxton and Montauk fine sandy loam, 3 to 15 % slopes, extremely stony	Coarse-loamy lodgment till derived from granite and/or coarse-loamy lodgment till derived from gneiss and/or coarse-loamy lodgment till derived from gneiss and/or coarse-loamy lodgment till derived from granite	No	0.20	>60 (Typical)	1.5-2.5
86D Paxton and Montauk fine sandy loam, 15 to 35 % slopes, extremely stony	Coarse-loamy lodgment till derived from granite and/or coarse-loamy lodgment till derived from gneiss and/or coarse-loamy lodgment till derived from gneiss and/or coarse-loamy lodgment till derived from granite	No	0.20	>60 (Typical)	1.5-2.5
100* Suncook loamy fine sand	Sandy alluvium	No	0.28	>65 (Typical)	5.0-6.0
101** Occum fine sandy loam	Coarse-loamy alluvium	No	0.28	>65 (Typical)	5.0-6.0
102** Pootatuck fine sandy loam	Coarse-loamy alluvium	No	0.24	>65 (Typical)	1.5-2.5
103* Rippowam fine sandy loam	Coarse-loamy alluvium	Yes	0.15	>65 (Typical)	0.0-1.5
108 Saco silt loam	Coarse-silty alluvium	Yes	0.28	>60 (Typical)	0.0-0.5
109 Fluvaquents-Udifluvents complex, frequently flooded	Alluvium	Fluvaquents are hydric; Udifluvents are not hydric	0.32	>60 (Typical)	0.0-6.0
305 Udorthents-pits complex, gravelly	Gravelly outwash	No	0.28	>65 (Typical)	2.0-4.5

Table 5-1: Soils and Soil Characteristics along the Proposed Route

USDA Soil Map Unit Name and Symbol	Parent Material	Hydric Soil	Erosion Factor[1]	Depth to Bedrock (inches)	Depth to Water Table (feet)
306 Udorthents-Urban land complex	Drift	No	0.28	>72 (Typical)	4.5-6.0
307 Urban land	Areas where native soil has been altered or obscured by urbanization and structures (e.g., buildings, paved areas, industrial areas).				

Source: USDA Natural Resources Conservation Service, Online Soil Surveys and Geographic Data of New London, Tolland and Windham Counties, accessed 2009, and United States Department of Agriculture, Natural Resources Conservation Service, 2008, Soil Survey of the State of Connecticut (ftp://ftp-fc.sc.egov.usda.gov/CT/soils/connecticut.pdf), accessed November 2010.

* Soils classified as Farmland Soils of Statewide Importance are soils that fail to meet one or more of the requirements of prime farmland, but are important for the production of food, feed, fiber, or forage crops. They include those soils that are nearly prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods. (http://www.cteco.uconn.edu/guides/resource/CT_ECO_Resource_Guide_Soils_Farmland.pdf, Accessed November 2010)

** Soils classified as Prime Farmland Soils, according to 7 Code of Federal Regulation 657.5, have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and are also available for these uses (the land could be cropland, pastureland, rangeland, forest land, or other land, but not urban built-up land or water). Prime Farmland has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. Prime Farmland soils are permeable to water and air, are not excessively erodible or saturated with water for a long period of time, and either do not flood frequently or are protected from flooding.

1. Erosion Factor (K (dimensionless)): Indicates the erodability of the whole soil, the higher the value, the more susceptible the soil to erosion.

-- No Data Available.

Table 5-4
Watercourses along
the Proposed Route

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Table 5-4: Watercourses along the Proposed Route

Municipality	Watercourse Series Number[1] and Name (as applicable)	Water Quality[2] / Fisheries Classification[3] (as applicable)	Watercourse Type (P or I)[4]
Lebanon/Columbia			
	S20-1/Tenmile River	B/cold-water	P
Columbia			
	S20-1A*	A	P
	S20-1B	A	P
Coventry/Columbia			
	S20-2/Hop River	B/cold-water	P
Coventry			
	S20-3	A	P
Coventry/Mansfield			
	S20-4/Willimantic River	B/cold-water	P
Mansfield			
	S20-5	A	I
	S20-6*	A	P
	S20-7*	A/warm-water	P
	S20-8	AA/warm-water	P
	S20-9/Conantville Brook	AA/warm-water	P
	S20-10*	AA/warm-water	I
	S20-11	AA	I
	S20-12	AA	P
	S20-12A	AA	I
	S20-13	AA	P
	S20-14	AA	P
	S20-15	AA	I
	S20-16	AA/cold-water	I
	S20-17/Sawmill Brook	AA/cold-water	P
	S20-17B	AA	P
	S20-18	AA/cold-water	I
	S20-19A*	AA	I
	S20-19*	AA	I
	Mansfield Hollow Lake	AA/warm-water	P

Table 5-4: Watercourses along the Proposed Route

Municipality	Watercourse Series Number[1] and Name (as applicable)	Water Quality[2] / Fisheries Classification[3] (as applicable)	Watercourse Type (P or I)[4]
Mansfield / Chaplin			
	S20-20	AA/cold-water	P
Chaplin			
	S20-21	AA/cold-water	I
	S20-21A	AA	I
	S20-22/Natchaug River	B/AA/cold-water	P
	S20-23	AA/cold-water	P
	S20-24*	AA/cold-water	P
	S20-25	AA	P
	S20-26	AA	P
	S20-27	AA	I
	S20-28	AA	I
	S20-29/Buttonball Brook	AA/cold-water	P
	S20-30	AA	P
Hampton			
	S20-31	A	I
	S20-32/Merrick Brook	A/cold-water	P
	S20-33*	A	I
	S20-34	A	I
	S20-35	A	I
	S20-36	A	I
	S20-37	A	I
	S20-38	A	I
	S20-38A	A	I
	S20-39A/Cedar Swamp Brook	A/cold-water	P
	S20-39/Cedar Swamp Brook	A/cold-water	P
	S20-40/Little River	A/cold-water	P
	S20-40A	A	I
	S20-41	A/cold-water	P
	S20-41A Humes Brook	A	I
	S20-41B	A	I
	S20-41C	A	I

Table 5-4: Watercourses along the Proposed Route

Municipality	Watercourse Series Number[1] and Name (as applicable)	Water Quality[2] / Fisheries Classification[3] (as applicable)	Watercourse Type (P or I)[4]
Brooklyn			
	S20-41D	A	I
	S20-41E	A	I
	S20-41F	A	I
	S20-41G	A	I
	S20-42/Stony Brook	A / cold-water	P
	S20-42A	A	P
	S20-42B*	A	I
	S20-43	A	I
	S20-44/Blackwell Brook	A	P
	S20-45 Tanner Brook	A	P
	S20-46	A	I
	S20-47	A	I
	S20-47A	A	I
	S20-48	A	I
	S20-49/White Brook	A/warm-water	P
	S20-153	A	I
	S20-49A	A	I
	S20-49B	A	I
	S20-50	A	P
	S20-51/White Brook	A/warm-water	P
	S20-52/Creamery Brook	A/warm-water	P
	S20-52A	A	I
	S20-52B*	A	I
	S20-53*	A	P
	S20-54A	A	I
Brooklyn/Pomfret			
	S20-54	A	I
Killingly/Pomfret			
	S20-55/Quinebaug River	B/cold-water	P
Killingly			
	S20-56*	A	I

Table 5-4: Watercourses along the Proposed Route

Municipality	Watercourse Series Number[1] and Name (as applicable)	Water Quality[2] / Fisheries Classification[3] (as applicable)	Watercourse Type (P or I)[4]
	S20-57	A	I
	S20-57A	A	P
Putnam/Killingly			
	S20-58/Quinebaug River	B/cold-water	P
	S20-59/Quinebaug River	B/cold-water	P
Putnam			
	S20-59A	A	I
	S20-59B	A	I
	S20-59C	A	I
	S20-60/Culver Brook	A/warm-water	P
	S20-60A	A	P
	S20-60B	A	P
	S20-60C	A	P
	S20-60D	A	I
	S20-60E/Culver Brook	A /cold-water / wild brook trout	P
	S20-61	A	P
	S20-61A/Lippits Brook	A /warm-water	P
	S20-62	A	P
	S20-63/Munson Brook	A/warm-water	P
	S20-64/Fivemile River	A/cold-water	P
Thompson			
	S20-65	A	P
	S20-66/Teft Brook	A	P
	S20-67	A	I
	S20-68	A	I

1. Series No. refers to waterbody numbers designated in the CL&P field reports (Volume 2) and illustrated on the aerial photographs in Volumes 9 and 11.
2: Table 5-2 defines the water classifications as defined by the Connecticut Water Quality Standards. Information was confirmed with Susan Peterson of the CT DEEP on December 7, 2011.
3: Fishery Classifications (for watercourses that support fish resources) were obtained by personnel communication with Neal Hagstrom , Senior Fisheries Biologist at CTDEP. December 10, 2010; June 17, 2011, and December 5, 2011.
4: P = Perennial; I = Intermittent.
* Indicates that an existing culvert occurs along the stream in the vicinity of existing or proposed access roads.

Table 5-5
Delineated Wetlands, Vernal Pools, and Wetlands Supporting Amphibian Habitat: Proposed 345-kV ROWs

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Table 5-5: Delineated Wetlands, Vernal Pools, and Wetlands Supporting Amphibian Breeding Habitat: Proposed Route

Municipality; Vol. 9 / Vol. 11 Mapsheet Nos.	Wetland Series No.[1]	Wetland Classification[2]	Relationship to Proposed 345-kV Lines (Feet traversed / adjacent) [3]	Vernal Pool / Amphibian Breeding Habitat		
				Vernal Pool / Habitat No.	Location along ROWs	Species Observed
Lebanon						
1/1	W20-1	PFO / PSS	200 feet			
1/1	W20-2	PFO / PSS	Adjacent			
1/1-2	W20-3	PSS / PFO	Adjacent			
1/2	W20-4	PSS	666 feet			
Lebanon / Columbia						
1 / 2-3	W20-5*	PSS / PFO	156 feet (state) 303 feet (federal)			
Columbia						
1/3	W20-6	PFO / PSS	Adjacent			
1/3	W20-7	PSS / PFO	Adjacent			
2/4	W20-8	PSS / PFO	208 feet			
2/4-5	W20-9	PSS / PFO	241 feet	CO-1-VP CO-2-VP	North of existing Pole No. 9010; not traversed West of existing Pole No. 9011; not traversed	Wood frog
2/5	W20-10	PFO / PSS	Adjacent			
2/5-6	W20-11	PSS / PFO	248 feet			
2/5-6	W20-12	PSS	Adjacent			
2/6	W20-13	PSS / PFO	430 feet			
2/7	W20-14	PSS	Adjacent			
2/7	W20-15	PSS	113 feet			
2-3/7	W20-16	PSS	Adjacent			
2-3/7	W20-17	PFO / PEM	Adjacent			
3/7-8	W20-18	PSS	59 feet			
3/7-8	W20-19	PSS	Adjacent			
3/7-8	W20-20	PSS	Adjacent			
3/8	W20-21	PFO / PSS	Adjacent			

Table 5-5: Delineated Wetlands, Vernal Pools, and Wetlands Supporting Amphibian Breeding Habitat: Proposed Route

Municipality; Vol. 9 / Vol. 11 Mapsheet Nos.	Wetland Series No.[1]	Wetland Classification[2]	Relationship to Proposed 345-kV Lines (Feet traversed / adjacent) [3]	Vernal Pool / Amphibian Breeding Habitat		
				Vernal Pool / Habitat No.	Location along ROWs	Species Observed
3/8	W20-22	PSS	Adjacent			
3/8	W20-23	PSS / PFO	203 feet			
Columbia / Coventry						
3/8-9	W20-24	PSS / PFO	581 feet			
Coventry						
3/9	W20-25	PFO	Adjacent			
4/10	W20-26	PSS / PFO	63 feet			
4/10-11	W20-27	PEM / PFO	Adjacent	CV-1-VP	East of existing Pole No. 9027; not traversed	Spotted salamander; spring peeper breeding chorus; caddisfly larvae
4/11	W20-28	PFO / PSS	138 feet			
4-5/12	W20-29	PFO	60 feet			
5/12-13	W20-30	PEM / PFO	380 feet	CV-1-ABH	Beneath proposed 345-kV line; north of existing Pole No. 9031	Spotted salamander; spring peeper breeding chorus; isopods; oligochaete worm
5/13-14	W20-31	PEM / PFO	164 feet	CV-2-ABH CV-3-ABH	Beneath proposed 345-kV line; adjacent to existing Pole No. 9034 South of existing Pole No. 9034; not traversed	Gray tree frogs chorusing
Mansfield						
5/13-14	W20-32	PEM	Adjacent			
5/15	W20-33	PFO / PSS	Adjacent			
5-6/15-16	W20-34	PFO	Adjacent			
6/15-16	W20-35	PSS / PFO	Adjacent			
6/16	W20-36	PFO	Adjacent			
6/16-17	W20-37	PFO	Adjacent			
6/16-17	W20-38	PSS / PFO	18 feet			

Table 5-5: Delineated Wetlands, Vernal Pools, and Wetlands Supporting Amphibian Breeding Habitat: Proposed Route

Municipality; Vol. 9 / Vol. 11 Mapsheet Nos.	Wetland Series No.[1]	Wetland Classification[2]	Relationship to Proposed 345-kV Lines (Feet traversed / adjacent) [3]	Vernal Pool / Amphibian Breeding Habitat		
				Vernal Pool / Habitat No.	Location along ROWs	Species Observed
6/16-17	W20-39	PFO / PSS	158 feet			
6/17	W20-39A	PSS / PFO	Adjacent			
6/17	W20-40	PFO	Adjacent			
6/18	W20-41	PFO / PSS	129 feet	MA-1-VP	Beneath existing 345-kV line, east of Pole No. 9043	Wood frog; spotted salamander
6/18	W20-42	PFO / PSS	100 feet			
6/18-19	W20-43	PFO / PSS	531 feet	MA-2-VP MA-3-VP MA-4-VP MA-5-VP MA-6-VP MA-7-VP	Separate pools in proximity of proposed structure No. 46 Separate pools west and north proposed structure No. 47	Wood frog; spotted salamander; green frog Wood frog; spotted salamander; fairy shrimp
6/19-20	W20-44	PFO / PSS	187 feet	MA-8-VP	Beneath existing 345-kV line, east of Pole No. 9048; northern portion traversed by proposed 345-kV line.	Spotted salamander
7/21	W20-45	PFO	Adjacent			
7/21	W20-45A	PEM / PFO	Adjacent			
7/21	W20-46	PFO / PSS	151 feet			
7/22	W20-47	PFO / PSS	10 feet			
7/22	W20-48	PFO / PSS	196 feet			
7/22	W20-49	PEM	Adjacent			
7/22	W20-50	PFO / PSS	186 feet	MA-9-VP	Adjacent to existing and proposed 345-kV line, near existing Pole No. 9055	Wood frog
7/23	W20-51	PSS	Adjacent			
7/23	W20-52	PFO / PSS	13 feet			

Table 5-5: Delineated Wetlands, Vernal Pools, and Wetlands Supporting Amphibian Breeding Habitat: Proposed Route

Municipality; Vol. 9 / Vol. 11 Mapsheet Nos.	Wetland Series No.[1]	Wetland Classification[2]	Relationship to Proposed 345-kV Lines (Feet traversed / adjacent) [3]	Vernal Pool / Amphibian Breeding Habitat		
				Vernal Pool / Habitat No.	Location along ROWs	Species Observed
7/23	W20-53	PFO / PSS	199 feet	MA-10-VP	East of existing Pole No. 9059; beneath proposed 345-kV line	Wood frog; spotted salamander; fairy shrimp
7/24	W20-54	PSS / PFO	Adjacent			
7/24	W20-55	PFO / PSS	326 feet	MA-11-VP	West of existing Pole No. 9063; not traversed	Wood frog
7-8/25	W20-56	PFO / PSS	198 feet	MA-12-VP MA-13-VP MA-14-VP MA-15-VP MA-16-VP	West of existing Pole No. 9065; Beneath and adjacent to existing 345-kV line	Wood frogs; red-backed salamander; green frog; water striders
8/25	W20-57	PFO	24 feet			
8/25-26	W20-58	PFO / PSS	252 feet			
8/26	W20-59	PFO	Adjacent			
8/27	W20-60	PSS	Adjacent			
8/27-28	W20-61	PFO / PSS	94 feet			
8/28-29	W20-62	PEM	8 feet			
8/28	W20-62A	POW	Adjacent			
8/28-29	W20-62B	POW	Adjacent			
8/28-29	W20-62C	POW	Adjacent	MA-1-ABH	South of existing Pole No. 9074	Pickerel frog
9/31	W20-63	PFO / PSS	Adjacent	MA-18-VP MA-19-VP	East of existing Pole No. 9079	Spotted salamander; spring peeper; wood frog; *Ambystoma* spermatophores
9/31	W20-64	PFO / PSS	141 feet	MA-17-VP	East of existing Pole No. 9079	Spotted salamander; spring peeper
9/33	W20-65**	PUB / PFO	Adjacent			
9/34	W20-66**	PUB / PFO	578 feet including (Mansfield Hollow Lake)			
10/36	W20-67	PFO	Adjacent			

Table 5-5: Delineated Wetlands, Vernal Pools, and Wetlands Supporting Amphibian Breeding Habitat: Proposed Route

Municipality; Vol. 9 / Vol. 11 Mapsheet Nos.	Wetland Series No.[1]	Wetland Classification[2]	Relationship to Proposed 345-kV Lines (Feet traversed / adjacent) [3]	Vernal Pool / Amphibian Breeding Habitat		
				Vernal Pool / Habitat No.	Location along ROWs	Species Observed
Mansfield / Chaplin						
10/36	W20-68	PEM / PFO / PSS	28 feet	MA-2/CH-1-ABH	Beneath existing 345-kV line; east of existing Pole No. 9090	Wood frog; spring peeper
Chaplin						
10/37	W20-68	PEM / PFO / PSS	Adjacent			
10/37	W20-69	PFO / PSS	9 feet			
10/38	W20-70**	PFO / PSS	79 feet	CH-1-VP CH-3-VP	East of existing Pole No. 9094; traversed by proposed 345-kV line North of proposed structure No. 96	Spotted salamander; spring peeper; caddisfly larvae; Wood frog; stonefly larvae; green frog
10/38	W20-71**	PSS	Adjacent			
10/38	W20-72/73**	PSS / PFO	294 feet including Natchaug River	CH-2-VP	Beneath existing 345-kV line	Spotted salamander; wood frog; fairy shrimp
10-11/39	W20-74**	PFO	Adjacent			
11/39	W20-75**	PSS / PFO	Adjacent			
11/39-40	W20-76**	PFO / PSS	872 feet			
11/40	W20-77	POW / PSS / PFO	354 feet	CH-2-ABH	Beneath existing and proposed 345-kV lines	Green frog; painted turtle; damselfly nymphs
11/40	W20-78	PFO	Off ROW	CH-4-VP	Off ROW	Wood frog; spotted salamander; painted turtle; damselfly nymphs
11/40	W20-79	PFO	Off ROW	CH-5-VP	Off ROW	Wood frog; spotted salamander; fingernail clams; aquatic snails; caddisfly larvae; isopods; green frog
11/40	W20-80	PFO / PSS	57 feet			

Table 5-5: Delineated Wetlands, Vernal Pools, and Wetlands Supporting Amphibian Breeding Habitat: Proposed Route

Municipality; Vol. 9 / Vol. 11 Mapsheet Nos.	Wetland Series No.[1]	Wetland Classification[2]	Relationship to Proposed 345-kV Lines (Feet traversed / adjacent) [3]	Vernal Pool / Amphibian Breeding Habitat		
				Vernal Pool / Habitat No.	Location along ROWs	Species Observed
11/41	W20-81	PFO / PSS	513 feet	CH-3-ABH CH-6-VP CH-7-VP CH-8-VP	East of proposed structure No. 103; Beneath existing and proposed 345-kV lines	Wood frog; spotted salamander; American toad; caddisfly larvae
11/41	W20-82	PSS	Adjacent			
11-12/41-42	W20-83	PSS / PFO	22 feet	CH-9-VP	South of existing 345-kV line	Wood frog
11-12/42	W20-84	PSS / PFO	225 feet	CH-10-VP CH-11-VP CH-12-VP	South of existing 345-kV line, along southern boundary of ROW; CH-12-VP Off ROW	Wood frog, spotted salamander; green frog adults; red-back salamander
11-12/43	W20-85	POW / PFO / PSS	446 feet			
12/44	W20-86	PUB / PEM / PFO	578 feet	CH-4-ABH	Beneath existing and proposed 345-kV lines	Spring peeper; gray tree frog
12/44-45	W20-87	PFO / PSS	84 feet	CH-13-VP	Beneath and south of proposed 345-kV line	Spotted salamander; green frog; ribbon snake
12-13/46	W20-88	PFO / PSS	49 feet	CH-5-ABH	Beneath existing 345-kV line	Wood frog; spotted salamander; green frog
13/46-47	W20-89	PFO /PSS / POW	16 feet	CH-14-VP CH-6-ABH	South of proposed 345-kV line and access road; CH-6-ABH beneath existing 345-kV line	Wood frog; spotted salamander; bull frog; red-spotted newt; caddisfly larvae; leech; whirley gigs
13/48	W20-90	PFO	4 feet			
13/47-48	W20-91	POW / PSS	986 feet	CH-7-ABH	Beneath existing and proposed 345-kV lines	Spotted salamander; red-spotted newt; gray tree frog; whirley gigs; northern water snake
Chaplin / Hampton						
13/48-49	W20-92	PFO / PSS	64 feet			

Table 5-5: Delineated Wetlands, Vernal Pools, and Wetlands Supporting Amphibian Breeding Habitat: Proposed Route

Municipality; Vol. 9 / Vol. 11 Mapsheet Nos.	Wetland Series No.[1]	Wetland Classification[2]	Relationship to Proposed 345-kV Lines (Feet traversed / adjacent) [3]	Vernal Pool / Amphibian Breeding Habitat		
				Vernal Pool / Habitat No.	Location along ROWs	Species Observed
Hampton						
13/49	W20-93	PSS	Adjacent			
13-14/50	W20-94	PFO / PSS	49 feet	HA-1-VP	North of and adjacent to proposed 345-kV line	Spotted salamander; caddisfly
14/50-51	W20-95	PFO / PSS	114 feet			
14/50	W20-95A	PFO	Adjacent			
14//51	W20-96	PSS	Adjacent			
14/51	W20-97	PFO / PSS	Adjacent			
14/52-53	W20-98	PFO / PSS	495 feet	HA-2-VP	Along southern ROW boundary, south of access road	Wood frog; spotted salamander; caddisfly larvae
14/53	W20-99	PFO / PEM	Adjacent			
14-15/53-54	W20-100	PFO / PSS	1,031 feet	HA-3-VP HA-1-ABH HA-2-ABH HA-4-VP	Adjacent to / north of proposed 345-kV line west of proposed Pole No. 135 Beneath existing 345-kV line South of existing 345-kV line	Spotted salamander; spotted turtle; green frog; gray tree frog; caddisfly larvae; pickerel frog spotted salamander; whirley gigs; green frog; water striders spotted salamander; green frog; ribbon snake ; American toad
14-15/54	W20-101	PFO	Adjacent	HA-5-VP	Along southern ROW boundary, south of access road	Wood frog; spotted salamander; green frog
15/-55	W20-102	PFO / PSS	53 feet			
15/55-56	W20-103	PFO / PSS	293 feet			
15/55-56	W20-104	PFO / PSS	322 feet			
15/56	W20-105	PEM	Adjacent			

Table 5-5: Delineated Wetlands, Vernal Pools, and Wetlands Supporting Amphibian Breeding Habitat: Proposed Route

Municipality; Vol. 9 / Vol. 11 Mapsheet Nos.	Wetland Series No.[1]	Wetland Classification[2]	Relationship to Proposed 345-kV Lines (Feet traversed / adjacent) [3]	Vernal Pool / Amphibian Breeding Habitat		
				Vernal Pool / Habitat No.	Location along ROWs	Species Observed
15/56	W20-106	PFO	209 feet			
15/56-57	W20-107	PEM / PFO	Adjacent			
15/56-57	W20-108	PSS / PFO	418 feet			
15/57	W20-109	PSS / PFO	102 feet			
15-16/58	W20-110	PSS / PFO	263 feet			
16/58	W20-111	PSS	Adjacent	HA-6-VP	Beneath and south of existing 345-kV line	Spotted salamander; wood frog; fairy shrimp; green frog; caddisfly larvae
16/58-59	W20-112	PSS	Adjacent	HA-3-ABH	Beneath and north of existing 345-kV line	Spotted salamander; wood frog; green frog
16/59	W20-112A	PFO	Off ROW	HA-9-VP	Off ROW	Fairy shrimp; green frog
16/59	W20-113	PFO	4 feet	HA-7-VP	Beneath and north of proposed 345-kV line	Spotted salamander; fairy shrimp; green frog; caddisfly larvae
16/59	W20-114	PFO	27 feet	HA-8-VP	North of proposed 345-kV line	Spotted salamander; green frog; red-backed salamander
16/59	W20-115	PFO / PSS	59 feet			
16/59-60	W20-116	PFO / PSS	414 feet	HA-4-ABH	North of proposed structure No. 149	Spotted salamander
16/60-61	W20-117	PSS / PFO / PEM	683 feet	HA-5-ABH	Beneath and south of proposed 345-kV line	Spotted salamander
16-17/61	W20-118	PFO / PSS	377 feet	HA-10-VP HA-11-VP HA-12-VP	Adjacent to Drain Street, beneath and north of existing 345-kV line	Spotted salamander; wood frog; American toad; pickerel frog
17/62	W20-119	PSS	Adjacent			
17/63	W20-121	PSS	Adjacent	HA-13-VP	South of existing 345-kV line	Spotted salamander; wood frog; amphipods

Table 5-5: Delineated Wetlands, Vernal Pools, and Wetlands Supporting Amphibian Breeding Habitat: Proposed Route

Municipality; Vol. 9 / Vol. 11 Mapsheet Nos.	Wetland Series No.[1]	Wetland Classification[2]	Relationship to Proposed 345-kV Lines (Feet traversed / adjacent)[3]	Vernal Pool / Amphibian Breeding Habitat		
				Vernal Pool / Habitat No.	Location along ROWs	Species Observed
Hampton / Brooklyn 17/63-64	W20-120	PFO / PSS	857 feet	HA-6/BR-1-ABH	Along proposed and existing 345-kV lines	Spotted salamander; wood frog; green frog; gray tree frog
Brooklyn						
17-18/64-65	W20-122	PFO / PSS / PEM	831 feet	BR-2-ABH BR-3-ABH	Southern boundary of ROW, south of existing 345-kV line Along and beneath existing and proposed 345-kV lines	Wood frog; spring peeper breeding chorus; gray tree frog Spotted salamander; whirley gigs; green frog; bull frog; leeches
18/65-66	W20-123	PFO / PSS	103 feet	BR-1-VP	North of proposed Pole No. 166	Wood frog; spotted salamander; amphipods; isopods; spring peepers
18/66	W20-124	PFO / PSS	Adjacent			
18/66	W20-125	PSS / PFO	135 feet	BR-2-VP BR-3-VP	Southern edge of ROW, south of existing 345-kV line Beneath and north of proposed 345-kV line	Wood frog; green frog Spotted salamander; wood frog; American toad
18/68	W20-126	PFO	Adjacent			
18/68	W20-127	PSS / PFO	78 feet	BR-4-VP	Adjacent and south of proposed 345-kV line	Marbled salamander; wood frog; green frog; caddisfly larvae
18-19/68	W20-128	PFO	Adjacent			
18-19/69	W20-129	PSS / PFO	Adjacent	BR-5-VP	Beneath and north of existing 345-kV line	Spotted salamander; wood frog

Table 5-5: Delineated Wetlands, Vernal Pools, and Wetlands Supporting Amphibian Breeding Habitat: Proposed Route

Municipality; Vol. 9 / Vol. 11 Mapsheet Nos.	Wetland Series No.[1]	Wetland Classification[2]	Relationship to Proposed 345-kV Lines (Feet traversed / adjacent) [3]	Vernal Pool / Amphibian Breeding Habitat		
				Vernal Pool / Habitat No.	Location along ROWs	Species Observed
19/70	W20-130	PFO / PSS	403 feet	BR-6-VP BR-7-VP	Beneath and north of proposed 345-kV line Beneath and south of existing 345-kV line	Wood frog; spotted salamander; spring peeper breeding chorus Spotted salamander; wood frog; green frog
19/71	W20-131	PFO	8 feet			
19/71	W20-132	PFO	85 feet			
19/71	W20-133	PEM / PFO	84 feet			
19/71	W20-134	PSS	Adjacent			
19/71	W20-135	PFO	Off ROW			
19/72	W20-136	PFO	Adjacent			
19/72-73	W20-137	PFO / PSS	233 feet	BR-8-VP BR-9-VP BR-10-VP	North of proposed 345-kV line Beneath existing 345-kV line Southern edge of ROW	Wood frog Wood frog; spotted salamander' Fairy shrimp
19-20/72-73	W20-138	PFO / PSS	200 feet	BR-11-VP	Beneath existing and proposed 345-kV lines	Wood frog; spotted salamander; wood frog; spring peeper; spotted turtle; caddisfly larvae; dragonfly nymph
19-20/73	W20-139	PFO / PSS	172 feet	BR-4-ABH BR-12-VP	Beneath proposed 345-kV line Northern edge of ROW, north of proposed 345-kV line	Spotted salamander; caddisfly larvae Wood frog; aquatic beetles

Table 5-5: Delineated Wetlands, Vernal Pools, and Wetlands Supporting Amphibian Breeding Habitat: Proposed Route

Municipality; Vol. 9 / Vol. 11 Mapsheet Nos.	Wetland Series No.[1]	Wetland Classification[2]	Relationship to Proposed 345-kV Lines (Feet traversed / adjacent) [3]	Vernal Pool / Amphibian Breeding Habitat		
				Vernal Pool / Habitat No.	Location along ROWs	Species Observed
20/74	W20-140	PFO / PSS	138 feet	BR-13-VP BR-14-VP	North of proposed structure No. 186 Beneath and south of proposed 345-kV lines	Spotted salamander; marbled salamander; spring peeper Wood frog; spotted salamander; fairy shrimp
20/74	W20-141	PFO	Off ROW			
20/74	W20-142	PFO	54 feet			
20/74	W20-143	PSS / PFO	111 feet	BR-15-VP	Beneath existing and proposed 345-kV lines	Spotted salamander; wood frog
20/74	W20-144	PFO / POW	Adjacent			
20/75	W20-145	PFO	19 feet			
20/75	W20-146	PFO	Off ROW			
20/75	W20-147	PFO / POW	Adjacent			
20/75-76	W20-148	PUB / PEM / PFO / PSS	188 feet			
20/76	W20-149	PFO / PSS	Adjacent	BR-16-VP	Southern boundary of ROW, south of existing 345-kV line	Spotted salamander; caddisfly larvae; leeches
21/77	W20-150	PFO / PSS	403 feet			
21-22/79-80	W20-151	PEM / PUB / PFO	211 feet			
22/80	W20-152	PSS	Adjacent			
22-23/80-82	W20-153	PEM / PUB / PSS / PFO	1,602 feet	BR-5-ABH	Beneath existing and proposed 345-kV lines	Spotted salamander
23/82-83	W20-154	PFO / PSS	1,130 feet	BR-17-VP	Beneath proposed 345-kV line	Spotted salamander
23/83-84	W20-154A	PSS / PFO	Adjacent			
23/84	W20-155	PEM	26 feet			

Table 5-5: Delineated Wetlands, Vernal Pools, and Wetlands Supporting Amphibian Breeding Habitat: Proposed Route

Municipality; Vol. 9 / Vol. 11 Mapsheet Nos.	Wetland Series No.[1]	Wetland Classification[2]	Relationship to Proposed 345-kV Lines (Feet traversed / adjacent) [3]	Vernal Pool / Amphibian Breeding Habitat		
				Vernal Pool / Habitat No.	Location along ROWs	Species Observed
23/84	W20-156	PSS	Adjacent			
23-24/84-86	W20-157	PEM / PSS / PFO	1,406 feet	BR-18-VP	South of access road, adjacent to existing 345-kV line	Spotted salamander
24/86	W20-158	PSS / PUB / PFO	272 feet	BR-19-VP	Beneath existing and proposed 345-kV lines	Spotted salamander; amphibious snails; caddisfly larvae
24/86-87	W20-159	PSS / PFO / POW	Adjacent			
24/88	W20-159A	PEM / PFO	17 feet			
24/89-89A	W20-160 / W20-160A	PSS / PFO	88 feet / Off ROW	BR-6-ABH	Off ROW	Spotted salamander; green frog; aquatic beetle
	W20-160B	PFO	Off ROW			
Pomfret						
27/94	W20-161	PFO	Off ROW	PO-1-VP	Off ROW	Spotted salamander; wood frog; fairy shrimp; amphibious snail
26/93	W20-161A	PFO	Adjacent			
27/95-96	W20-162*	PSS / PFO / POW	684 (federal) 196 (state)	PO-1-ABH	Beneath existing and proposed 345-kV lines	Spotted salamander; green frog; amphibious snail; caddisfly larvae; dragonfly nymphs
27-28/96-97	W20-163	PSS / PEM / PFO / POW	89 feet			
Killingly						
27-28/96-97	W20-164*	PSS / PEM / PFO / POW	542 feet			
28/97	W20-165	PSS / PFO	57 feet			
28/97	W20-166	PSS	Adjacent			
28/98	W20-167	PFO	Off ROW			
28/99	W20-168	PSS / PFO	90 feet	KI-1-VP	Beneath and along existing 345-kV line	Wood frog; spotted salamander

Table 5-5: Delineated Wetlands, Vernal Pools, and Wetlands Supporting Amphibian Breeding Habitat: Proposed Route

Municipality; Vol. 9 / Vol. 11 Mapsheet Nos.	Wetland Series No.[1]	Wetland Classification[2]	Relationship to Proposed 345-kV Lines (Feet traversed / adjacent) [3]	Vernal Pool / Amphibian Breeding Habitat		
				Vernal Pool / Habitat No.	Location along ROWs	Species Observed
28-29/99-100	W20-169	PSS / PFO	345 feet	KI-1-ABH	Beneath existing and proposed 345-kV lines	Spotted salamander; ribbon snake
29/100-101	W20-170	PFO / PEM	Adjacent			
29/100	W20-170A	PSS / PFO	Adjacent			
29/101-102	W20-171	PSS / PFO	43 feet			
29/101	W20-171A	PSS	Adjacent			
Putnam						
30/102-103	W20-172*	PSS / PFO	321 feet including Quinebaug River	PU-1-VP	Beneath existing transmission line, west of proposed 345-kV line	Spotted salamander; amphibious snail; caddisfly larvae
30/103	W20-173	PSS	Off ROW			
30/103	W20-174	PSS / PFO	Adjacent	PU-2-VP	Northwest of existing transmission line and proposed 345-kV line	Fairy shrimp; spring peeper; caddisfly larvae
30/103-104	W20-175	PSS / POW	Adjacent	PU-3-VP	Beneath existing 345-kV line	Wood frog; fairy shrimp; spotted turtle; amphibious snail; spring peepers; caddisfly larvae; dragonfly nymph
30/104	W20-176	PSS / POW	Adjacent	PU-4-VP	Beneath existing 345-kV line	Spotted salamander; fairy shrimp; spring peeper; caddisfly larvae
Killingly						
30-31/105	W20-177	PSS / PFO	Adjacent	KI-2-VP	Beneath existing transmission line; south of proposed 345-kV line	Spotted salamander; fairy shrimp; spring peeper; caddisfly larvae
30-31/105-106	W20-178*	PSS / PFO	91 feet (federal) 824 (state)	KI-3-VP	Extends across northern portion of ROW, beneath existing and proposed lines	Spotted salamander; fairy shrimp; spotted turtle; caddisfly larvae; isopods; amphipods

Table 5-5: Delineated Wetlands, Vernal Pools, and Wetlands Supporting Amphibian Breeding Habitat: Proposed Route

Municipality; Vol. 9 / Vol. 11 Mapsheet Nos.	Wetland Series No.[1]	Wetland Classification[2]	Relationship to Proposed 345-kV Lines (Feet traversed / adjacent) [3]	Vernal Pool / Amphibian Breeding Habitat		
				Vernal Pool / Habitat No.	Location along ROWs	Species Observed
Putnam						
31-32/110	W20-179	PSS	Adjacent			
31-32/110	W20-180	PFO / PSS	20 feet			
32/110	W20-181	PSS	Adjacent			
32/111	W20-181A	PSS / PEM	Adjacent			
32/110	W20-181B	PFO	Adjacent			
32/112	W20-182	PSS / PFO	Adjacent			
32/111-112	W20-182A	PSS / PEM	Adjacent			
32-33/112	W20-183	PFO / PSS	8 feet			
33/113	W20-184	PSS / PEM / PFO	220 feet			
34/115	W20-185	PSS	Adjacent			
34/116	W20-186	PFO / PSS	Adjacent			
34-35/116-117	W20-187	PFO / PSS / PUB	361 feet	PU-5-VP	South of proposed 345-kV line; east of existing Pole No. 9287	Wood frog
35/117-118	W20-188	PFO / PSS	870 feet	PU-1-ABH PU-6-VP	Beneath and south of proposed 345-kV line, east of existing Pole No. 9290 North of proposed 345-kV line	Wood frog; spotted salamander; American toad; green frog Wood frog; isopods; mosquito larvae
35/118	W20-189	PFO / PEM	Adjacent			
35/119	W20-190	PSS / PFO	Adjacent	PU-2-ABH	Beneath and south of existing 345-kV line	Green frog; spring peeper

Table 5-5: Delineated Wetlands, Vernal Pools, and Wetlands Supporting Amphibian Breeding Habitat: Proposed Route

Municipality; Vol. 9 / Vol. 11 Mapsheet Nos.	Wetland Series No.[1]	Wetland Classification[2]	Relationship to Proposed 345-kV Lines (Feet traversed / adjacent) [3]	Vernal Pool / Amphibian Breeding Habitat		
				Vernal Pool / Habitat No.	Location along ROWs	Species Observed
35-36/119-120	W20-191	PFO / PSS / PEM	985 feet	PU-3-ABH PU-7-VP	Beneath existing and proposed 345-kV lines Beneath and south of existing 345-kV line	Green frog; spring peeper; painted turtle; caddisfly larvae Wood frog; spotted salamander; fairy shrimp; caddisfly larvae
35-36/120	W20-192	PFO / POW	4 feet	PU-8-VP	Adjacent to and north of proposed 345-kV line	Wood frog; spotted salamander; fairy shrimp; caddisfly larvae
36/121	W20-193	PFO / PSS	241 feet			
36/121-122	W20-194	PSS / PFO	79 feet	PU-9-VP	Beneath existing 345-kV line; west of existing Pole No. 9300	Spotted salamander; fingernail clams; red-spotted newt; snapping turtle; dragonfly nymph
36-37/122-123	W20-195	PFO / PSS	947 feet	PU-10-VP PU-11-VP	Extends across and along ROW beneath existing and proposed 345-kV lines East of existing Pole No. 9303	Wood frog; spotted salamander; predacious diving beetle larvae; dragonfly nymphs; leeches Wood frog; spotted salamander
36-37/123-124	W20-196	PSS	Adjacent	PU-12-VP	Southern boundary of ROW	Spotted salamander; spring peeper; hellgrammite; isopods; mosquito larvae
37/124-125	W20-197	PFO / PSS / PEM	1,125 feet	PU-13-VP PU-14-VP	Beneath proposed 345-kV line; east of U.S. Route 44	Spotted salamander; spring peeper; caddisfly larvae
37-38/126	W20-198	PUB / PEM / PFO / PSS	232 feet	PU-4-ABH	Beneath existing and proposed 345-kV lines	Spotted salamander; backswimmers; spring peeper

Table 5-5: Delineated Wetlands, Vernal Pools, and Wetlands Supporting Amphibian Breeding Habitat: Proposed Route

Municipality; Vol. 9 / Vol. 11 Mapsheet Nos.	Wetland Series No.[1]	Wetland Classification[2]	Relationship to Proposed 345-kV Lines (Feet traversed / adjacent) [3]	Vernal Pool / Amphibian Breeding Habitat		
				Vernal Pool / Habitat No.	Location along ROWs	Species Observed
37-38/126	W20-199	PFO / PSS	82 feet	PU-15-VP	Across ROW beneath existing and proposed 345-kV lines	Wood frog; spotted salamander; adult predacious diving beetles; caddisfly larvae; mosquito larvae
37-38/126-127	W20-200 / W20-201	PFO / PSS / POW	515 feet			
Thompson						
38/127	W20-202	PSS	Adjacent			
38/127-129	W20-203	PEM	1,065 feet	TH-1-ABH	Across ROW beneath existing and proposed 345-kV lines	Spotted salamander; spring peeper; predacious diving beetle larvae; amphibious snails; dragonfly nymph; damselfly nymph; leeches
38-39/129-130	W20-204	PSS / PFO	41 feet			
38-39/129-130	W20-205	PFO	Adjacent			
38-39/130	W20-206	PSS / PFO	3 feet			
38-39/130-131	W20-207	PFO / PSS	87 feet	TH-1-VP	Beneath existing 345-kV line, south of access road	Spotted salamander; caddisfly larvae; isopods
39/132	W20-208	PFO	Adjacent			
39/132	W20-209	PEM	Adjacent			
39/132	W20-210	PFO	Adjacent			
40/134	W20-211	PFO / PSS	73 feet			

NOTES:

[1] Series No. refers to wetland number designated in the field report (Volume 2) and illustrated on the aerial photographs in Volumes 9 and 11.

[2] Wetlands classification according to Cowardin et al 1979; PEM = Palustrine Emergent Wetland; PFO = Palustrine Forested Wetland; PSS = Palustrine Scrub-Shrub Wetland; POW = Palustrine Open Water; PUB = Palustrine Unconsolidated Bottom.

[3] "Feet traversed" refers to linear distance crossed by center of proposed 345-kV transmission lines, as depicted on the Volume 11 maps. "Adjacent" refers to a wetland that is within the CL&P ROW (easement), but is not directly traversed by the proposed center of the new 345-kV line. "Off ROW" refers to wetlands that are not within CL&P's easement or are otherwise outside of the anticipated construction work area (such as on CL&P-owned property, but not part of the proposed Project construction footprint).

* Portions of these wetlands do not meet the three-parameter criteria for federal jurisdictional wetlands, and are solely state jurisdictional. These state jurisdictional wetlands are illustrated on the aerial photographs in Volumes 9 and 11.

** Indicates wetlands within federally-owned lands in the towns of Mansfield and Chaplin where CL&P proposes to acquire additional easements to expand the existing 150-foot-wide ROW.

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Table 5-15
Summary of Potential Scenic Areas Traversed
by or in the Vicinity of the Proposed Route
with Views of the Existing CL&P Transmission Lines

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Table 5-15: Summary of Potential Scenic Sites Crossed by or in the Vicinity of the Proposed Route with Views of the Existing CL&P Transmission Lines

Town / Scenic Feature	Volume 9 Map Sheet No. / Relation to ROW	Feature Information	Summary Results of Field Review
Lebanon			
Airline State Park Trail (Southern Section)	1 Crosses	The Airline State Park Trail is a national recreational trail that is being developed along an abandoned railroad ROW. The trail provides hiking, biking and horseback riding opportunities.	The Airline State Park Trail is well marked and is easily accessible via both Kingsley Road and Village Hill Road. Adjacent land uses consist principally of forest land, with some residences and open fields near the roads, and visible from the trail. At the ROW crossing, the trail is slightly below grade and traverses a wet area. Shrubby deciduous vegetation borders both sides of the trail at the ROW crossing. The existing transmission line conductors span the trail: an H-frame structure is located immediately to the northeast of the trail and is visible from it. The transmission line conductors and structures are visible only in the immediate vicinity of the trail. This is due to the dense deciduous forested vegetation that borders either side of the trail leading to the ROW, and also because the trail crosses the ROW at a bend. In this area, the trail is relatively wide and well-maintained, with a gravel and sand base. There was evidence of use by hikers, horseback riders, and bikers.
Coventry			
Hop River	3 Crosses	The Hop River extends through and is bordered by the Hop River State Park Trail (see below). In the vicinity of the Proposed Route, the river forms the town boundary between Columbia and Coventry.	The ROW spans the river between State Route 66 in the Town of Columbia and U.S. Route 6 in the Town of Coventry. In this area, the Hop River State Park Trail is aligned north of and upslope of the river. Outside of the managed ROW, lands adjacent to the river consist of undeveloped deciduous forest, which can be expected to screen long views of the transmission line structures and ROW. From the river at the ROW crossing, the predominant views are to the north, where conductor spans, the transmission line structures, and managed ROW are visible. Long views to the south are screened by topography and vegetation.
Hop River State Park Trail	3 Crosses just north of Hop River	The Hop River State Park Trail, which is on an old railroad bed, connects the state's Charter Oak and Air Line trails and is approximately 15 miles long, extending from the Town of Bolton to the Willimantic River in the Town of Windham. The trail is a designated Connecticut Greenway and is used by hikers, bikers, and equestrians. Along the 5.4-mile section of the trail in Columbia and Coventry, the trail meanders adjacent to the Hop River.	The ROW traverses the trail perpendicularly, directly north of the Hop River. Except at the ROW crossing and in the immediate vicinity, views of the transmission lines are limited by both vegetation and topography. On either side of the ROW, the trail is bordered principally by deciduous forest lands. In addition, both to the west and the east of the ROW, bends in the trail preclude long views. Where the ROW crosses the trail, the principal viewpoint is to the south, where the dominant views are of the Hop River (foreground views) and the transmission line structures, extending beyond the river and State Route 66 (long views).
Flanders River Road Town Open Space	5 Crosses, both sides of Flanders Road	The municipal open space extends along both sides of Flanders Road, with the eastern boundary abutting the Willimantic River (which forms town boundary with Mansfield).	The ROW extends across the open space property on both sides of Flanders Road. The property is undeveloped and consists of a mix of deciduous forest, shrubland, and open fields. Portions of the property on the southwest side of Flanders Road appear to have been previously used for parking, sand/gravel pile storage, etc. There are no signs indicating the property is town open space and no designated trails or other recreational areas. Land uses along Flanders Road generally include scattered rural residential development and agricultural and forest land. The transmission line structures and ROW are prominent at and in the vicinity of the road crossing. At the crossing, there are long views of the ROW extending down a slope to the southwest. At other locations along Flanders Road, views of the ROW are blocked by topography and vegetation.
Mansfield			
Joshua's Tract	5 800 feet to south	This parcel is identified on Mapsheet 5, but is not recorded in the *Joshua's Tract Walk Book*. The ROW is located to the north/northwest of the parcel.	This parcel is located on the west side of Thornbush Road, adjacent to the Willimantic River. Thornbush Road, which is bordered by scattered mobile homes and small houses, dead ends about 500 feet to the north of the land trust parcel. The land trust parcel does not include any trails and is apparent only due to small signs on some of the trees identifying the area as a wildlife preserve. The parcel itself is characterized by relatively dense deciduous forest vegetation. Under leaf off conditions, the transmission line conductors are visible to the northwest from certain locations on the parcel. However, these views are not a predominant part of the visual environment, which is oriented instead on the river and on the wooded areas of the parcel. In addition, there are no designated trails on the parcel.
Highland Road Town Open Space	6 Crosses and to the north	This town open space extends along and north of the ROW in the vicinity of several newer residential areas, including Stone Ridge Lane, Highland Road, Stearns Road, and Woodmount Drive. The parcel abuts an area of CL&P-owned land to the east, along the ROW.	This open space does not include any designated trails, and no markers indicating the designation of the property were evident. With the exception of the shrub type vegetation along the ROW, the parcel is characterized by mature deciduous forest vegetation. Several wetlands are located along the ROW within this open space, and a small stream, within a ravine meanders toward the ROW within the portion of the open space that is situated to the east of Woodmount Drive. The ROW and transmission line structures are evident from the open space parcel (and nearby homes) along Stone Ridge Lane (which back up to the ROW), as well as at the ROW crossing of Highland Drive. However, due to topography and vegetation (mostly forested), these views are limited to the immediate vicinity of the ROW. The transmission line structures are not evident from the open space areas adjacent to the cul-de-sac along Woodmount Drive, but would be visible to those hiking south (to the ROW) within this parcel. (However, there are no designated hiking trails in this area.)

Table 5-15: Summary of Potential Scenic Sites Crossed by or in the Vicinity of the Proposed Route with Views of the Existing CL&P Transmission Lines

Town / Scenic Feature	Volume 9 Map Sheet No. / Relation to ROW	Feature Information	Summary Results of Field Review
Nipmuck Trail (CFPA): West Branch	7 Crosses west of Sawmill Brook	The Nipmuck Trail is a CFPA blue-blazed hiking trail that extends across the ROW and north through the Wolf Rock Nature Preserve (owned by Joshua's Tract Conservation and Historic Trust). The existing transmission line crossing is mentioned in CFPA's *Walk Book East (*p. 148).	The trail extends perpendicularly across the ROW, just west of Sawmill Brook. The trail extends through hilly topography and dense deciduous forest vegetation on either side of the ROW. As a result, views of the ROW and existing transmission line are limited except in the areas immediately across and adjacent to the ROW. At the trail crossing, the ROW extends up hills both to the west and, after spanning Sawmill Brook, to the east. As a result, long views of the ROW and structures on the ROW also are limited.
Mansfield Hollow Dam	9 Approximately 4000 feet south of ROW	Dam and levee system.	The transmission line structures extend across the levee system, south of Bassetts Bridge Road, and are visible from both the levee and from the top of the Mansfield Hollow Dam. From the top of Mansfield Hollow Dam, the ROW also is visible as it extends down the wooded slope west of Storrs Road (State Route 195). The areas in the immediate vicinity of the levee are maintained in grassy vegetation, making the existing transmission line structures visible from various locations on the levee, from Bassetts Bridge Road, and from trails. The Mansfield Hollow Dam area and levee system appears to be well utilized for outdoor recreational purposes, including hiking and biking.
Mansfield Hollow State Park	9 Crosses for 0.5 miles	The park is multi-seasonal recreational area, with fishing, hunting, hiking, biking, boating, ice boating, x-country skiing, dog training, and picnicking.	The transmission line structures and ROW are visible from Bassetts Bridge Road, the levee, the Red Trail, and Mansfield Hollow Lake. However, long views of the structures and ROW generally are precluded by bends in the transmission line ROW, topography, and dense forested vegetation (consisting of a mix of coniferous and deciduous trees) that borders the ROW. At the Bassetts Bridge Road crossing of Mansfield Hollow Lake, some of the existing transmission line structures are noticeable above the treetops in views to the south across the lake.
Mansfield Hollow State Park Red Trail	9 Crosses and extends along ROW for short distance	The trail crosses and also extends for a short distance along the transmission line ROW. (See map of trail p. 81 *Joshua's Tract Walk Book* and also on CTDEP state park and WMA map).	
Mansfield WMA[51] / Nipmuck Trail (East Branch)	9/10 Crosses WMA 0.4 miles Crosses trail adjacent to east side of lake	Through the WMA, this trail section extends from the North Windham Road CTDEP parking area trailhead to the Basset Bridge parking lot in the park. Along this segment, there are three CFPA-identified vistas, all extending west across the lake.	In this area, the trail extends primarily through dense forest vegetation (consisting of a mix of coniferous and deciduous species). Although the trail parallels Mansfield Hollow Lake, in most areas, it does not directly border the lake. The trail crosses perpendicularly across the existing transmission line ROW.
Chaplin / Hampton			
Airline State Park Trail (Northern Section); Portion in Chaplin extends through parcel of Natchaug State Forest	12/13 Crosses in Hampton Parallels in Chaplin	Trail parallels ROW on the south for about 1.9 miles, including crossing a portion of the Natchaug State Forest, before traversing the ROW north of Parker Road (just south of US Route 6) in Hampton.	In general, portions of this section of thetrail appear less well maintained than the western portion (i.e.,Southern Section of the trail near Lebanon). However, the trail was well marked. The ROW crossing is not visible from Parker Road, due to topography, vegetation, and a curve in the trail. In this area, the trail extends through a rock cut and is below grade. Groundwater seeping out of the rock layers has made this section of the trail very boggy. At the ROW crossing, an H-frame structure is visible to the west, as are the conductors. However, views of the transmission line are limited by the curve of the trail (when approaching from either side of the ROW crossing) and – at the crossing – are limited because the trail is in a deep cut. There are no long views of the ROW from the trail.
Brooklyn			
Municipal Open Space	20 Crosses	The ROW extends across a portion of this designated open space for approximately 800 feet, southwest of and adjacent to Wolf Den Road. In this area, lands adjacent to Wolf Den Road consist of undeveloped forest.	This undeveloped open space property consists predominantly of deciduous forested areas, intermixed with some open field, shrubland, and wetlands. The ROW / transmission lines are visible at and in the vicinity of the Wolf Den Road crossing, particularly across the open space parcel, where the maintained open field/shrub vegetation on the ROW allows views of lands to the south and west that are otherwise blocked by the forested vegetation and topography on the rest of the open space parcel.
State Route 169 National Scenic Byway	21/22 Crosses	State Route 169 (Pomfret Road) is a National Scenic Byway. The National Scenic Byways Program is part of the U.S. Department of Transportation, Federal Highway Administration. Under the program, the U.S. Secretary of Transportation recognizes certain roads as National Scenic Byways or All-American Roads based on their archaeological, cultural, historic, natural, recreational, and scenic qualities.	State Route 169 is bordered by various historic structures and settings, including a mix of agricultural / open space lands and forested areas bordered by stone walls. The ROW crosses State Route 169 approximately 0.5 miles north of the northern boundary of the designated Brooklyn Green Historic District. The ROW also is directly south of the Herrick Road "T" intersection with State Route 169. The ROW traverses State Route 169 at an angle, extending through sloped deciduous forested areas to the southwest of the crossing and through flatter terrain in open field and wetlands to the northeast. A low, historic-appearing stone wall extends across the ROW bordering the northeast side of the road. For travelers along State Route 169, the ROW is most visible at the road crossing; terrain and forested vegetation otherwise limit long-distance views. In addition, as a result of the open fields, stone wall, and wetlands, the principal view along the ROW is to the northeast. Views of the ROW (to the northeast) also are evident from the Herrick Road intersection.

[51] The Proposed Route crosses another portion of the WMA, including the Natchaug River, in the Town of Chaplin. However, there are no public trails, other designated public access points, or scenic areas in this area. As a result, this portion of the WMA was not identified as "visual site" and no field investigations were conducted.

Table 5-15: Summary of Potential Scenic Sites Crossed by or in the Vicinity of the Proposed Route with Views of the Existing CL&P Transmission Lines

Town / Scenic Feature	Volume 9 Map Sheet No. / Relation to ROW	Feature Information	Summary Results of Field Review
Quinebaug River Trails	24/25 Some trails extend across ROW	Hiking / recreational use trails on CL&P-owned property in vicinity of Quinebaug River and Day Street Junction. Trails are listed on the Town of Brooklyn web site.	Public access to the trails is via Day Street, near CL&P's Brooklyn Substation, south of the Proposed Route. CL&P's existing 115-kV transmission line and substation are visible from the beginning of the trail system. At Day Street Junction, multiple transmission lines (345-kV and 115-kV) extend north along the ROW. These lines are visible from certain portions of the trail system. The proposed new 345-kV would be located west of these existing transmission lines.
Pomfret			
Quinebaug River Town Boat (Canoe / Kayak) Launch	27 Adjacent to ROW	Canoe / kayak boat launch and parking area located adjacent to and within existing ROW.	The canoe / kayak launch and parking area are located on CL&P-owned property adjacent to the State Route 101 (Killingly Road) and the Quinebaug River, and along the existing ROW. The existing transmission lines span the parking area.

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SECTION 6

POTENTIAL ENVIRONMENTAL EFFECTS AND MITIGATION MEASURES

6. POTENTIAL ENVIRONMENTAL EFFECTS AND MITIGATION MEASURES

This section identifies and analyzes the potential short- and long-term effects that the construction and operation of the proposed Project would have on the environment, ecology, and on scenic, historic, and recreational values, and then describes the measures that CL&P proposes to avoid, minimize, or mitigate adverse effects. As discussed in this section, the avoidance, minimization, and mitigation of adverse effects to environmental resources, land uses, and cultural resources were key considerations in the Project planning process, and will continue to be important during the finalization of Project design and the preparation of the Project D&M Plan. The D&M Plan would include the specifications for Project construction, operation, and maintenance, including the environmental mitigation measures defined in this Application and specified in the Council's Certificate.[1]

Section 6.1 discusses the potential effects, and measures to mitigate such effects, associated with the construction and operation of the new 345-kV transmission lines between Card Street Substation, the Lake Road Switching Station, and the Connecticut / Rhode Island border. Section 6.2 describes the potential environmental effects and mitigation measures related to the proposed modifications to Card Street Substation, Lake Road Switching Station, and Killingly Substation that are required to support the new 345-kV transmission lines.

Overall, the proposed Project would minimize adverse environmental effects by collocating the new 345-kV transmission lines along CL&P ROWs, adjacent to existing overhead 345-kV transmission lines (with 96% of the Proposed Route and Proposed Configurations for the new transmission lines entirely

[1] The D&M Plan also would incorporate the relevant conditions of regulatory approvals received from other agencies, including the CT DEEP, SHPO, and USACE if such approvals are issued prior to or during the D&M Plan preparation phase.

within existing CL&P ROWs) and by developing the proposed substation and switching station modifications within the existing station fence lines on property that is already designated for utility use. Although the construction and operation of the Project would result in unavoidable short- and long-term effects on certain environmental, ecologic, cultural, and recreational / scenic resources, CL&P has identified measures that can be effectively applied to mitigate these effects to the extent practical. The identified mitigation measures are based on CL&P's experience in the construction, operation, and maintenance of the existing transmission lines along the Project ROWs, on the results of the field investigations and agency consultations conducted for the Project, and on recent, directly relevant expertise in siting and constructing 345-kV transmission facilities elsewhere in Connecticut.

For example, as part of the Project planning process, CL&P has already modified the new 345-kV transmission line design to place new structures outside of wetlands where possible. Similarly, as has been the case on other recent 345-kV transmission line projects, CL&P would commit to prepare Project-specific construction plans related to erosion and sedimentation control; stormwater management; spill prevention, control, and clean-up; and ROW revegetation. CL&P also would preserve riparian vegetation, as compatible with overhead transmission line operation, near streams to the extent practical, and would align new permanent access roads in upland (rather than wetland) areas where possible. Finally, CL&P has identified two feasible transmission line configuration options that could be adopted to either minimize or avoid the need for ROW expansion across the federally-owned recreational lands in the Mansfield Hollow area (refer to Section 10).

Furthermore, along with the mitigation methods identified in this section, additional measures to avoid or minimize adverse effects on the environment may be identified during the course of the Council proceedings and during the process of acquiring Project-specific permits and approvals from other state and federal agencies, including the CT DEEP, SHPO, and the USACE. Mitigation measures, as described herein or as included as conditions of regulatory approvals, would be reflected in the final Project design and incorporated into D&M Plan or other Project specifications, as appropriate.

During construction, CL&P would monitor the construction contractors' compliance with the D&M Plan, and would comply with the environmental inspection provisions of other state and federal permits, as applicable. CL&P would provide regular monitoring reports to the Council, if so directed by the Council's certificate. In addition, if directed by the Council, CL&P would be amenable to funding an independent environmental inspector, who would periodically monitor environmental aspects of the Project construction and would report directly to the Council, as well as to CL&P and to the Chief Elected Officials of towns along the Proposed Route. Such inspections would typically occur weekly.

After the completion of Project construction (including restoration of the ROWs and staging areas), CL&P would implement a post-construction monitoring program, which would be designed and executed pursuant to the conditions of regulatory approvals from the Council, CT DEEP, and the USACE. In general, the post-construction monitoring would be performed to verify the success of Project restoration and, as necessary, to identify additional restoration measures that may be required. Monitoring may include, for instance, inspections of percent vegetative cover, wetlands functions, and permanent erosion controls on the restored ROWs.

6.1 PROPOSED CARD STREET SUBSTATION TO LAKE ROAD SWITCHING STATION TO CONNECTICUT / RHODE ISLAND BORDER ROUTE

6.1.1 Topography, Geology, and Soils

The construction and operation of the new 345-kV transmission lines would have negligible effects on topography and geology, and only minor, short-term, and highly localized effects on soils. These effects would be concentrated in the vicinity of work sites along the ROWs, or where earth-moving activities, if any, are required at off-ROW Project support areas (e.g., off-ROW access roads, staging areas).

6.1.1.1 Topography and Geology

Generally, the construction of the Project would result in minor, localized changes in elevation only at locations where grading and filling are required, such as at certain structure sites where crane pads must be established, or along access roads that must be improved or developed to safely support construction equipment. Grading would not be required, in most instances, where the terrain along the ROWs is relatively level, where no access road improvements or new access roads are needed, or where the conductors span the underlying terrain.

At structure locations where crane pads are needed, changes in grades (e.g., cut or fill) can be expected to be generally short-term and localized to the crane pad area[2] and to any associated access roads leading to the pads. After work at a structure location is completed, the crane pads typically would be removed and the area restored to approximate pre-construction grade. Similarly, temporary access roads would represent a short-term change in grade. After the completion of transmission line construction activities, temporary access roads would be removed.

However, in some locations, permanent access roads must be maintained to facilitate the operation and maintenance of the transmission lines. Such permanent access roads would result in long-term, but highly localized changes in grade. The locations of proposed temporary and permanent access roads and the potential effects of such roads on wetlands along the Proposed Route are discussed in Section 6.1.2. The Volume 9 maps identify the general locations of access roads along the ROWs, whereas the Volume 11 maps provide more detail regarding the locations of existing and potential new access roads along the Proposed Route.

[2] The typical construction work area (crane pad) for a tangent structure is 100 feet x 100 feet and the typical construction work area for a deadend structure is 100 feet x 140 feet; however, the specific size and shape of an individual crane pad can vary due to site or environmental constraints.

6.1.1.2 Soils

Soils would be disturbed by the same types of Project construction activities that would cause localized alterations to grades, such as the creation or expansion of on- or off-ROW access roads, the establishment of staging areas and contractor yards, leveling (cut or fill) as required to create crane pads, and earth-disturbing activities required to install the transmission line structures. Soils also could be disturbed as a result of vegetation removal activities along the ROWs. However, the soil disturbance would be short-term, lasting only for the duration of the construction at a particular location, until revegetation or other forms of soil stabilization are achieved.

At locations where earth disturbing activities are required, temporary erosion and sedimentation control measures (e.g., silt fence, hay/straw bales, filter socks, mulching, temporary reseeding) would be used to minimize the potential for soil erosion and sedimentation off the ROWs or outside the authorized Project work limits, and particularly into watercourses or wetlands (either on or off the ROWs). These temporary controls would be deployed as necessary, typically in conjunction with or after vegetation removal or grading. Erosion and sedimentation control measures, which would be installed based on the judgment of CL&P's in-field representatives and in accordance with regulatory requirements, would be inspected and maintained (replaced as necessary) throughout the construction period, until final stabilization of disturbed areas is achieved or until permanent controls (if required) are established.

The need for and extent of temporary and permanent erosion and sedimentation controls would be a function of site-specific field considerations such as:

- Slope (steepness, potential for erosion, and presence of environmentally sensitive resources, such as wetlands or streams at the bottom of the slope).
- Type of vegetation removal method used and the extent of vegetative cover remaining after removal (e.g., presence/absence of understory or herbaceous vegetation that would minimize the potential for erosion and degree of soil disturbance as a result of clearing equipment movements).
- Type of soil and erodibility factor (K value).

- Soil moisture regimes.
- Schedule of pending construction activities in particular ROW areas.
- Proximity to water resources (e.g., wetlands, watercourses), public roads, or other sensitive environmental resources.
- Time of year. The types of erosion and sedimentation control methods used along the ROWs would depend on the time of year construction work is initiated and completed. For example, re-seeding is typically ineffective during the winter months. In winter, with frozen ground, controls other than re-seeding (such as wood chips, straw, and hay, geotextile fabric, erosion control logs) typically would be deployed or maintained to control erosion and sedimentation and thus to stabilize disturbed areas until reseeding can be performed under optimal seasonal conditions.

The measures selected would be appropriate to minimize the potential for erosion and sedimentation in particular areas of soil disturbance. CL&P would adhere to NU's *Best Management Practices Manual Connecticut Construction & Maintenance Environmental Requirements* (refer to Volume 6) and would prepare a Project-specific *Erosion and Sedimentation Control Plan*, which would be included in the D&M Plan. The *Erosion and Sedimentation Control Plan* would conform to the requirements of CT DEEP's *General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities* and with the 2002 *Connecticut Guidelines for Soil Erosion and Sedimentation Control*.

After the completion of earth-disturbing activities in any area, permanent soil stabilization measures (e.g., seeding, mulching) would be performed. Temporary erosion controls would be maintained, as necessary, throughout the period of active construction until restoration has been deemed successful, as determined by post-construction monitoring and adherence to BMPs for storm water pollution control/prevention and erosion and sedimentation control. The decision to remove temporary erosion and sedimentation controls would be made based on the effectiveness of restoration measures, such as percent vegetative cover achieved, in accordance with applicable permit and certificate requirements. When no longer needed, erosion controls (such as silt fence, stakes, and twine from hay / straw bales) would be removed from the ROWs and disposed of properly.

Blasting and Rock Removal

For the most part, blasting is not expected to be needed to install transmission line structures for the Project. The proposed structures are H-frames or steel poles. Some of these structure types would require foundations with anchor bolts.

The preferred techniques for removing rock, if encountered, would be to use either mechanical methods (e.g., mechanical excavators and pneumatic hammers) or mechanical methods supplemented by controlled drilling and blasting. Potential effects from rock removal may include dust, vibration, and noise. If blasting is required, CL&P would develop (or direct its construction contractors to develop) a *Blasting Control Plan*, in compliance with state and industry standards. This plan would be provided to the state and local Fire Marshals.

Furthermore, if blasting is necessary, CL&P would require its construction contractors to employ methods to minimize potential adverse effects (refer to Section 4.2.2). For example, blasting charges, if required, would be designed to loosen only the material that must be removed to provide a stable foundation, and to avoid fracturing other rock. Excavated material that cannot otherwise be used at the site would be removed and properly disposed of elsewhere, pursuant to Project specifications (e.g., the *Material Handling Guideline*).

6.1.2 Water Resources

The Proposed Route follows existing CL&P ROWs across and adjacent to multiple wetlands and watercourses (collectively referred to as water resources), most of which are traversed by the existing overhead transmission lines and (in some locations) distribution lines that currently occupy the ROWs. Through Project design and construction planning, CL&P has attempted to avoid or minimize the potential for adverse direct and indirect effects to water resources to the extent practical. For effects that are unavoidable, CL&P would implement mitigation measures, including the use of construction best management practices (temporary erosion and sedimentation controls), on-ROW restoration, and wetland compensation / mitigation. Specific water-resource mitigation measures would be identified, designed, and implemented in accordance with conditions of the Project-specific approvals received from the Council, CT DEEP, and the USACE.

As a result, most potential effects to water resources associated with the development of the new 345-kV transmission lines would be short-term and highly localized, with the exception of tree removal within forested wetlands along the Proposed Route, unavoidable structure placement within wetlands, and permanent access road expansions or development across wetlands and streams. Tree removal within forested wetlands (as required to allow construction and thereafter to maintain safe distances between vegetation and the transmission line conductors) would not represent any loss of wetland habitat, but would constitute a long-term effect by converting the wetland habitat type from forested to scrub-shrub and / or emergent. In contrast, both the unavoidable placement of new transmission line structures or guys within wetlands and the development of permanent access roads across certain wetlands and streams would involve fill, resulting in a long-term loss of habitat (refer to Sections 6.1.2.1 and 6.1.2.2 for additional information). During the Project planning, CL&P has attempted to avoid permanent fill in watercourses and wetlands to the extent feasible.

Apart from the effects associated with the conversion of on-ROW forested wetlands to scrub-shrub or emergent wetlands, structure placement in certain wetlands, and permanent access roads across certain water resources, the operation and maintenance of the Project facilities would not have long-term, adverse effects on water quality or water resources. The limited, localized, permanent effects on wetlands would be largely the result of expanding the width of the vegetatively managed portion of the ROW. The areas would be managed in accordance with CL&P's established vegetation management program, the objective of which is to maintain a climax vegetative community of low scrub-shrub growth that does not interfere with the overhead transmission line facilities and allows for inspection and access along the ROWs.

Potential direct short-term effects on water resources could stem from erosion and sedimentation into watercourses or wetlands as a result of soil disturbance and vegetation removal along the ROWs, fill or sedimentation associated with the installation and use of temporary access roads (including culverts) across wetlands and small watercourses, temporary fill required at crane pad locations in wetlands, and disturbance to wetland plant communities located along the ROWs. In addition, the movement of construction equipment and vehicles along the ROWs would increase the potential for inadvertent spills of fuels or lubricants, which could potentially enter water resources.

Long-term, but localized direct effects would occur as a result of filling required for the unavoidable development of certain permanent access roads within wetlands and the placement of certain structures within wetlands (in locations where the line structures cannot practically be situated in upland areas. In such wetlands, fill would be required for the permanent access road base and for the structure foundations and, in some areas, guy anchors.

Direct, long-term changes to wetland communities would occur as a result of the removal of trees within forested wetlands[3] along the ROWs during construction and the subsequent management of these areas in lower-growth vegetation, pursuant to transmission line safety standards. The affected forested wetlands would be converted to scrub-shrub and/or emergent wetlands for the life of the Project, resulting in a cover type change, with no net loss of wetland habitat.

As defined by the USACE, direct wetland impacts include permanent and temporary effects that result in fill and excavation discharges resulting from a single and complete project with the immediate loss of the aquatic ecosystem within the footprint of fill. Temporary impacts do not result in a long-term loss of wetlands, which are assumed to be restored in-situ following the completion of construction activities. In contrast, permanent wetland impacts involve fill that results in a net loss of wetlands.

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[3] Some wetlands in which the dominant vegetation is emergent and scrub-shrub also may contain individual trees that must be removed.

The construction of the proposed transmission lines would result in permanent wetland impacts as a result of the unavoidable placement in wetlands of new 345-kV line structures, guy anchors, and new or expanded permanent access roads. Temporary wetland impacts associated with the development of the proposed transmission lines would include the placement of temporary timber mats (or equivalent) for access roads and crane pads, the placement of temporary fill (e.g., rock) over geotextile fabric as an alternate means of constructing an access road or crane pad, the burial of grounding systems (counterpoise) as necessary near structures, and the installation of temporary poles to support wire stringing operations over roadways and other such features encountered along the ROWs.

Secondary impacts are those impacts to inland waters, waterways, and wetlands, outside the footprint of fill, which result from and are associated with the discharge of dredged or fill material, including but not limited to wetlands that are drained, dredged, flooded, cleared, or degraded resulting from a single and complete project. Examples may include habitat fragmentation as a result of forest clearing, interruption of travel corridors for wildlife (for example, for amphibians that migrate to and from seasonal or vernal pools used as breeding habitat), shading impacts from temporary bridges over watercourses, and hydrologic regime changes.

Cumulative effects can be defined in two separate ways: 1] as the gross total of permanent, temporary and secondary impacts to wetlands and waters of the U.S. as a result of a single and complete project; or, on a broader scale, 2] the environmental effects associated with a proposed project that are added to or interact with the impacts associated with other past, present, or reasonably foreseeable future projects. Generally, cumulative effects are used to gauge the significance of a particular project's impacts on a region.

In designing and planning the construction of the transmission lines, CL&P has incorporated, or would implement during construction, measures to avoid or limit adverse effects to water resources to the extent feasible. For example, where feasible, CL&P proposes to avoid direct work in watercourses (with the exception of in-water activities required for the installation of temporary and permanent culverted access across certain streams), minimize the placement of structures and permanent access roads in wetlands, install temporary construction mats or equivalent (rather than permanent access roads) for wetland crossings where practical, and employ best management practices to limit the potential for erosion/sedimentation or for inadvertent spills of fuels and lubricants into water resources.

CL&P would prepare, and would require its construction contractor to implement, a Project-specific *Stormwater Pollution Prevention and Control Plan,* in accordance with CT DEEP requirements as specified in the *General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities*. Similarly, CL&P would compile a Project-specific *Spill Prevention, Control, and Countermeasure (SPCC) Plan* to be implemented by the construction contractors; this plan would address the measures for preventing and, as necessary, responding to inadvertent spills or leaks of fuels, lubricants, etc. during construction along the Project ROWs. Both plans would be developed in conjunction with the preparation of the Project D&M Plan.

Moreover, any construction work potentially affecting water resources would be performed in accordance with the conditions of Project permits required from the USACE, the CT DEEP, and the Council. Pursuant to Section 401 of the federal Clean Water Act, CL&P would submit an application to the CT DEEP for a Water Quality Certification. Pursuant to Section 404 of the Clean Water Act, CL&P and National Grid would jointly submit an Individual Permit application to the USACE for the Interstate Reliability Project activities proposed in Connecticut, Rhode Island, and Massachusetts.

Adherence to the conditions of Project permits issued by the CT DEEP and USACE would serve to further avoid, minimize, or mitigate potential adverse effects to water resources during the construction and operation of CL&P's proposed facilities in Connecticut. CL&P would incorporate the conditions of the CT DEEP and USACE permits into Project documents, and would require the Project construction contractors to adhere to such conditions.

6.1.2.1 Waterbodies

All of the watercourses located along the Proposed Route (54 perennial and 50 intermittent streams) are presently spanned by CL&P's existing transmission lines. Some of the smaller stream crossings along these existing ROWs are traversed by existing CL&P access roads.

The proposed 345-kV transmission lines also would span all major watercourses. However, temporary and, in some areas permanent, access (i.e., use of existing access roads or creation of new access roads) would be required across the smaller streams along the ROWs. No access would be required across the larger watercourses, such as the Willimantic, Natchaug, and Quinebaug rivers, or across Mansfield Hollow Lake; instead, the ROW would be accessed from either side of these larger waterbodies.

The development of the proposed transmission lines would not create a new linear utility corridor across any watercourses, but rather would increase the width of the managed portion of the existing ROW and would add another overhead transmission line span at each crossing. Except at streams where new access road crossings must be installed or existing access roads improved, including at streams where culverts would be required, the Project would not involve in-stream work and thus would have limited direct effects on waterbodies and water quality.

Crossings of smaller streams by construction equipment would be minimized to the extent practical. CL&P would direct its construction contractors to cross streams using existing on-ROW access roads, where feasible. In areas where new access road crossings must be installed, or where existing roads must be improved or expanded across streams, temporary and localized effects to water resources would occur. These effects would consist of short-term increases in turbidity (e.g., due to crossing installation or improvement), removal of stream shading vegetation at the crossing, and temporary disturbance to riparian zones.

To limit the potential for erosion from adjacent upland areas and to preserve streamside vegetation, CL&P would minimize ROW clearing at watercourse crossings to the extent practical. Only the minimum amount of vegetation necessary for the construction and reliable operation of the transmission facilities (including the provision of safe equipment access, as needed) would be removed. In general and where possible, vegetation removal near streams would be performed selectively, preserving desirable streamside vegetation (within a 25-foot-wide undisturbed riparian zone adjacent to either stream bank) for habitat, shading, bank stabilization, and erosion/sedimentation control.

Potential effects on watercourses may occur from the selective removal of vegetation within riparian zones/buffers (as necessary to allow safe construction or to maintain appropriate vegetation clearances from conductors) and the movement of construction equipment across watercourses via either temporary equipment bridges or permanent access roads. Where alternative means of access are not available, temporary bridges (consisting of timber mats, metal bridges, timber mats or metal bridges with culverts, or equivalent) may be used for equipment crossings. Erosion and sedimentation controls also would be installed as appropriate. Use of such materials would minimize or avoid direct effects to banks and stream bottom sediments, and would minimize sedimentation and turbidity to the extent practical.

Culverts. To maintain the existing transmission lines that occupy the ROWs along which the new 345-kV lines would be located, CL&P has installed access roads, with culverts, across 12 watercourses[4]. These existing access roads, which CL&P proposes to use for Project construction, cross five perennial streams with existing culverted crossings and seven intermittent watercourses with existing culverted crossings.

[4] The 12 streams include 14 permanent culverts.

Based on constructability studies conducted to date, CL&P estimates that 41 new temporary or permanent culverts would be required along 39 streams (two proposed culverts would be installed along streams S20-41B [un-named intermittent stream, Town of Hampton] and S20-49 [White Brook, Town of Brooklyn]). Of the 39 streams where proposed new temporary or permanent culverts may be required, 20 are perennial watercourses and 19 are intermittent watercourses.

Table 6-1 lists the watercourses where new permanent or temporary culverts may be required. Table 5-4 identifies the watercourses where CL&P has existing culverted access road crossings (these watercourses also are included at the end of Table 6-1). In addition, the existing and proposed locations of culverts are illustrated on the Volume 11 maps.

New culverts would be required to allow equipment access across certain watercourses where no culvert currently exists. However, such culverted crossings would only be proposed where constructability studies indicate that other types of crossings (e.g., temporary mat or temporary metal bridge spans) are not practical, alternative access is not available, or permanent access must be established for the reliable operation and maintenance of the transmission lines.

CL&P is presently conducting further investigations to determine access road requirements, including across watercourses. As a result of these analyses, the number of proposed culverted watercourse crossings may change.

Any new permanent culverts would be designed and installed in accordance with USACE and CT DEEP stream crossing guidelines, and would require regulatory approvals. These guidelines specify that culvert design should allow for the maintenance of ambient stream flows, the continuous flow of the 50-year frequency storm, and fish passage.

Table 6-1: Watercourses with Proposed Access Road Crossings (Culverts)*

Watercourse No.[1] and Name (as applicable)	Water Quality[2] / Fisheries Classification[3] (as applicable)	Watercourse Type (P or I)[4]
Mansfield		
S20-7	A/warm-water	P
S20-8	AA/warm-water	P
S20-9 / Conantville Brook	AA/warm-water	P
S20-11	AA	I
S20-12	AA	P
S20-18	AA/cold-water	I
S20-20	AA/cold-water	P
Chaplin		
S20-21	AA/cold-water	I
S20-24	AA	P
S20-25	AA	P
S20-26	AA	P
S20-28	AA	I
S20-29/Buttonball Brook	AA/cold-water	P
S20-30	AA	P
Hampton		
S20-32/Merrick Brook	A/cold-water	P
S20-35	A	I
S20-36	A	I
S20-40A	A	I
S20-41A / Humes Brook	A	I
S20-41B	A	I
Brooklyn		
S20-41D	A	I
S20-41E	A	I
S20-45/Tanner Brook	A	P
S20-48	A	I
S20-153	A	I
S20-49 / White Brook	A/warm-water	P
S20-49A	A	I
S20-49B	Ae	I
S20-50	A	P
S20-51 / White Brook	A/warm-water	P
S20-52 / Creamery Brook	A/warm-water	P
S20-52A	A	I
S20-54A	A	I
Pomfret		
S20-54	A	I
Killingly		
S20-57A	A	P
Putnam		
S20-61A / Lippitts Brook	A/warm-water	P
S20-63/Munson Brook	A/warm-water	P

Table 6-1: Watercourses with Proposed Access Road Crossings (Culverts)*

Watercourse No.[1] and Name (as applicable)	Water Quality[2] / Fisheries Classification[3] (as applicable)	Watercourse Type (P or I)[4]
Thompson		
S20-66	A	P
S20-67	A	I

Notes to Table 6-1:

[1] Series No. refers to waterbody numbers designated in the CL&P water resource reports (Volume 2) and illustrated on the maps in Volumes 9 and 11.

[2] Table 5-3 defines the water classifications as defined by the 2011 Connecticut Water Quality Standards.

[3] Fishery Classifications (for watercourses that support fish resources) were obtained by personnel communication with Neal Hagstrom, Senior Fisheries Biologist at CT DEEP. December 10, 2010, June 17, 2011, and December 5, 2011.

[4] P = Perennial; I = Intermittent.

*Based on currently available data, access roads involving culverts are assumed to be required at these stream crossings. However, as CL&P continues to perform Project design studies and constructability reviews, the stream crossings where access roads are required may change.

Streams with existing permanent culverts along CL&P access roads are summarized as follows (refer also to Table 5-4)

Town / Watercourse No. and Name (as applicable)	Water Quality / Fisheries Classification[3] (as applicable)	Watercourse Type (P or I)[4]
Columbia / S20-1A	A	P
Mansfield / S20-6	A	P
Mansfield / S20-7	A/warm-water	P
Mansfield / S20-10	AA/warm-water	I
Mansfield / S20-19A	AA	I
Mansfield / S20-19	A	I
Chaplin / S20-24	AA / cold-water	P
Hampton / S20-33	A	I
Brooklyn / S20-42B	A	I
Brooklyn / S20-52B	A	I
Brooklyn / S20-53	A	P
Killingly / S20-56	A	I

CL&P will coordinate with CT DEEP and the USACE regarding the need for permanent and temporary culverts, as well as concerning options to culverts that may be practical in certain areas. For example, across streams located in wetlands, use of larger-diameter crushed rock may allow equipment crossings while maintaining flow, without the use of a culvert.

Prior to submitting permit applications to the CT DEEP and USACE, CL&P will conduct integrity inspections of the existing culverts and identify the culverts that would have to be replaced. Any culverts that are deemed to either be in disrepair or otherwise unable to support the anticipated weight of the construction vehicles required for the Project would be replaced at the same location and designed to maintain the ambient stream flows.

Mitigation Measures. CL&P would implement the following mitigation measures to minimize the potential effects of construction activities in or near watercourses:

- Where existing access roads across streams must be improved, clean materials would be used (e.g., clean riprap or equivalent and rock fords).
- At streams that support fisheries resources, improvements to or the development of access road crossings would be scheduled, to the extent possible, to avoid conflicts with fish spawning or migration. The CT DEEP *Stream Crossing Guidelines* indicate that in inland waters, unconfined in-stream construction activities should only be performed between June 1 and September 30. The USACE guidelines (as identified in the USACE's *General Permit* for Connecticut) indicate that in-water construction activities should be limited to low flow conditions, which are listed as July 1 through September 30.
- Water flows in streams (if water is present at the time of construction) would be unconstrained throughout construction.
- Concrete (used for some structure foundations) would not be mixed, placed, or disposed of so as to enter a watercourse.
- Where culverts must be installed, the mitigation measures recommended in the CT DEEP *Stream Crossing Guidelines* would be implemented as appropriate.
- Existing riparian vegetation within 25 feet of watercourse banks would be maintained, to the extent practical and consistent with ROW vegetation management requirements.

- Temporary access roads (e.g., consisting of timber mats, metal bridges, or equivalent) across streams would be removed as part of the restoration phase of the Project.

- The D&M Plan(s) and other construction specifications would incorporate the conditions of permits received from the USACE and the CT DEEP relating to the protection of water resources.

6.1.2.2 Wetlands

As identified in Table 5-5, of the 227 wetlands identified within CL&P's easements, 127 would be within the portions of the ROW traversed by the Proposed Route.[5] The development of the Project would unavoidably affect some of these wetlands. However, CL&P has designed and proposes to construct the Project to avoid or minimize adverse effects to wetlands to the extent practical. Where adverse effects to wetlands are unavoidable, CL&P would implement construction best management practices and would develop a compensatory *Wetland Mitigation Plan* pursuant to the approval of the USACE and the CT DEEP.

Most of the wetlands within CL&P's ROWs have historically been affected, to some degree, by the vegetation management practices or other procedures associated with CL&P's operation of the existing overhead transmission lines (and in some areas, distribution lines) between Card Street Substation, Lake Road Switching Station, and the Connecticut / Rhode Island border. The principal effects associated with these existing lines were the conversion of forested wetlands to the scrub-shrub or emergent wetland types that presently characterize the managed portions of the ROWs, as well as the establishment of certain structures and access roads in wetlands.

The construction and operation of the new 345-kV transmission lines along the presently un-managed portions of these ROWs would result in similar, but incremental, effects to wetlands. Temporary effects

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5 The 227 wetlands include all wetlands delineated within the entire width of CL&P's existing ROWs, as well as within the 11-acre easement expansion area that would be required for the development of the new 345-kV transmission line across the USACE-owned Mansfield Hollow properties using CL&P's Proposed Configuration. The 127 wetlands are those located along the Proposed Route for the new 345-kV line and therefore potentially affected by the proposed Project construction and maintenance activities. Additional wetlands, or portions of these same wetlands, may be affected by access road improvement or development on other portions of the ROWs, including areas beneath the existing transmission lines.

to wetlands would occur from vegetation removal activities (e.g., temporary access for clearing equipment across wetlands), the development and use of temporary construction access roads (e.g., using timber mats, gravel/rock placed over geotextile fabric, or equivalent) through wetlands, the placement of temporary crane pads and temporary structure support poles[6] in wetlands, the removal of scrub-shrub or emergent wetland vegetation, and incidental sedimentation due to dewatering activities or erosion.

Long-term effects on wetlands will result from the following activities:

- The removal of vegetation within forested wetlands (as necessary) along the approximately 70- to 90-foot-wide portions of the ROWs required for the construction and operation of the new transmission lines.[7] Within these areas, forested wetlands would be converted to scrub-shrub or emergent marsh wetland habitats, resulting in a long-term cover type change in wetland communities, but not in an overall net wetland loss.

- The permanent expansion of existing access roads or the creation of new permanent gravel access roads (up to 20 feet wide). Permanent access through wetlands would involve fill and would represent a net loss of wetland habitat. Permanent access roads will only be required if no alternative upland access is available.

- The installation of line structures in wetlands (where upland structure sites are not practical due to design constraints such as long distance spans between structures or angle locations where there is a shift in the direction of the ROW). The unavoidable placement of structures and guy anchors in wetlands would involve fill in wetlands, thereby representing a net loss of wetland habitat.

Through the Project design and construction planning performed to date, CL&P has avoided or minimized potential adverse effects to wetlands to the extent practical, while taking into primary consideration the safe installation, maintenance, and reliable operation of the proposed lines. For example, CL&P has revised the Project design to locate new 345-kV line structures in upland areas wherever practical.

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6 To install the new transmission line, temporary poles may have to be installed in wetlands that are located along the ROWs adjacent to certain public road crossings. These temporary poles are used during conductor stringing to prevent the wires from sagging into overhead distribution lines located along public roads or into the road. These temporary poles would be removed following the completion of the stringing operation. Temporary poles also would have to be installed for the No ROW Expansion Option in the Mansfield Hollow area (refer to Section 10).

7 The width of vegetation removal is a function of the type of transmission line structure. For details, refer to the cross-sections in Section 3 (Appendix 3A), the Volume 9 maps, and Volume 10.

The original Project design called for the placement of the new 345-kV line structures along the ROWs generally adjacent to the existing 345-kV line structures. A total of 47 existing 345-kV line structures are presently located in wetlands. Due to the juxtaposition of wetland boundaries across the ROWs, the alignment of the new structures adjacent to these existing structures would have resulted in the placement of 57 new 345-kV line structures in wetlands. However, to date, CL&P has revised the Project design to relocate 33 of these structures to upland areas. The remaining 24 structures cannot be relocated to upland areas due to transmission line design standards, line spacing requirements, and potential safety issues.[8] Additional structure locations may change as the Project design is refined, based on information obtained from further field studies (e.g., subsurface investigations, final engineering and environmental surveys, constructability reviews), input from the municipalities and regulatory agencies, and the conditions of the Council's approval.

As summarized in Table 6-2, approximately 1.5 acres of wetlands would be permanently filled for the construction of permanent access roads and structure foundations to build the proposed Project. Approximately 9 acres of wetlands would be temporarily affected by construction work areas, such as crane pads, or timber mat access roads; these areas would be restored following the completion of the 345-kV transmission line installation. The following assumptions were used in determining the affected areas identified in Table 6-2:

- Within CL&P's existing ROWs, an additional 70 to 90 feet of vegetation removal (including tree clearing) would be required, adjacent to the presently managed portions of the ROWs, to accommodate the new 345-kV transmission lines.

- Along the 1.4 miles of federally-owned land in the towns of Mansfield and Chaplin where CL&P proposes to acquire additional easements to install the new transmission line, the estimated width of additional ROW vegetation removal was estimated to include all of the additional easement width (that is, 55 feet along the 0.9-mile section of ROW in Mansfield and 85 feet along the 0.5-mile section in Chaplin). In addition, vegetation removal was assumed along all of the un-managed areas along the northern portions of the CL&P's existing 150-foot-wide ROW.

[8] In the Town of Putnam, along the 0.6-mile segment of ROW illustrated by XS-12 BMP (Elvira Heights area), two existing 345-kV H-frame structures (on the 347 Line) that are currently within wetlands would be replaced with delta steel monopole structures, which also would be within wetlands.

- Crane pad dimensions are assumed to be typically 100 feet by 100 feet.

- Access roads are assumed to be approximately 20 feet wide; existing access roads were assumed to all be 12 feet wide and thus would have to be expanded by 8 feet. The 20-foot-wide area represents the potential total impact area, including a minimum travel surface of approximately 12 to 16 feet wide and associated space for grading (as needed) and erosion and sedimentation controls.

- To facilitate conductor stringing across public roads, temporary poles may be installed along the ROWs within 30 feet of such roads. Near some roads, temporary poles may need to unavoidably be placed in wetlands. An affected area of approximately 10 feet by 10 feet is estimated at each such temporary pole site within a wetland. The temporary poles would be removed after the successful conductor stringing; as a result, the disturbance to wetlands from this activity would be short-term.

Table 6-2: Estimated Surface Area of Waters of the United States Potentially Affected by the Proposed Transmission Lines (Temporary and Permanent Effects) and Total Secondary Effects of Forested Wetland Conversion to Scrub-Shrub or Emergent Wetland Types

PROJECT ACTIVITY	ESTIMATED TEMPORARY EFFECT (ACRES)	ESTIMATED PERMANENT EFFECT (ACRES)
Access Roads	3.5	1.2
Crane Pads**	4.4	0
Guy Easements	0.9	<0.1
Structure Foundations	<0.1	<0.1
Total Estimated Primary Wetland Effects (Fill)	**8.9**	**1.5**
Total Estimated Secondary Wetland Effects: Conversion of Existing Forested Wetlands to Scrub-Shrub or Emergent Marsh Habitat from vegetation removal and management for the Life of the Project		**44.5 acres (federal wetlands)** **1.9 acres (state wetlands)**

Notes:

* This table provides estimates of (1) permanent effects (e.g., permanent fill at structure sites and for new and expanded access roads) and (2) temporary effects (e.g., crane pads, temporary access roads, or temporary guy easements). Vegetation removal is a secondary effect and all of the permanent and temporary effects, as noted above in (1) and (2) were subtracted to obtain this estimated secondary effect (i.e., acres of forested wetland clearing not otherwise accounted for in other impact categories).

** No crane pads are anticipated to be left in wetlands. In addition to effects to Waters of the United States, an estimated 0.4 acre of state wetlands would be temporarily affected as a result of the installation of crane pads. Portions of the following wetlands do not meet the three-parameter criteria for federal jurisdictional wetlands, and are solely state jurisdictional: W20-5, W20-162, W20-164, W20-172, and W20-178 as shown on the maps in Volumes 9 and 11.

Overall, approximately 51 acres[9] of forested wetland vegetation along the ROWs would be removed during construction. These areas include all forested wetlands and state wetlands that would be cleared or otherwise temporarily impacted in the existing ROW and the new expanded ROW. These forested wetlands would be permanently converted to scrub-shrub or emergent wetlands, representing a long-term cover type change to wetland habitat, but not a net loss of wetlands (refer to Table 6-3, located at the end of this section). This estimate assumes that in order to accommodate the construction of the new transmission lines, an additional 70 to 90 feet of forested vegetation, on average, would have to be removed adjacent to the portions of the ROWs that are presently managed in low-growth or other vegetation types compatible with overhead transmission line use (refer to Table 4-2 for a summary of the existing and proposed managed ROW widths, by ROW segment).

Of the approximately 51 acres of forested wetlands that would be cleared for the development of the proposed 345-kV transmission lines, approximately 2.8 acres (0.1 acre in the Town of Mansfield and 2.7 acres in the Town of Chaplin) would be located on the federally-owned properties in the Mansfield Hollow area, across which CL&P proposes to acquire additional easements. In addition, to install two new 345-kV line structures (Structure Nos. 99 and 100), less than 0.1 acre (all in the WMA in the Town of Chaplin) of wetland W20-76 would be permanently filled on federally-owned properties. Additionally, wetlands on federally-owned properties would be temporary filled to construct crane pads and proposed access roads associated with Structure Nos. 99 and 100.

For the line structures that would unavoidably have to be located in wetlands, CL&P would limit the temporary effects to the wetlands, either by reducing the crane pad size or by re-configuring the crane

[9] The approximately 51 acres of forested wetland vegetation affected by the proposed Project includes the 46.4 acres of estimated secondary wetland effects (44.5 acres of forested [federal] wetlands and 1.9 acres of forested [state] wetlands) and approximately 4.6 acres of forested wetlands affected by temporary and permanent effects resulting from the Project activities such as access roads and crane pads. Additionally, floodplain soils are also accounted for as part of the wetland effects discussion because in Connecticut, state wetlands are defined based solely on soil type, including floodplain soils.

pad, if practical, to avoid placement of temporary fill and/or timber mats in wetlands.[10] In general, where a new structure must be located in a wetland, temporary construction materials (e.g., timber mats) would be used for equipment support and for access roads. In some wetland areas, however, field conditions (such as thickness of organics, depth of water, steep slopes, etc.) may require the use of a temporary gravel crane pad underlain by geotextile fabric to provide a safe working surface. The temporary fill used for the crane pads in wetlands would be removed after the completion of structure installation.

To provide access across wetlands to new structures (where no access road currently exists), CL&P would either construct a new crushed stone access road underlain by geotextile fabric, or install a timber-mat (swamp mat or equivalent) road. In wetlands where there is a deep organic layer or the wetlands are prone to extended inundation, the gravel access roads would remain in place permanently to provide a firm base for future equipment access to the transmission facilities. Properly sized culverts (or alternative methods suitable to CT DEEP) would be installed, as necessary, to maintain a hydraulic connection within the wetland(s).

In some wetlands, CL&P anticipates that a permanent "access road base" may be established. In such areas, the surficial fill materials used to construct the access roads would be removed down to the pre-construction elevation so as to not interfere with the wetland surface hydrology. The underlying material serves as a firm base either for equipment access or for the future placement of temporary timber mats to allow operations and maintenance access across these larger wetland systems. All other timber-mat or gravel access roads would be removed after construction.

Best management practices, as detailed in NU's *Best Management Practices Manual Connecticut Construction & Maintenance Environmental Requirements* (refer to Volume 6), would be employed to minimize disturbances to wetlands during Project construction, as applicable. The wetland boundaries

[10] Modifications to crane-pad dimensions would take into consideration the amount of temporary work space needed for the size and types of equipment required for safe structure installation, as well as the topographic and subsurface conditions at and in the vicinity of the crane-pad site.

along the ROWs would be clearly demarcated (e.g., re-flagged by a registered soil or wetland scientist) prior to the commencement of work. When working in or traversing such wetlands, CL&P would also employ the construction procedures detailed in Section 4.2.1.1 and summarized below for ease of reference:

- Comply with the conditions of federal and state permits and certificates related to wetlands.
- Install, inspect, and maintain erosion and sedimentation controls and other applicable construction best management practices around work sites in or near wetlands to minimize the potential for erosion and sedimentation.
- Conduct vegetation clearing in or across wetlands, where necessary, to minimize adverse effects such as by using low-impact vegetation removal equipment and temporary timber mats or log riprap to prevent rutting.
- Limit grading and filling for access roads and crane pads in wetlands to the amount necessary to provide a safe work space.
- Install temporary construction matting or geotextile and crushed stone pads for access roads across wetlands or to establish safe and stable construction work areas/crane pads within wetlands, where necessary. The type of stabilization measures to be used in wetlands would depend on soil saturation.
- Pile cut woody wetland vegetation so as not to block surface water flows within or otherwise to adversely affect the wetland integrity.
- Cut forested wetland vegetation without removing stumps unless it is determined 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 and to minimize adverse affects on the wetland functions.
- Implement procedures for petroleum product management that would avoid or minimize the potential for spills into wetlands (e.g., to the extent practical, store petroleum products in upland areas more than 100 feet from wetlands; refuel construction equipment, except for equipment that cannot be practically moved, in upland areas and if refueling must occur within a wetland, provide temporary containment).
- Restore structure work sites in – and temporary access ways through – wetlands following the completion of line installation activities.

- Restore wetlands temporarily affected by construction activities. As the final phase of transmission line construction, restore wetlands to approximate pre-construction contours and configurations to the extent practicable; replace topsoil and/or organic soils disturbed by construction (as appropriate); stabilize with temporary seeding; and allow native vegetation to recolonize.

To compensate for the effects to wetlands that would occur as a result of the Project, CL&P would consult with the CT DEEP, the USACE, and other appropriate regulatory agencies to assess mitigation options. The extent of compensatory wetland mitigation required would depend on the final Project design and the amount of direct permanent and temporary effects and secondary and cumulative wetland effects. Compensatory wetland mitigation options for the Project, which would be specifically evaluated as part of the CT DEEP and USACE regulatory review processes, may consist of wetlands restoration and/or enhancement (on or off the ROWs) including invasive species control; wetlands creation; wetlands preservation; and/or conservation restrictions to preserve wetlands and associated uplands.

6.1.2.3 Groundwater Resources and Public and Private Water Supplies

The construction and operation of the 345-kV transmission lines would not adversely affect groundwater resources, including Aquifer Protection Areas, public water supplies, or private groundwater wells.

As identified in Section 5.1.2.3, no public wells would be traversed by or are located in the vicinity of the Project. Private wells provide drinking water to the majority of the Project region. The Proposed Route would cross the eastern edge of one Level A Aquifer Protection Area (No. 112) mapped by the CT DEEP and located in the Town of Putnam. Approximately 3.3 acres of this aquifer protection area are within the CL&P ROW. However, no new transmission line structures would be placed within the Aquifer Protection Area; three new structures (Nos. 283, 284, and 285) would be located adjacent to the east edge of the Aquifer Protection Area.

Additionally, the Town of Brooklyn has an Aquifer Protection Area (No. 68) located 1.7 miles southeast of the Proposed Route, whereas the Town of Killingly currently has three Aquifer Protection Areas (Nos.

68, 69, and 71), the closest of which (No. 69) is located 1.8 miles south of the Proposed Route. None of these aquifer protection areas would be affected by the proposed Project.

The excavations required for the installation of the overhead transmission line structures are expected to be above any aquifers used for potable water supply. Groundwater may be encountered in low areas (wetlands, floodplains, etc.) where excavation for some structure foundations is necessary. However, it is unlikely the excavation or limited blasting (if any) associated with the installation of certain structure foundations would affect groundwater used for water supply.

If shallow groundwater is encountered during excavation for structure foundations, dewatering would be performed in accordance with applicable permit conditions and best management practices. Such practices may include pumping the water into temporary settling/dewatering basins or dewatering bags, followed by discharge (via filter materials) back onto the ground to allow for infiltration, into catch basins (if permitted by the CT DEEP, and/or the municipality), or into a tank truck and then transported off-site to a suitable disposal location.

During construction, CL&P would require its contractors to adhere to its best management practices and any Project-specific permit requirements regarding the storage and handling of any hazardous materials used during the work. Proper storage, secondary containment, and handling of potentially hazardous materials such as diesel fuel, motor oil, grease and other lubricants, would be required. Furthermore, CL&P would require its contractors to adhere to a SPCC Plan, which would be developed to incorporate the standard hazardous materials storage, handling, and response procedures, as applicable to the Project.

Construction staging areas and contractor yards would be identified during the preparation of the D&M Plans, or thereafter, by the Project contractor(s). These areas would typically be located at existing developed areas (parking lots, existing storage yards, etc.). Where the storage of construction materials and equipment, including fuels and lubricants, is necessary in mapped aquifer protection areas, CL&P

would comply with CT DEEP and local requirements which prohibit the use or storage of more than 2.5 gallons of each type of hazardous material at any one time without a permit.[11] CL&P and/or its construction management contractor would perform due diligence on any site selected to develop the appropriate construction best management practices for the site. CL&P's standards for spill prevention, control, and countermeasure, erosion/sediment control, and other best management practices would apply.

6.1.2.4 Flood Zones

As described in Section 5.1.2.4, the Project would not involve the placement of any permanent structures within state-designated SCELs.[12] However, temporary and permanent effects on floodplains would occur at certain locations along the Proposed Route where activities would occur within designated 100-year FEMA flood zones.

Permanent effects would result from the establishment of transmission line structures and permanent access roads within regulatory floodplains; these permanent structures could affect flood storage capacities. In addition, during construction, temporary effects would result from the installation within floodplains of crane pads, temporary access roads, and temporary access road improvements. However, after construction is complete, these temporary facilities would be removed and the areas of construction disturbance would be returned to pre-construction contours and elevations.

Along the Proposed Route, 36 new structures would be located within the FEMA-designated floodplains along 14 waterbodies. The locations of these proposed structures, based on current Project plans, are listed in Table 6-4.[13] Due the lateral extent of the floodplain boundaries associated with these waterbody

[11] Town of Putnam Municipal Regulations, Aquifer Protection Areas, effective date March 12, 2009; CT DEEP regulation per Section 22a-354i-5 Prohibited and Regulated Activities in Connecticut Aquifer Protection Areas – Land Use Controls at http://www.ct.gov/dep/lib/dep/regulations/22a/22a-354i-1through10.pdf. Accessed October 27, 2011.

[12] During initial Project planning, one of the proposed 345-kV line structures (structure number 35) was originally sited within the SCEL of the Willimantic River. However, CL&P modified the Project design to relocate this structure outside of the SCEL (refer to Volume 9 map 5 of 40).

[13] These include 35 new 345-kV transmission line structures and one new 69-kV transmission line pole, located adjacent to new 345-kV transmission line structure 23 within the floodplain of the Hop River in the Town of

crossings, spanning the entire floodplain(s) is not feasible; therefore, the installation of new 345-kV transmission line structures in FEMA-designated floodplains would be unavoidable.

Table 6-4: Permanent Transmission Line Structures Proposed for Location with FEMA 100-Year Floodplains

Municipality	Proposed 345-kV Line Structure Numbers	Watercourses with Designated 100-Year Floodplain
Columbia	7	Tenmile River
	23, 24, and one 69-kV distribution line pole located between 6538 and 6539	Hop River
Coventry	34	Willimantic River
Mansfield	84, 85, and 86	Mansfield Hollow Lake
Chaplin	96, 97, 98, and 99	Natchaug River
Hampton	138 and 144	Cedar Swamp Brook
	149 and 161	Little River
Brooklyn	164 and 165	Little River
	203, 205, and 210	White Brook (including Lester Williams Pond)
	211	White Brook and Creamery Brook
Pomfret	237 and 239	Quinebaug River
Killingly	240 and 262	Quinebaug River
Putnam	256	Quinebaug River
	298, 299, 306, and 307	Little Dam Tavern Brook
	310 and 311	Munson Brook
	316 and 317	Fivemile River
Thompson	321	Teft Brook

The Proposed Route would follow the existing ROW across the 100-year floodplain associated with Mansfield Hollow Lake, and would span the levee on the west side of the lake. As part of the proposed Project, the new 345-kV transmission line would also span the levee and three new 345-kV structures would be located within the lake's 100-year floodplain.

In addition, permanent effects on floodplains would occur from the installation of new access roads or the improvement of existing permanent access roads. Based on initial Project plans, less than 0.5 acre of permanent access roads would be located within floodplains. As part of the Project's application to CT

Columbia. The new 69-kV transmission line pole is also located between existing 69-kV transmission line pole numbers 6538 and 6539 (see Volume 9 mapsheet 3 of 40).

DEEP for a 401 Water Quality Certification, CL&P would commission hydrologic/hydraulic modeling analyses to assess the potential effects of the proposed Project facilities on floodplains. Compensatory flood storage volume would be designed to mitigate permanent effects on 100-year floodplains.

6.1.3 Biological Resources

The construction and operation of the new 345-kV transmission lines would cause generally minor effects on vegetative communities and wildlife. The potential effects will be concentrated primarily within and near the existing ROWs along which the proposed facilities would be aligned. With the exception of the conversion of existing forested habitat to scrub-shrub habitat, these effects would typically be short-term, lasting one to two seasons post-construction.

6.1.3.1 Vegetation

6.1.3.1.1 Vegetation Communities Affected, including Upland and Wetland Forest Clearing

The construction and operation of the Project would affect portions of the various vegetative communities that presently characterize the CL&P ROWs along which the new 345-kV transmission lines would be located. In general, the construction of the new 345-kV lines adjacent to CL&P's existing transmission lines would involve the removal of trees and shrubs within the construction footprint. To facilitate clearing within forested wetlands or to provide access across wetlands to reach areas where vegetation must be removed, timber mats or log riprap may be temporarily placed in wetlands. These temporary access measures would be used only during vegetation clearing activities.

Subsequently, the operation of the Project would require the management of vegetation beneath and in the vicinity of the new transmission lines to maintain low-growth communities, consistent with utility industry standards. Along the existing ROWs, this would increase the width of the vegetation that CL&P would manage in herbaceous, shrub-scrub, or other low-growth vegetative types. In currently forested wetlands, tree removal would result in a permanent cover type change and the conversion to scrub-shrub and/or emergent wetlands, such as are characteristic of the wetlands within the presently managed portions of the ROWs.

In conjunction with the operation of the existing 345-kV lines between Card Street Substation, Lake Road, and the Connecticut / Rhode Island border, CL&P presently manages vegetation, on average, on approximately 150 feet of the typical 300-foot-wide ROWs and on more than 150 feet where the ROW is wider and supports more than one line. After the installation of the new 345-kV transmission lines, along most segments of the ROWs, an additional 70- to 90-foot width would be managed in low-growth vegetation (refer to Table 4-2 for a summary of existing CL&P easement widths, widths of current vegetation management, and estimated additional vegetation removal required for the Project).

The existing CL&P transmission line ROWs within which the Proposed Route would be located encompass approximately 1,386 acres. With the proposed 11-acre ROW expansion in the Mansfield Hollow area, the existing and proposed ROW expansion includes a total of 1,397 acres. Of this, 411 acres (30%) are deciduous and coniferous forested upland and approximately 93 acres (7%) are palustrine forested wetland (consisting predominantly of deciduous forest cover with some areas of mixed deciduous / coniferous forest).

Within the existing CL&P ROWs and proposed ROW expansion area in Mansfield Hollow, approximately 273 acres of forested habitat would be affected by the Project (approximately 222 acres of forested upland and 51 acres of forested wetland).[14] Of the 273 acres of affected forested habitat (approximately 261 acres, or 96%) is within CL&P's existing ROWs. However, approximately 12 acres (4%) of the total forested habitat affected by the Project is within the Mansfield Hollow area.[15] On the federal properties in the Mansfield Hollow area, the Project would affect 9.5 acres of forested upland and

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[14] Floodplain soils are also accounted for as part of the wetland effects discussion because in Connecticut, state wetlands are defined based solely on soil type, including floodplain soils.

[15] The 11 acres of forested habitat include forested habitat within the existing CL&P ROW easement and within the proposed CL&P ROW expansion easement.

2.8 acres of forested wetland. This habitat includes forested areas within both the un-managed northern portions of CL&P's existing ROW and the proposed 11-acre easement expansion area.

Based on the results of field investigations, a forest inventory of the ROWs, and analyses of aerial photography / vegetative cover types, CL&P estimates that most of the forest vegetation to be removed (273 acres[16]) consists of trees with an average diameter at breast height (dbh) greater than 5 to 6 inches. In comparison, Connecticut has approximately 1.8 million acres of forest land, with 225 million trees over 5 inches dbh. Thus, the forested areas that would be affected by the proposed Project represent less than 0.015% of the state's total trees.

The predominant forested communities that would be affected by the Project are mixed deciduous woodlands. In the areas where tall-growing trees must be removed during construction, the ROWs subsequently would be managed in shrubland or old field habitat, for the life of the Project.

Converting forest to shrubland, open field, or old field vegetation along the transmission line ROWs would modify habitat, representing a long-term, but not necessarily an adverse, affect. In fact, the creation of additional shrubland and early successional habitat (and the preservation of such existing habitat) along the ROWs would represent a long-term benefit because shrubland habitat is otherwise declining in New England. This decline is a result of various factors (e.g., conversion of farms, suburban / urban development, ecological succession, absence of fire).

In Connecticut, transmission line ROWs are a major source of shrubland habitat. The ROWs are managed to promote early successional habitats, dominated by scrub-shrub vegetation and open areas with dense grasses and other herbaceous vegetation. Scrub-shrub communities within ROWs provide a variety of wildlife habitat functions (e.g., food, cover and nesting habitat for birds and small mammals,

[16] Estimates indicate that approximately 56,000 trees with dbh of 5 inches or greater would be removed from the ROWs as a result of the Project.

and cover and browse for whitetail deer; Ballard et al., 2004).[17] These plant communities also tend to offer habitats preferred by certain rare and other invertebrate species, including moths, butterflies, and bees, for certain stages of their annual life-cycles.

Other vegetative cover types within the ROWs that would be affected by the construction of the Project include existing open field/shrubland, agricultural land, areas occupied by houses/yards, commercial/industrial land uses and other land-use types (e.g., a golf driving range). However, the effects on these cover types and land uses would be mostly short-term. After the completion of Project construction, these vegetative community types and land uses, which are compatible with the existing transmission lines, would continue to coexist with the operation and maintenance of the proposed transmission line facilities.

6.1.3.1.2 Vegetation Management and Preservation Goals and Methods

The objective of CL&P's well-established vegetation management program is to maintain safe access to its transmission facilities and promote the growth of vegetative communities along its ROWs that are compatible with transmission line operation and in accordance with federal and state standards. The vegetation along the new transmission lines would be managed in accordance with these standards.

While CL&P has historically conducted ROW vegetation maintenance as a matter of good utility practice, since April 7, 2006, all public utilities have been required to comply with mandatory national standards adopted by the NERC and approved by FERC following the August 14, 2003 Northeast blackout, an event which was found to have been triggered by line outages caused by overgrown vegetation. CL&P's vegetation management practices are designed to allow the reliable operation of transmission lines by preventing the growth of trees or invasive vegetation interfering with the transmission facilities or access along the ROWs. As a result, the vegetation within the managed portions of CL&P's ROWs typically

[17] 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.

consists of shrubs, herbaceous species, and other low-growing species. Unused or un-managed portions of CL&P's ROWs not proximate to the existing lines may be characterized by forest vegetation, which is allowable as long as it does not conflict with the operation of overhead transmission lines.

For the Project, to stabilize disturbed sites after the installation of the new transmission lines, CL&P would restore approximate pre-construction elevations, seed with appropriate grass-type mixes, and mulch with hay/straw or wood chips as appropriate. Vegetative species compatible with the use of the ROWs for transmission line purposes are expected to regenerate naturally over time. CL&P would promote the re-growth of desirable species by implementing ROW vegetative management practices to control tall-growing trees and promote native plant colonization.

When performing ROW management, CL&P would take particular care to preserve vegetation along watercourses and within wetlands to the extent possible. In general, CL&P may alter, to some degree, its vegetation management activities in the following areas:

- Areas of visual sensitivity where vegetation removal may be limited for aesthetic purposes.
- Steep slopes and valleys spanned by transmission lines.
- Agricultural lands.
- Near homes where owner-maintained ornamental vegetation does not interfere with the construction or operation of the facilities.
- Within wetlands, amphibian breeding habitats, or along streams to preserve some shrub cover.
- Within the 25-foot vegetated riparian zone adjacent to watercourses and waterbodies.
- In areas documented to support rare animal species or host plant species that support rare invertebrates.

While undesirable tall-growing woody species within the ROWs and proximate to the new lines would be removed during construction, desirable species are preserved to the extent practical. In selected locations, certain desirable low-growing trees or tall growing shrubs, due to their growth characteristics and locations relative to the new lines, may be allowed to remain on the ROWs. These species would be trimmed to ensure adequate clearance from wires and structures, pursuant to CL&P's *Right-of-Way Vegetation Initial Clearance Standard for 115-kV and 345-kV Transmission Lines*. However, any vegetation preserved during construction activities may be removed in the future in accordance with CL&P's *Specification for Rights-of-Way Vegetation Management*. Generally, all tall-growing tree species would be removed from the conductor zones on the ROWs, whereas low-growing tree species and taller shrub species would be retained in the areas outside of the conductor zones. The conductor zone is the area directly beneath the conductors extending outward a distance of 15 feet from the outermost conductors.

6.1.3.1.3 Landowner Outreach and Beneficial Use of Forestry Products

The timber and firewood resources along the Proposed Route belong to the landowners across whose property the ROW is aligned. CL&P's policy is to proactively coordinate with landowners regarding the disposition and use of the trees to be removed along the ROWs. If requested by the landowner, the firewood and timber portions of the trees would be left on the landowner's property on the edge of the ROW. After the limbs are removed, the boles of the trees would be piled in tree-lengths for landowners to cut and remove at their convenience.

Timber and firewood removed along the ROW on CL&P-owned property or on parcels where the landowners are not interested in retaining the wood would become the property of the Project's land clearing contractor. CL&P would competitively bid the vegetation removal work for the Project and would select a contractor taking into consideration the contractor's plans for the beneficial use of the forest products.

6.1.3.2 Wildlife and Fishery Resources

6.1.3.2.1 Wildlife

The development of the 345-kV transmission lines would result in both temporary and permanent alteration of wildlife habitat along the ROWs, as well as direct effects on wildlife such as disturbance, displacement, or mortality. However, these effects would be localized on and in the vicinity of the ROWs, and would be generally short-term (for the duration of the construction phase of the Project). These effects also would be minor due to the availability of undisturbed habitat types, similar to those found on the ROWs, in adjacent areas and in the Project region as a whole. Furthermore, the Project would have a long-term beneficial effect on certain wildlife species (e.g., birds, butterflies, moths, bees) that use shrubland habitats.

During construction, the removal of vegetation within the construction footprint would displace wildlife and would reduce cover, nesting, and foraging habitat for some species. Other construction activities (e.g., the development of access roads and crane pads, general construction equipment movements, and construction-related noise) would similarly disturb or displace mobile wildlife species, such as large mammals and birds. These species would likely move to comparable nearby habitats.

In general, these adverse effects to wildlife would be localized to the immediate vicinity of construction sites. Some displaced wildlife could be expected to return to the ROWs shortly after the completion of construction activities. Furthermore, CL&P would minimize adverse effects to wildlife by adhering to mitigation measures, including Project-specific procedures expected to be developed in consultation with CT DEEP and the USACE during the permitting process. Following construction, wildlife species would be expected to re-colonize the habitats along the ROWs.

Within the construction ROW, the removal of existing forest vegetation and the conversion to low-growing vegetative communities would have a long-term beneficial effect on wildlife by providing additional habitat for species that use shrubland, open areas, edge, and early successional habitats. The wildlife species that would benefit from the additional shrubland habitat include mammals (e.g., New England cottontail, white-tailed deer, eastern mole, bats), various bird species (e.g., American Woodcock, Prairie Warbler, Brown Thrasher, Field Sparrow, Eastern Towhee, Red-tailed Hawk, Indigo Bunting, Gray Catbird, among others), and certain moth, butterfly, and bee species (as well as other invertebrates favoring shrubland habitats).

Forest-dwelling species would be displaced from the managed portions of the ROW, resulting in a long-term, but localized effect. Because of the dominance of forest in the Project region as a whole, forest-dwelling species displaced from the ROW would be expected to move to nearby forested habitats.

Overall, although the species of wildlife using the ROWs would be expected to change slightly, the ROWs would continue to provide diverse wildlife habitat. The exchange of forested habitats for shrublands is often interpreted as a net gain for regional biodiversity (Confer and Pascoe, 2003[18]). A study conducted by Nickerson and Thibodeau (1984) indicated an increase in wildlife utilization, especially in avian species, following clearing of ROWs.[19] The study attributed this increase in wildlife usage to the conversion of forested areas into both wetland and upland shrub and emergent plant communities. The management of ROW vegetation provided edge-effect feeding, nesting, and cover habitat for various species. The ROWs also serve as open corridors connecting non-contiguous natural areas.

Scrub-shrub habitats along the ROWs are dominated by low-growing, woody vegetation with trees nearly or entirely absent. Historically, these habitats were created by natural and anthropogenic disturbances, which have declined over time. Due to these reductions in disturbances, this habitat type currently represents a small and declining portion of the overall landscape in the northeastern U.S. (Trani et al.,

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18 United States Department of Agriculture (USDA), 2001, Trends in Connecticut's Forests: A Half-Century of Change, USDA Forest Service, Northeastern Research Station and Connecticut Department of Environmental Protection, Division of Forestry, Hartford, CT.

19 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, MA.

2001[20]). The overall lack of this type of habitat places additional value on existing and newly created scrub-shrub habitat often associated with utility corridors and the "edge effect" that these utility corridors create.

During the operating life of the transmission lines, routine vegetation management activities would result in localized and short-term displacement or disruption to wildlife species along and near the ROWs. Adverse effects on wildlife would be minimized, to the extent practical, by conducting routine vegetation management activities outside of critical wildlife use periods.

6.1.3.2.2 Fisheries

The construction and operation of the Project would have only minor and localized effects, if any, on fishery resources. The proposed 345-kV transmission lines would span all major waterbodies containing fisheries (e.g., the Tenmile River, Hop River, Willimantic River, Mansfield Hollow Lake, Natchaug River, the Little River, Blackwell Brook, Quinebaug River, and the Fivemile River). With the exception of temporary equipment access and the installation of 41 proposed new temporary or permanent culverts along access roads across smaller watercourses (Table 6-1), no new facilities are proposed for installation in any waterbodies, and no access roads will be installed across larger watercourses.

As listed in Table 6-1, access roads would be required across certain smaller watercourses that potentially support fisheries (e.g., Buttonball Brook, Merrick Brook, and Munson Brook). However, CL&P proposes to use temporary equipment bridges to span streams, or bridge and culvert combinations to maintain stream flows while providing access. Access roads across streams would be designed to avoid or minimize direct disturbance to stream banks and substrates to the extent practical, and would conform to USACE and CT DEEP permit requirements.

[20] Trani, M.K., Brooks, R.T., Schmidt, T.L., Rudis, V.A., Gabbard, C.M., 2001. Patterns and Trends of Early Successional Forests in the Eastern United States. Wildlife Society, Bulletin 29, 413–424.

Stream-bank vegetation provides important cover and shading for fish. Within a 25-foot-wide area adjacent to watercourses, riparian vegetation along the ROWs would be maintained, where possible. Vegetation would be cut only if necessary to maintain required clearances from conductors and access to and from the transmission facilities.

Temporary soil erosion and sedimentation controls would be installed around areas of disturbed soils at work sites up-gradient from streams. These temporary erosion controls would remain in place until the disturbed areas are revegetated or otherwise stabilized.

6.1.3.2.3 Amphibians

Based on the results of ROW field surveys conducted in both 2008 and 2011, the Proposed Route would traverse or be located near 88 vernal pools, as well as 29 other areas determined to function as amphibian breeding habitats. These areas, which are identified in Table 5-5 and are illustrated on the Volume 11 maps, and represent the vernal pools and amphibian breeding habitats identified within the width of CL&P's existing ROWs (i.e., both the presently managed and un-managed portions of the easements). Species commonly encountered during the surveys included spotted salamander, marbled salamander, wood frog, spring peeper, and fairy shrimp.

The majority of these vernal pools/amphibian-breeding habitats were found in wetlands that occupy the managed portions of the existing CL&P ROWs (characterized by shrub-scrub growth) and that extend into forested (i.e., presently un-managed) areas of the ROWs proposed for the location of the new transmission lines. Existing transmission line structures are located within 17 wetlands that provide vernal pool habitat or amphibian breeding habitat; four existing structures are located in amphibian breeding habitat areas of three wetlands (refer to Table 6-5, located at the end of this section). In addition, 10 existing access roads extend across vernal pools and seven existing access roads extend across amphibian breeding habitat areas. Existing access roads cross an additional 22 wetlands that provide vernal pool habitat or amphibian breeding habitat.

The construction of the new transmission lines would result in both direct and indirect adverse effects to amphibians. Table 6-5 summarizes these potential effects, by wetland. The principal construction activities that could affect amphibians include:

- The removal of vegetation in or the tree canopy over vernal pools;
- The development of or improvements to existing access roads through amphibian habitats;
- The movement of vehicles and equipment use on access roads in the vicinity of amphibian migratory routes;
- The placement of structures, counterpoise, and guys in vernal pools or amphibian breeding habitats (if such areas cannot otherwise be avoided);
- The potential for erosion and sedimentation into amphibian habitats;
- The loss of structural habitat features such as pit and mound micro-topography; and
- The development and use of distinct construction areas (crane pads constructed from fill material and/or timber mats) for structure installation in amphibian habitats during breeding periods, as well as at other times throughout the year.

The potential for adverse effects on amphibians could increase if construction activities cannot be scheduled to avoid critical amphibian breeding or migration periods in areas proximate to confirmed vernal pools and/or amphibian breeding habitats. Amphibian species that over-winter in uplands and migrate to wetland habitats to breed would be most vulnerable to disturbance associated with construction activities. Numerous amphibian species exhibit this reproductive strategy and the exact amphibian assemblages vary according to location along the CL&P ROWs.

Three of the more common of these species include wood frog, spotted salamander and, to a lesser degree, marbled salamander. Critical migration periods for these species vary annually and are closely associated with annual variations in weather. However, for adult individuals, most migration to and from the vernal pools and other amphibian breeding habitats typically occurs in March and April, with some activity carrying over into May. For the marbled salamander, the breeding strategy is opposite that of other mole salamander species, with adult migration to the pool areas occurring in the late summer and early fall. Both spring and fall migration events coincide with heavy rainfall.

To avoid or minimize adverse effects on amphibians, CL&P would locate, to the extent practicable, new structures, access roads, and construction work areas outside of wetlands that provide amphibian breeding habitat. However, some of the breeding habitats are embedded in larger wetland systems, which presently contain existing transmission line structures or access roads. As a result, it would not be feasible to avoid all such areas entirely.

As summarized in Table 6-5 and illustrated on the Volume 11 maps, based on the current Project design, the crane pad for one new transmission line structure would affect two vernal pool habitats (BR-13-VP and BR-14-VP). Six crane pads associated with new line structures in the towns of Chaplin, Hampton, Pomfret, Putnam, and Thompson could be located in amphibian breeding habitats (CH-7-ABH, HA-5-ABH, HA-6/BR-1-ABH, PO-1-ABH, PU-3-ABH, and TH-1-ABH). New line structures would be situated in an additional 10 wetlands that include areas that function as vernal pools or amphibian breeding habitat; however, no structures are anticipated to result in impacts to vernal pools. In addition, the development and use of access roads to these structure sites could result in additional temporary and permanent effects to the amphibian-breeding habitat functions.

CL&P continues to perform Project design studies and constructability reviews to minimize and avoid impact to vernal pool habitat areas, amphibian breeding habitats, and wetlands and streams that occur along the proposed Project route. CL&P would implement CT DEEP-approved measures to avoid or minimize potential adverse effects to vernal pools and amphibian breeding habitats as a result of the construction and operation of the new transmission lines. CL&P expects to consult with the CT DEEP to refine appropriate mitigation measures as the planning for the Project proceeds.

In addition, CL&P's consultants have reviewed the document entitled," Best Development Practices, Conserving Pool-Breeding Amphibians in Residential and Commercial Developments in the Northeastern United States"[21]. While a linear overhead transmission line such as the Project is not entirely consistent with the types of development described in this document, there are conservation issues and management recommendations that are applicable.

As a result of past experience, agency consultations, and literature reviews, CL&P has identified the following types of measures that may be applicable to minimize adverse Project effects on amphibians:

- Where feasible in areas proximate to vernal pools and other confirmed amphibian breeding habitats, adhere to the seasonal windows for tree clearing to avoid negative effects 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 erosion and sedimentation controls around distinct work sites and access roads to minimize the potential for sediment deposition into amphibian breeding areas, and remove such controls promptly after final site stabilization.
- Evaluate the use of temporary timber-mat access roads in wetlands in lieu of constructing gravel access roads in the vicinity of amphibian-breeding habitats.
- Minimize the removal of low-growing vegetation surrounding amphibian breeding pools.
- During the operation of the new transmission lines, incorporate measures to protect amphibian breeding habitat (e.g., maintain as much vegetative cover within and around vernal pools and other amphibian habitats 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 (e.g., CT DEEP) and would be incorporated into the D&M Plan(s) for the Project.

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[21] Calhoun, A.J.K. and M.W. Klemens. 2002 Best development practices: Conserving pool-breeding amphibians in residential and commercial developments in the northeastern United States. MCA Technical Paper No. 5, Metropolitan Conservation Alliance, Wildlife Conservation Society, Bronx, New York.

6.1.3.2.4 Birds

The proposed Project would result in both long-term benefits and short-term, but minor, effects on bird species that inhabit the ROWs and nearby areas. The principal effects would include:

- Long-term habitat modification due to the removal of trees along the ROWs during construction and the subsequent management of the ROWs in shrubland or other low-growing vegetative communities;
- Temporary displacement of bird species from the ROW and possible adjacent areas during construction (due to direct disturbance and noise); and
- Localized and short-term displacement as a result of periodic vegetation management activities during operation.

During the construction of the new transmission lines, forested and other vegetation along the ROWs would be removed, displacing the bird species that use such habitats. In addition, construction-related noise would likely disturb birds that would otherwise frequent the ROWs and adjacent areas. However, such noise-related disturbances will be localized in the vicinity of construction activities and would be short-term.

Depending on the time of year that construction activities are performed, bird breeding and nesting activities along and in the vicinity of the ROWs may be adversely affected. In general, the nesting season for a majority of the breeding birds found in the Project region extends from May 1 through July 31. Tree and other vegetation removal within the ROWs during this period could result in a loss of a breeding season for those species with established nests within or near proposed work sites. To the extent practical, taking into consideration the sequence of construction activities and other planning factors, CL&P would attempt to perform ROW vegetation removal activities outside of the breeding bird season to avoid or minimize adverse effects on nesting species.

After the completion of construction, the ROWs would be revegetated and managed in shrubland or other low-growth habitat typical of CL&P’s existing managed ROWs and consistent with CL&P’s standards for overhead transmission lines. Overall, the construction of the new 345-kV transmission lines will result in a net long-term loss of approximately 273acres of woodland habitat preferred by certain forest-dwelling bird species.

However, forest land is the dominant vegetative cover type in the Project region (and also in Connecticut as a whole) and thus ample alternative habitat for woodland bird species displaced from the presently forested portions of the ROWs will be available nearby. Further, CL&P has minimized the forest removal required for the Project by aligning the new 345-kV lines adjacent to existing, already managed, portions of its transmission line ROWs. The alignment of the new transmission lines within CL&P's existing ROWs, adjacent to areas currently under vegetation management consistent with transmission line use, would limit the width of vegetation removal, compared to the clearing that would otherwise be required for the creation of a new utility corridor for overhead lines. In addition, during construction, CL&P proposes to limit vegetation removal to areas needed for the installation and safe operation of Project facilities.

The permanent loss of the 273 acres of woodland habitats (mixed deciduous forest/conifers and forested wetlands) along the ROWs would be offset by a corresponding increase in the acreage of early successional habitat types, which are favored by certain bird species. Because early successional habitats, such as those found on managed utility ROWs, are in decline in Connecticut as well as throughout the northeastern U.S., the expansion of these habitat types along the Project ROWs would benefit bird species that use such areas. The recent declines in populations of shrubland birds in the Northeast are a growing concern among avian conservationists. Consequently, any adverse effects to woodland-dwelling bird species would be mitigated to a large extent by benefits to shrubland bird species.

Increasing the width of the managed ROWs to accommodate the proposed new transmission lines, and maintaining the ROWs in shrubland or other low-growing vegetation, would have a long-term, positive effect on bird species that use old-field/shrub and sapling thickets, shrub swamps, emergent marsh, and to a lesser degree open water (i.e., wetlands that periodically flood), as the amount of this habitat type would permanently increase. Studies of a 100-foot-wide ROW in Massachusetts indicated nest predation was highest along the ROW/forest edge, and a wider ROW may therefore actually benefit shrubland-nesting bird species by providing more potential nesting sites away from the edge habitat (King and Byers 2002).[22]

Lastly, adverse effects to woodland-dwelling birds associated with the permanent removal of forest habitats from the ROWs would likely be offset by the implementation of CL&P's compensatory mitigation plan for the Project. This plan, which would be developed in consultation with the USACE and the CT DEEP, is anticipated to include the preservation of upland forest lands, including forested buffers around forested wetlands.

6.1.3.3 Federal and State Listed or Proposed Threatened, Endangered, or Special Concern Species

CL&P contacted both the USFWS and the CT DEEP to identify general measures to avoid or minimize adverse effects on federal- and state-listed species that may inhabit the ROWs. CL&P expects to consult in more detail with these agencies as the planning for the Project continues. As a result of the implementation of the measures discussed below, or similar or additional measures that may be identified during future agency consultations, CL&P anticipates that no significant adverse effects would occur to any listed species.

6.1.3.3.1 Federally Listed Species

Although no federally listed threatened or endangered species are reported to occur in the Project area, one candidate species, the New England cottontail, is known to inhabit areas in the general vicinity of the ROW in the Town of Lebanon. The New England cottontail inhabits scrub-shrubland habitats such as

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[22] King, D.I. and B.E. Byers. 2002. *An Evaluation of Powerline ROWs as Habitat from Early Successional Shrubland Birds.* Wildlife Society Bulletin, 30(3), 868-874.

those found along utility corridors; therefore, the USFWS recommended vegetation management to preserve scrub-shrub habitat along the Project ROWs.

The increase in shrubland habitat that would be created by the Project would potentially benefit the New England cottontail. CL&P would conform to the USFWS's recommendation by implementing its standard vegetation management program with periodic ROW management to promote the growth of shrubs, herbaceous species, and low-growing tree species.

6.1.3.3.2 State-Listed Species

Based on initial consultations with the CT NDDB and follow-up wildlife habitat surveys, 29 state-listed species potentially inhabit areas in the vicinity of the Proposed Route. These include seven bird species, one turtle species, two snake species, one aquatic snail species, one dragonfly species, and 17 butterfly and moth species. Table 6-6 lists these rare species, identifies the legal status of each species, summarizes each species' ecological/habitat preference, and provides a general location of each species' habitat in relation to the ROWs.

The following sections summarize the potential effects and the types of possible mitigation measures that CL&P has identified to date for protecting these species. As the planning for the Project proceeds, CL&P will consult with the CT DEEP to define species-appropriate mitigation strategies. Such mitigation would be incorporated into the D&M Plan(s) and other Project specifications.

Table 6-6: Summary of State-Listed Threatened, Endangered, or Special Concern Species in Vicinity of Proposed Route

Scientific (Latin) Name	Common Name	Town	State Status*	Habitat (Nesting/Breeding/Active Periods)
Birds				
Eremophila alpestris	Horned Lark	Mansfield	SE	Open areas/fallow fields April-August
Ammodramus savannarum	Grasshopper Sparrow	Mansfield	SE	Grasslands, pastures and old fields with open ground May-August
Falco sparverius	American Kestrel	Mansfield	ST	Grassland or shrubland at the edge of forest; requires cavities for nesting April-August
Passerculus sandwichensis	Savannah Sparrow	Mansfield	SSC	Grasslands and field habitats with damp soils May-August
Sturnella magna	Eastern Meadowlark	Mansfield	SSC	Grasslands and old fields May-August
Caprimulgus vociferus	Whip-poor-will	Putnam	SSC	Scrubby immature woods, wooded areas following a disturbance May-July
Reptiles				
Thamnophis sauritus	Eastern ribbon snake	Chaplin, Hampton, Killingly, Putnam	SSC	Wetlands, edges of ponds and streams April 1 through October 31
Heterodon platirhinos	Eastern hognose snake	Mansfield	SSC	Sandy soils, wooded areas April 1 through October 31
Glyptemys insculpta	wood turtle	Pomfret	SSC	Riparian areas with large floodplains, forests, fields April 1 through October 31
Aquatic Snail				
Gyraulus circumstriatus	aquatic snail	Mansfield	SSC	Fresh water
Odonates				
Gomphus adelphus	moustached clubtail (Dragonfly)	Chaplin	ST	Cold water gravelly or rocky rivers June and July

Table 6-6: Summary of State-Listed Threatened, Endangered, or Special Concern Species in Vicinity of Proposed Route

Scientific (Latin) Name	Common Name	Town	State Status*	Habitat (Nesting/Breeding/Active Periods)
Lepidoptera				
Butterflies				
Erynnis horatius	Horace's duskywing	Mansfield Chaplin	SSC	Xeric rocky areas; open woodlands and edges; oaks and wildflowers
Callophryus irus	Frosted elfin	Mansfield Chaplin Brooklyn, Killingly, Pomfret, Thompson	ST	Xeric and open disturbance-dependent habitats on sandy soil; hosts include wild indigo or lupine
Erynnis brizo	Sleepy duskywing	Mansfield Thompson	SSC	Barrens and areas with poor, thin or well drained (often sandy) soils; oaks, early spring wildflowers
Chlosyne harrisii	Harris' checkerspot	Mansfield Chaplin Windham	ST	Moist areas (bogs, meadows, marshes)
Erynnis persius	Persius duskywing	Killingly	SE	Open, sunny oak woodlands, balds, and barrens
Moths				
Zale obliqua	Oblique Zale Moth/Noctuid moth	Mansfield	SSC	Pitch pine/scrub oak habitats and barrens
Zanclognatha martha	Pine Barrens Noctuid moth	Mansfield	ST	Pitch pine/scrub oak habitats and barrens
Lepipolys (Sympistis) perscripta	Scribbled sallow	Mansfield Thompson	SSC	Disturbed sandy soil habitats, with host plant *Lineria canadensis* (Blue Toadflax)
Apamea burgessi	Burgess' cutworm	Chaplin Killingly	SSC	Xeric sandy sites
Chaetaglaea cerata	Noctuid moth	Mansfield	SSC	Pitch pine/scrub oak habitats and barrens and heathlands on sandplains
Eucoptocnemis fimbriaris	Noctuid moth	Mansfield Killingly	SSC	Dry grassy or sandy fields, Pitch pine/scrub oak habitats and barrens, and other open, dry sites
Schinia spinosae	Jointweed Flower Moth	Mansfield	SSC	Sandplains and open disturbed sites, associated with jointweed
Euchlaena madusaria	Shrub euchlaena, Moth	Mansfield Thompson	ST	Lowbush blueberry heathlands and grasslands, scrub oak shrublands
Chlosyne harrisii	Harris' checkerspot	Mansfield and Chaplin	SE	Moist areas such as bogs, meadows and marshes
Hemaris gracilis	Slender clearwing	Killingly, Thompson, Pomfret	ST	Open shrub lands
Hemileuca maia	Buck moth	Putnam	SE	Expansive, open (sunny), pitch pine-scrub oak barrens and woodlands
Metarranthis apiciara	Barrens metarranthis	Killingly	SE	Dry rocky woods to pitch pine barrens

*Key: SSC=State Species of Special Concern, ST=State Threatened, SE=State Endangered

Bird Species

Of the six state-listed bird species initially identified by the CT NDDB (refer to Table 6-6), five typically inhabit grassy or old field habitats and shrub land areas, while the sixth, the Whip-poor-will, is found principally in a variety of habitats, including shrubby, immature woods and deciduous and mixed forest lands. A seventh species, the Brown Thrasher (a state-listed species of special concern), was not listed as occurring in the Project vicinity by the CT NDDB, but was observed by CL&P's consultants during ROW surveys in 2008; this species also occupies shrub habitats.

Except for the Whip-poor-will, the state-listed birds known to inhabit areas near the ROWs all generally prefer shrub or grassland habitats, which would increase as a result of the Project. Therefore, the Project could have long-term positive, localized effects on some of these species. In contrast, the construction of the Project would represent a loss of available woodland breeding habitat on the ROW for the Whip-poor-will. However, because of the predominance of forested areas in the Project region as a whole, the removal of forested vegetation along the ROWs would have a negligible effect on Whip-poor-will populations. (Further, field surveys for the Whip-poor-will conducted in both 2008 and 2011 along ROW segments in the Town of Putnam failed to identify the presence of this species; refer to Volume 4, *Inventory of Potential Breeding Bird Species and Habitats*.)

Construction, vegetation removal, and other activities along the ROWs could directly affect existing habitat, including nest sites, for all of the identified rare bird species. These disturbances would be temporary and localized. If displaced by construction activities, these bird species would likely return to the ROWs once construction is complete.

CL&P's consultants performed pre-construction avian surveys in the areas identified by the CT NDDB to determine if the subject rare species are using the Project ROWs. Although no listed bird species were documented as using the ROWs, the American Kestrel, Brown Thrasher, and Eastern Meadowlark were observed in the vicinity of the ROW in the identified habitats in the Mansfield Hollow area. However, because the shrublands on the ROW provide suitable habitat for the three species, it is possible that they may periodically use the ROW. As noted above, no listed species were observed on or adjacent to the subject habitats in Putnam (refer to the *Inventory of Potential Breeding Bird Species and Habitats along the Connecticut Portion of the Interstate Reliability Project*, Volume 4).

CL&P would coordinate with CT DEEP to identify appropriate mitigation measures for state-listed bird species. Mitigation options that could be considered may include scheduling vegetation removal activities outside of the breeding bird season and developing methods to identify and avoid active nest sites for any rare avian species located within the construction workspace (e.g., the nest site and the areas immediately adjacent could be isolated with fencing and avoided by construction until such time as the young have successfully left the nest site and fledged).

Wood turtle (*Glyptemys insculpta*)

One area near the Proposed Route in the Town of Pomfret was identified by the CT NDDB as potentially supporting the wood turtle. The mapped habitat is associated with the Quinebaug River, and is located west of the Proposed Route. However, because the Proposed Route would span the Quinebaug River just south of the mapped habitat area, wood turtles could be present in the vicinity of the ROW at this river crossing.

Due to the ecology and life history of the wood turtle, potential negative effects to this species are easier to avoid than other species of turtles. This is due to the fact that the wood turtle over-winters in moving water bodies, often in the deeper portions or pools of larger streams and small rivers tucked into root masses and other forms of underwater structure. Hibernation typically occurs from approximately November 1 through April 1.

In the vicinity of the mapped habitat for this turtle species, CL&P does not anticipate any in-water work associated with the construction of the new transmission lines. Therefore, the Project would not be expected to result in any negative effects on this important habitat component. When active, this species uses riparian habitats bordered by woodlands, meadows, and linear ROWs such as those associated with natural gas pipelines and overhead transmission lines.

Although the construction of the proposed Project is unlikely to affect turtles during the hibernating period, it is possible that activities (e.g., vegetation removal and grading) performed along the ROWs when the turtles are actively foraging (i.e., during April through October) could adversely affect individual turtles. For example, turtles could be killed or temporarily displaced as a result of construction activities. However, when construction is complete, the turtles would once again use these habitats.

The CT DEEP has in the past stated a preference for construction activities within wood turtle habitat to be performed during the dormant period for the species (i.e., November through March). However, CL&P recently consulted with the CT DEEP regarding mitigation for potential adverse effects on wood turtles for another overhead transmission line project in Connecticut, and the CT DEEP was amendable to different construction timing restrictions, along with the following mitigation provisions:

- During the wood turtle's active period (April 1 through October 31), a CT DEEP-approved turtle ecologist/monitor would be present whenever construction activities take place in wood turtle habitats. To ensure their safety, any wood turtles encountered would be removed from active work space and placed in the direction they were moving when first observed.

- A contractor awareness program would be developed and implemented to ensure all contractors can identify the turtles and are made aware of the proper handling and care procedures for the species should one be observed in active work space.

- Initial ROW vegetation removal activities would minimize removal of low-growth vegetation in all areas adjacent to rivers/streams documented to support wood turtles.

- An erosion and sedimentation control plan would be implemented to avoid and/or minimize the deposition of sediment into wetland habitats. (Erosion controls such as silt fence and hay/straw bales would also provide some measure of protection by precluding wood turtles from accessing active construction areas.)

CL&P would consult further with the CT DEEP to define appropriate measures to avoid or mitigate adverse effects to wood turtles as a result of the Project. These measures could include some or all of the above provisions and would be specific to the wood turtle habitats in the vicinity of the Proposed Route near the Quinebaug River.

Aquatic snail (*Gyraulus circumstriatus*)

According to the CT NDDB, the aquatic snail occurs in aquatic habitats in the Mansfield Hollow section of the Project ROW. This snail prefers shallow water habitats of lakes and shorefronts where it feeds on algae. The organism is vulnerable to significant water elevation changes, to which it cannot respond quickly enough and is stranded out of water where it desiccates and perishes. The snail is also vulnerable to changes in water quality parameters such as dissolved oxygen and salts. In addition, negative impacts to this species are possible from erosion and sedimentation to the subject habitats as a result of construction activities in adjacent uplands.

However, as currently designed, the Project would not involve any in-water work in the subject habitat (i.e., no structures or access roads would be placed in lakes or along shores known to provide habitat for this snail). As a result, the snail is not expected to be directly affected. Potential indirect effects (e.g., sedimentation into watercourses) would be minimized by preserving the vegetation along the ROWs in riparian zones and by installing and maintaining the proper erosion and sedimentation controls around areas of disturbed upland soils.

Odonates – moustached clubtail (*Gomphus adelphus*)

According to the CT NDDB, this dragonfly occurs in the vicinity of the ROW south of the Sherman Corner area in the towns of Mansfield and Chaplin. The moustached clubtail's habitat includes clear, cold-water rivers or streams with gravel or rocky riverbeds. Potential effects to this rare invertebrate could occur if construction activities cause a reduction in water quality, either by direct in-water disturbance or indirect effects associated with sedimentation/runoff into the watercourse as a result of earth-disturbing activities in adjacent areas.

As designed, the Project would require some construction activities that could directly affect aquatic habitats that could potentially support this rare dragonfly. For example, direct or indirect effects to water quality could occur from the installation of culverts across streams and from earth-disturbing activities near watercourses (e.g., development of access roads and crane pads). CL&P would coordinate with CT DEEP to identify appropriate measures to avoid or mitigate adverse effects to this species' habitat and in particular to its aquatic life-cycle. Potential mitigation options may include avoiding or minimizing construction workspace in the species' habitat, maintaining a vegetated riparian zone during construction, and implementing soil erosion and sedimentation controls.

Snakes – Eastern hognose snake (*Heterodon platirhinos*)

According to the CT NDDB, this species occurs along the ROW in the Mansfield Hollow area of the Town of Mansfield. The Eastern hognose snake prefers areas of woodlands and fields with well-drained sandy/gravelly soils and is typically dormant from approximately November 1 through April 1. Construction activities might temporarily displace this species from available habitats or, although unlikely, result in some individual mortality. However, abundant suitable habitat, which will not be disturbed by the Project, is present immediately adjacent to the ROW. Due to the presence of such habitats, adverse effects to this species are anticipated to be negligible.

Initial consultations with the CT DEEP indicated the agency's preference for construction activities to occur during the snake's dormant period. However, CL&P's more recent consultations with the CT DEEP regarding this species for another transmission line project resulted in the identification of other possible measures to mitigate potential adverse effects to Eastern hognose snakes. These measures include the following:

- In the subject habitats and during the active period for Eastern hognose snakes (April 1 through October 31), a CT DEEP-approved snake ecologist/monitor would be present on the ROW whenever construction takes place. Any hognose snake encountered would be removed from active workspace to ensure its safety.

- A contractor awareness program would be developed and implemented to ensure contractor personnel can identify the snakes and know the proper handling and care procedures for the species should one be observed in active work space.

To avoid or minimize the potential for adverse effects to the Eastern hognose snake as a result of the Project, CL&P would consult with CT DEEP to refine Project-specific mitigation measures.

Eastern ribbon snake (*Thamnophis sauritus*)

The Eastern ribbon snake is reported by the CT NDDB to occur along the Project ROW in the Towns of Putnam. During vernal pool surveys along the ROWs conducted in 2008 and 2011, CL&P's consultants found these snakes in wetlands in the towns of Chaplin, Hampton, and Killingly but no snakes were located in the Town of Putnam. This snake prefers areas near shallow water habitats with dense herbaceous and shrubby vegetation.

Much like the Eastern hognose snake, the construction of the proposed Project could affect the Eastern ribbon snake through direct mortality, as well as by displacement due to disturbance associated with construction activities. However, proper installation of temporary equipment bridges across watercourses, the preservation of a vegetated riparian zone along the ROWs adjacent to watercourses, and the installation and continued maintenance of erosion and sedimentation controls would together avoid or minimize effects to the species' preferred habitat.

During initial consultations with CL&P concerning the Project, the CT DEEP recommended that construction be conducted during this snake species' dormant season (i.e., November 1 to April 1). However, during an April 1, 2008 meeting regarding the proposed Project, CT DEEP stated a preference for construction to be performed during the snake's active period to avoid disturbance to snakes in unknown (winter) hibernation sites. Consistent with the potential mitigation measures for the Eastern hognose snake, CL&P would consider the following techniques to avoid or minimize potential adverse effects to Eastern ribbon snakes:

- In the subject habitats and during the active period for Eastern ribbon snakes (April 1 through October 31), a CT DEEP-approved snake ecologist/monitor would be present on the ROW during active construction. Any ribbon snakes encountered would be removed and transported to locations outside of active workspace.
- A contractor awareness program would be developed and implemented to ensure contractor personnel can identify the snakes and know the proper handling and care procedures for the species, should snakes be observed in active work spaces.

Butterflies and Moths

As identified in Section 5.1.3.3 and described in detail in the *Insect Report* included in Volume 4, surveys of the ROWs conducted by UCONN's CCB identified 17 rare butterfly and moth species. Table 6-6 lists these species, identifying the habitats of each, and general location found along the ROWs. CCB's recommended mitigation measures for the moth and butterfly species are presented in the *Insect Report* in Volume 4 and summarized below.

Potential effects to butterfly and moth species and their habitats relate to the reduction and/or destruction of the identified host plant communities as a result of construction activities, as well as direct impacts to larval stages of these species, if present in areas of impacted host plant communities. Such activities include but are not limited to the establishment of staging areas, access road construction or improvements, crane-pad construction, construction activities related to structure locations, and pulling pad locations for stringing lines.

As part of UCONN CCB's invertebrate survey, stands of host plants and host plant communities were identified, located via GPS, and depicted on digital orthophotographs. In addition, two critical habitats for Lepidoptera were identified along the ROWs. Referred to as "Portfolio" sites, these habitats are found in sandplain-shrubland areas in the Towns of Killingly, Putnam, and Thompson. Collectively, these two areas accounted for 65% of the rare Lepidoptera species occurrences recorded during the surveys.

According to UCONN CCB, the more important area occurs in Putnam and Killingly, extending from just west of the Quinebaug River east to the southwest-facing slope above Park Road. The second portfolio site occurs in Thompson, extending from Elmwood Hill Road northeast to the Rhode Island border.

By minimizing the temporary and permanent footprint of the Project's design to the extent practicable, CL&P anticipates reducing adverse effects to these important habitats. Additional rare species surveys are recommended by UCONN CCB, since the focus of the surveys conducted to date was to identify critical habitats, rather than to conduct a comprehensive survey of rare invertebrate colony locations along the ROWs.

Overall, consultations with UCONN CCB indicate that the construction of the Project, and subsequent management of the ROWs in shrubland, would benefit rare Lepidoptera, most of which are found in shrub land areas similar to those promoted by CL&P's ROW vegetation management program. UCONN CCB also has noted that while avoidance of host plant communities for rare Lepidoptera would be beneficial, the principal host vegetative species used by the moths and butterflies would all be expected to recolonize the ROWs naturally, shortly after construction activities cease. CL&P will continue to consult with UCONN CCB and CT DEEP to develop specific measures for mitigating adverse effects on rare Lepidoptera.

Where significant on-ROW plant stands/communities have the potential to serve as hosts for state-listed species of butterflies and moths, CL&P would attempt to minimize direct effects on these areas during construction, as practical. Identified plant communities could be protected by installing exclusion fencing, such as snow fencing. If the host-plant communities occur within the footprint of proposed construction work areas, CL&P would consult with the CT DEEP regarding any specific recommended mitigation measures, such as potential construction windows identified by UCONN's CCB.

In addition, in an effort to limit adverse effects on these species, CL&P anticipates using some or all of the following mitigation measures:

- Avoid impacts to mapped significant stands of host plants along the ROWs, where practical.
- Limit "improvements" (surfacing with gravel or excessive grading/widening) to existing dirt access roads along the ROWs.
- Develop and implement a *Vegetation Management Plan*, with the objectives of reducing invasive species colonization along the ROWs and promoting the growth of native host plant species assemblages for rare Lepidoptera.
- Avoid permanent adverse effects along the ROWs to the two identified "portfolio" sandplain-shrublands to the extent practicable.
- Perform additional rare species surveys targeted to certain areas of the ROWs.

Project wide, limiting the footprint of the Project in the significant stands of host plant/plant communities would be beneficial for sustaining extant rare species habitat. Large areas immediately adjacent to existing access roads have been documented as supporting significant stands of wild indigo. This plant species is an important host for the rare frosted elfin and Persius duskywing, both of which have been confirmed on the ROWs. Therefore, by limiting access road improvements, (e.g., grading, widening, surfacing with gravel) or by implementing access road improvements so as to avoid wild indigo to the extent practical, these plants would be preserved, thereby potentially benefiting these rare species.

After the completion of construction, the wider managed portions of the ROWs would likely promote additional habitat for the moths and butterflies that use shrubland communities, creating a long-term benefit for these species. As critical habitat and host plant community cover types are compatible with the long-term operation and maintenance of overhead transmission lines, CL&P is considering the development of a habitat management plan for rare butterflies and moths. Such a plan would need to be comprehensive and incorporate aspects of, as well as modifications to, CL&P's existing *Vegetation*

Management Plan. In addition, such a plan would have to incorporate measures consistent with an *Invasive Species Management Plan*.

6.1.4 Land Use, Recreational/Scenic Resources, and Land-Use Plans

The proposed 345-kV transmission lines would be located adjacent to existing CL&P overhead transmission lines, within ROWs that have been long-established for utility purposes. Consequently, the overall development of the proposed transmission line facilities would be consistent with existing and future land use plans and would typically result in incremental effects on land uses, recreational resources, and scenic views.

6.1.4.1 Land Use

The Project would result in both short-term and long-term effects on land uses. Because the new 345-kV transmission line would be aligned along existing CL&P ROWs that have been dedicated to utility use for decades, the overall effects on land uses will be minor and localized.

Except for approximately 11 acres across the federally-owned lands in the Mansfield Hollow area of the towns of Mansfield and Chaplin, the new 345-kV transmission lines would be located within existing CL&P easements or within CL&P-owned properties. Overall, approximately 5 miles (13.4%) of the 36.8-mile-long transmission line route will extend across lands owned by CL&P.

The acquisition of the 11 acres of new easement from the USACE would result in the conversion of these properties from forested, recreational uses to utility purposes. The existing forested areas would be converted to scrub-shrub land along these expanded ROW segments, representing a long-term change in land use. However, the same recreational uses (principally hiking and nature viewing) that occur along CL&P's existing managed ROW through the Mansfield Hollow properties would continue.

Table 6-7 summarizes the land uses, by town zoning data land use category along CL&P's Proposed 345-kV transmission line route within the existing CL&P ROWs. The construction of the proposed transmission lines would convert approximately 222 acres of upland forest and approximately 51 acres of forested wetlands to scrub/shrub lands (refer to Table 6-8).

Table 6-7: Summary of Land Uses, by Town, along CL&P's Proposed Route within the Existing CL&P ROWs

Town	Land Use Type Traversed[1] (acres)										
	Agricultural[1]	Commercial/ Industrial[1]	House/Yard[1]	Open Field – Shrub Land[1]	Open Water[2]	Emergent Wetlands[2]	Forested Wetlands[2]	Scrub-Shrub Wetlands[2]	Right-of-Way	State Wetlands[2]	Upland Forest[1]
Lebanon	0	0	0	5.4	0.4	0	0.3	3.2	0	0.9	1.2
Columbia	0	<0.1	3.3	42.7	0.5	0.3	2.5	13.9	1.4	0	8.2
Coventry	2.8	0	1.7	24.6	0.8	2.7	1.8	1.1	4.2	0	9.7
Mansfield	22.3	0.1	1.8	93.6	3.4	1.3	12.9	7.9	3.4	0	74.2
Chaplin	2.3	0	14.4	43.4	12.3	0.5	8.9	8.6	0.7	0	25.2
Hampton	8.6	0	3.3	51.8	1.0	0.1	19.9	15.9	1.5	0	52.9
Brooklyn	5.2	0	4.7	118.7	3.1	16.0	20.7	18.4	3.2	0	76.9
Pomfret	24.1	0	0.2	28.7	1.0	0	1.1	6.7	0.4	1.9	9.1
Killingly	4.3	9.7	2.1	79.2	1.6	0	1.5	7.9	4.1	8.8	3.9
Putnam	18.7	15.6	3.5	101.7	4.3	2.4	20.8	20.2	3.8	0	41.3
Thompson	0	0	0.3	34.9	0	8.1	1.2	1.3	0.7	0	24.8
Total	**88.3**	**25.4**	**35.3**	**624.7**	**28.4**	**31.4**	**91.6**	**105.1**	**23.4**	**11.6**	**327.4**

[1] Land use type based on town zoning data and not field investigations along the Proposed Route; therefore, the estimated numbers do not accurately represent actual conditions or water resource delineations completed in the field.

[2] Land use type is an estimate and may not be consistent with actual areas traversed by the Proposed Route based on field observations and field data for wetland boundaries (Volume 2).

Table 6-8: Approximate Acres of Forest Land to be Converted to Scrub-Shrub Land, by Town

Town	Areas within the Vegetation Removal Limits of the Proposed Route (Estimated Acres)	
	Forested Wetlands	Forested Upland
Lebanon	0.3	0.8
Columbia	0.3	3.5
Coventry	0.9	6.4
Mansfield	6.4	44.1
Chaplin	5.2	24.1
Hampton	11.4	31.0
Brooklyn	10.5	50.0
Pomfret	1.2	10.0
Killingly	2.8	1.2
Putnam	11.6	33.5
Thompson	0.4	17.0
Total*	**51.0**	**221.6**

Notes: 1. Forest land refers to mixed hardwood and deciduous tree species in both wetlands and uplands. 2. Totals include tree removal required along the Proposed Route pursuant to 345-kV conductor clearance specifications and represent the estimated acreage that would subsequently be managed in shrubland vegetation, consistent with the operation of the 345-kV overhead transmission lines. Additional forested vegetation removal may be required along access roads and construction work areas located outside of the identified "limits of vegetation removal" for conductor clearance purposes.

The upland forest land use type would be converted to open field – shrubland, whereas the forested wetland land-use type would be converted to emergent or scrub-shrub wetlands. Construction would also temporarily affect certain agricultural areas, open fields, residential areas (house/yard), and commercial and industrial properties within CL&P's existing ROWs. However, the operation of the Project would not affect these land uses, which are presently consistent with CL&P's existing easement requirements.

6.1.4.2 Consistency with Existing and Future Land-Use Plans

Municipal consultations and evaluations of land-use documents indicate that the development of the Project would not conflict with local land-use plans, because the proposed transmission facilities would be located within (or in the case of the federally-owned Mansfield Hollow properties, adjacent to) existing, long-established CL&P ROWs already dedicated to energy use. Along the ROWs, CL&P's existing easements already preclude permanent non-utility structures.

During, prior to, and after the 2008 MCF and the 2011 Supplemental MCF processes, CL&P solicited input from the various affected municipalities along the ROWs and expects to continue coordinating with such municipalities as planning for the Project progresses. CL&P has also reviewed the *Conservation and Development Policies Plan for Connecticut 2005-2010* (C&D Plan), prepared by the Connecticut Office of Policy and Management, for information relating to the State's growth in general, and regarding regional and local plans relevant to the towns of Lebanon, Columbia, Coventry, Mansfield, Chaplin, Hampton, Brooklyn, Pomfret, Killingly, Putnam, and Thompson. The C&D Plan objective is to guide and balance response to human, environmental, and economic needs in a manner best suiting Connecticut's future.

Based upon the general planning information provided in the C&D Plan, the Project is consistent with the overall C&D Plan goals and objectives and serves a public need for a reliable transmission of electricity for the State of Connecticut. As stated in the C&D Plan, "the ability to redevelop Connecticut's Regional Centers requires existing infrastructure be maintained and updated to support compact urban development. This holds true and is particularly relevant regarding electric capacity and delivery systems." (p. 22)

CL&P also reviewed the future land use and planning objectives of the WINCOG and the NECCOG (the two regional planning agencies encompassing the Project area). The Project is consistent with these plans. Based on the information provided in the *Windham Region Land Use Plan* (2010), the WINCOG seeks to promote coordinated land development of the planning region with the greatest efficiency and economy for the welfare and prosperity of its citizens. NECCOG's mission is to serve as a forum to identify, study, and solve regional issues, develop policies and initiate actions of mutual benefit to member towns, promote cooperative arrangements and coordinated action, coordinate and carry out comprehensive regional planning, and provide technical assistance to members.

6.1.4.3 Public Forests, Parks, Open Space, Recreational / Public Trust Lands, and Trails

The new 345-kV transmission lines would be aligned within CL&P's existing ROWs across various designated recreational areas, including Mansfield Hollow State Park, Mansfield Hollow WMA, the Natchaug State Forest, and recreational trails (e.g., Airline State Park Trail, Hop River Trail, Nipmuck Trail [both branches], and the Levee Trail and Red Trail within Mansfield Hollow State Park). In addition, as discussed in Section 6.4.1.1, CL&P proposes to acquire 11 acres of additional easement to install the new 345-kV line across the USACE-owned Mansfield Hollow WMA and Mansfield Hollow State Park.

In general, adverse effects on recreational uses would be short-term, lasting only for the duration of construction. The operation and maintenance of the new transmission lines would not alter the use of the recreational areas along the ROWs. Further, the expansion of shrubland habitat could benefit some recreational activities, such as hunting within the Mansfield Hollow WMA and Natchaug State Forest.

CL&P also considered the potential effects of the proposed 345-kV transmission lines on the Quinebaug-Shetucket Rivers Valley National Heritage Corridor, which encompasses 10 of the 11 towns along the Proposed Route. With the exception of the 1.4-mile segment through the Mansfield Hollow area where CL&P proposes to acquire 11 acres of new easement, the new transmission lines would be constructed and operated entirely within CL&P's existing ROWs, which were established for energy transmission purposes decades prior to the designation of the National Heritage Corridor. The proposed transmission lines would be consistent with the existing utility use of the ROWs and would not create significant adverse effects on the environment or cultural resources in the region. CL&P's adherence to Project-specific mitigation measures developed during the course of the Council's application review proceedings, as well as during the processes of obtaining permits from the CT DEEP and USACE would further serve to avoid or minimize adverse effects on the ecology and environment in the National Heritage Corridor area.

In the Mansfield Hollow areas, the existing CL&P ROW and proposed areas of easement expansion cross approximately 0.8 mile of Mansfield Hollow State Park and 0.1 mile of the Mansfield Hollow WMA within the Town of Mansfield, and approximately 0.5 mile of the WMA in the Town of Chaplin. The Project will have no long-term adverse effects on existing recreational areas or activities in the Mansfield Hollow areas. The Mansfield Hollow State Park and WMA are used year-round and CL&P would be sensitive to seasonal uses during construction; however, potential short term effects may occur during construction. Such potential short term effects may include temporary trail closures and the temporary suspension of hunting during construction activities in certain areas of the Mansfield Hollow WMA in the vicinity of the existing CL&P ROWs and easement expansion. Construction work would be coordinated, when possible, to avoid potential effects to hiking use and WMA use. The proposed Project would not affect major recreational use areas of the Mansfield Hollow State Park, including the boat launch on the lake, or the WMA in general (i.e., overall hunting, the dog training area).

CL&P would consult with representatives of these affected recreational areas to identify site-specific mitigation measures, including possible construction scheduling and ROW restoration. In addition, CL&P would provide an anticipated construction schedule to representatives of each recreational use area. The schedule would define CL&P’s proposed plans for minimizing disruptions to recreational uses during construction, such as proposed road closures, detours/re-routes, signs along trails and public use areas identifying work zones, etc.

6.1.4.4 Designated Protected and Scenic Resources

As identified in Section 5.1.4.5, the proposed 345-kV transmission lines would be aligned adjacent to CL&P’s existing overhead transmission lines across or near various designated public open space and scenic areas. CL&P has carefully evaluated the proposed Project facilities in relation to these areas and has attempted to minimize incremental visual effects to the extent practical by designing the new transmission facilities to be similar in appearance to the existing overhead line structures and by aligning new structures generally parallel to existing structures.

In addition, as described in Section 5.1.4.5, CL&P conducted field reconnaissance of all known scenic and protected open space areas in the vicinity of the ROWs to assess viewpoints from these areas to the existing transmission lines and, based on these analyses, to identify areas from which to perform photo-simulations to further evaluate the potential changes that the new overhead transmission lines would have on the viewscape. At each location where views of the transmission line were identified as a potentially dominant component of the local viewscape, CL&P prepared photo-simulations depicting views of the ROW (illustrating the new and existing transmission lines) under two conditions: (1) during the late fall through late winter/early spring, when no deciduous vegetation was present (i.e., “leaf off” conditions); and (2) during the late spring/summer, when deciduous vegetation had leafed out (i.e., “leaf on” conditions). While the “leaf off” conditions would represent the time periods when the ROWs and transmission lines would be most visible, the “leaf on” conditions would be more representative of the seasons when the public is most apt to use the public recreational facilities in the vicinity of the Proposed Route.

The results of the visual resource surveys, along with the photo-simulations, are provided in Volume 8. The following briefly summarizes potential views of the existing and proposed transmission lines, based on the field studies conducted.

- **Airline State Park Trail**. Following CL&P’s existing ROWs, the proposed 345-kV transmission line would traverse the Airline State Park Trail in the towns of Lebanon and Hampton. In addition, in the Town of Chaplin, the ROW extends south of and parallel to the trail for approximately 4,000 feet. At the trail crossing in Lebanon, the proposed 345-kV line would be located in the middle of the existing ROW, between two existing overhead lines. No new forested vegetation clearing is proposed here for the installation of the new 345-kV lines. Bends in the trail near the ROW crossing limit long views of the transmission lines. Consequently, the new structures would be visible only in the immediate vicinity of the trail crossing. In Chaplin, views of the existing ROW from the Airline State Park Trail are variable. In this area, dense deciduous forest borders both sides of the trail, limiting views even under "leaf off" conditions. Additional vegetation removal and new transmission line structures would be located on the north side of the existing ROW, farther away from the trail. Existing mature tree buffers along the south side of the ROW would not be affected by the Project as proposed; therefore, views of the ROW and structures from the trail would likely remain largely unchanged. In Hampton, the proposed transmission lines would span the Airline State Park Trail as it extends through a rock cut. Views of the new structures (as well as the existing structures) would be apparent only in the immediate vicinity of the trail crossing.

- **Hop River State Park Trail**. At the crossing of the Hop River State Park Trail in the Town of Coventry, the new 345-kV line would be located in the middle of CL&P's existing ROW, which contains both the existing 345-kV line and a double-circuit 69-kV line. The existing ROW and overhead transmission lines are prominently visible to trail users at and in the immediate vicinity of the trail crossing during either "leaf off" or "leaf on" conditions. However, the ROW crosses the trail perpendicularly, and bends in the trail both west and east of the ROW generally prohibit long views of the transmission line structures except at and close to the ROW crossing. At the ROW crossing, views are predominantly of the ROW to the south. The new 345-kV transmission lines would similarly be visible, resulting in an incremental change in the scenic environment. Photo-simulations of the proposed transmission line at the Hop River State Park Trail crossing are included in Volume 8, Appendix C.

- **Nipmuck Trail.** The Proposed Route would cross the CFPA's Nipmuck Trail twice in the Town of Mansfield. Along the Nipmuck Trial West Branch, views of the ROW and transmission line structures are limited, except at the actual ROW crossing, both by topography and dense forest vegetation. The proposed transmission line would change the visual environment only at the ROW crossing. The ROW crosses the Nipmuck Trail East Branch in the Mansfield Hollow WMA, just east of Mansfield Hollow Lake. In this area, the trail extends generally parallel to the eastern side of the lake and crosses the lake along Bassetts Bridge Road. The CFPA's Walk Book East identifies several vistas of the lake from the trail; one of these is a view across the lake toward the ROW. However, due to topography and dense forest vegetation, the existing transmission line structures are not visible from most locations along the trail. The predominant views of the transmission line are at the trail crossing. From the trail crossing, the transmission line structures are visible along the ROW both to the east and west. The proposed transmission line structures also would be visible from the trail crossing, and the removal of forest vegetation along the north side of the ROW for the new lines would increase views of the ROW as trail hikers approach the ROW crossing. However, these effects would be incremental because of the long-established presence of the existing 345-kV structures and t managed ROW. Photo-simulations of the Nipmuck Trail crossings are included in Volume 8, Appendix C.

- **Mansfield Hollow State Park and WMA.** The Proposed Route follows CL&P's existing ROW across portions of Mansfield Hollow State Park, including the levee trail and the Red Trail in the Town of Mansfield. Across the WMA in the Town of Mansfield, the ROW traverses the Nipmuck Trail (East Branch), as discussed above. In the Town of Chaplin, the ROW extends across 0.5 mile of a forested portion of the WMA to which there is no public access (e.g., trails). The existing 345-kV transmission line structures are visible from areas with both the park and WMA in Mansfield (e.g., from the levee trail, Bassetts Bridge Road, the Red Trail [which extends across the ROW], Mansfield Hollow Dam, Mansfield Hollow Lake, and the Nipmuck Trail East Branch). In addition, background views of the existing transmission line structures are visible from certain vantage points along the levee trail located south-southeast of the Mansfield Hollow Dam in the towns of Mansfield and Windham. The proposed 345-kV line structures would similarly be visible from these locations. Because of the presence of the existing line structures and managed ROW, the proposed Project would have an incremental effect on the visual environment in these areas. Volume 8, Appendix C, includes simulations of views of the proposed transmission line structures and ROW in the Mansfield Hollow area. Across the WMA in the Town of Chaplin, the proposed transmission line structures and wider vegetatively managed ROW would not be visible to the general public, since there is are no easy public access to this area.

- **Town of Mansfield Scenic Vistas**. Five scenic vistas were identified in Mansfield in the general vicinity of the Project. Saw Brook Lane is located west of State Route 195 and south of the ROW. The transmission line structures and ROW are not visible from Saw Brook Lane and no changes in views are anticipated. Mountain Road is located west of State Route 195 and north of the ROW. From the crest of this road, the existing transmission line structures are visible just above the tree line, and the proposed line structures will not appreciably change this view. On the northwest corner of Mansfield Hollow Lake, a scenic vista is located off State Route 89. However, the ROW is approximately 0.7 mile to the south and is not visible from this location. Viewing areas are located along the levee trail on both sides of Mansfield Hollow Dam. From the levee trail, some of the existing transmission line structures are visible under either “leaf off” or “leaf on” conditions. The new transmission line structures would also be visible from these locations and would represent an incremental change in the visual environment. The portion of Bassetts Bridge Road within Mansfield Hollow State Park may be considered scenic, with bordering forest lands, vistas of the lake, and overhanging woody vegetation. There is a scenic vista located where Bassetts Bridge Road crosses Mansfield Hollow Lake, approximately 0.3 mile north of the ROW lake crossing. From this location, the top of some of the existing transmission line structures are visible under either “leaf off” or “leaf on” conditions. However, the proposed expansion is not anticipated to have a significant impact on this view.

- **Hampton Scenic Vistas**. A scenic vista is located to the west of State Route 97 and north of Parker Road in Hampton. The ROW is not visible from this area as it is located downhill and is buffered by a forested area. The proposed transmission line would be located along the north side of the ROW and would not alter the views.

- **State Route 169 (Pomfret Road), Brooklyn.** The proposed transmission lines would span State Route 169, a National Scenic Byway, in Brooklyn. The ROW extends across this road almost perpendicularly and due to topography and vegetation, views are limited to areas at and in the immediate vicinity of the crossing. At the State Route 169 crossing, CL&P has designed the proposed 345-kV line to place the new structures in alignment with the existing 345-kV line structures and to maintain similar conductor heights between the structure spans and across the road. These designs, along with the near perpendicular ROW crossing of the road, would minimize the effects of the visual changes along the ROW to travelers on State Route 169. (Refer to Volume 8 for photo-simulations of the proposed transmission line structures at the State Route 169 crossing).

- **Brooklyn Scenic Vistas**. A scenic vista has been identified off Tatnic Hill Road. A forested buffer exists between Tatnic Hill Road and ROW and the ROW is not visible from this area. At a scenic vista located off Barrett Hill Road, no effects are anticipated as the ROW is located at the bottom of the hill and there is a substantial forested buffer. There are some views of existing structures along other portions of Barrett Hill Road. A scenic vista has also been identified in the Gray Mare Hill area. However, due to topography and intervening vegetation, there are limited views of the ROW in this area.

- **Brooklyn Quinebaug River Trails**. These trails are located on CL&P-owned land north of Day Street and are identified on the Town of Brooklyn website as public recreational / hiking trails. The property consists of a mix of open (agricultural) and forested areas, which extend along the west side of the Quinebaug River. Portions of the trails extend near or beneath CL&P's existing transmission line ROW near Day Street Junction. The existing transmission line structures are evident from portions of the trails. The new 345-kV line will be located to the west of the existing transmission line structures and also will be visible from certain vantage points along the trails.

6.1.4.5 Methods to Prevent and Discourage Unauthorized Use of ROW

CL&P's existing transmission line easements restrict the types of activities that can be conducted within the ROWs. Easements typically prohibit the construction of buildings, pools, and other structures within the ROWs. Additionally, CL&P has policies addressing requests from property owners and other parties external to CL&P. These policies outline an evaluation process and provide guidelines for allowing certain uses (such as driveways or parking lots), where appropriate. Requests prohibited by the easement agreements, or otherwise posing safety, engineering, environmental, or other concerns are rejected.

Where CL&P holds an easement as opposed to land ownership in fee, CL&P must receive landowner approval prior to installing fences, gates, etc. along the ROWs. CL&P seeks to work with landowners and agencies to discourage unwarranted access onto and use of its ROWs. CL&P installs signs warning the general public of the overhead hazards posed by contact with the high voltage transmission lines and, with landowner approval, regularly installs fences, gates, barricades, or berms to discourage access onto the ROWs.

In addition, Connecticut law prohibits the operation of ATVs on private land without the written permission of the landowner (Connecticut General Statutes Section 14-387). CL&P does not allow ATV use on its properties or easements.

6.1.5 Transportation, Access, and Utility Crossings

The construction of the new transmission lines would have minor, short-term, and localized effects on transportation patterns in the immediate vicinity of the Project. These effects would stem primarily from additional traffic on local roads associated with the movement of construction vehicles and equipment to and from contractor yards, staging areas, and work sites along the ROWs. The proposed 345-kV transmission lines would span all roads.

The construction of the 345-kV transmission facilities would not affect railroads or other utilities (e.g., pipelines, water lines, storm water or sanitary sewers), all of which would be spanned by the proposed overhead lines. Similarly, the operation of the Project, which would not generate traffic other than that associated with periodic ROW management, would not affect transportation systems or local traffic patterns.

During construction, the well-established public road network in the Project area would afford ready access to the ROWs for vehicles and equipment. Along the ROWs, construction equipment, materials, and support vehicles would use existing or improved access roads to reach work sites. In certain areas, CL&P proposes to use off-ROW access roads to reach on-ROW work sites.

During construction, personnel traveling to and from work sites, as well as the movement of construction equipment, may cause temporary localized increases in traffic. When heavy equipment and large structure components must be transported along public roads for delivery to the ROWs, temporary disruptions in local traffic patterns, delays, or detours could occur. Activities involving the installation of the conductors at or near road crossings also could result in minor, short-term, and localized traffic congestion, delays, or detours. However, any such traffic-volume increases would be short-term, as would any detours.

To minimize the potential for traffic issues during construction, CL&P would develop access and traffic control plan(s), working with representatives of the affected towns. Such plan(s), which would be implemented by CL&P's construction contractor(s), would define traffic-control requirements and identify measures for safe ingress and egress to the ROWs for construction equipment and other vehicles. For example, at construction work sites along public roads, signs would be erected to indicate the presence of construction work zones and flaggers may be used to direct traffic, as needed.

As discussed in Section 3.1.2, CL&P has consulted with the FAA regarding the proposed Project, in particular regarding the heights of the existing and proposed structures near the Windham and Danielson airports, which are located 3,700 feet and 2,850 feet, respectively, from the Proposed Route. The FAA issued NPHs on existing and proposed structures near Windham Airport and Danielson Airport. The FAA's preliminary determinations for issuing the NPHs were based on the proximity of the existing and proposed structures to aircraft flight paths and runways associated with the two airports, taking into consideration topography and structure height.

CL&P proposes to continue to coordinate with the FAA to define mitigation measures for structures receiving NPHs. Such mitigation measures would be developed as part of the final Project design and may include modifications to structure heights and / or using lights or markers on the proposed structures, conductors, or shield wires to increase visibility to air traffic.

6.1.6 Archaeological and Historic (Cultural) Resources

The 2008 *Cultural Resources Assessment* (refer to Volume 3) identified the cultural resources potentially affected by the development of the new 345-kV transmission lines along the Proposed Route. This report defined the known or potential archaeological resources within the Project areas and evaluated the potential indirect visual effects of the Project on historic properties listed or eligible for listing on the SRHP or NRHP. The 2011 *Historic and Archaeological Resources Supplement* (also in Volume 3) reviews the results of cultural resource studies conducted between 2008 and November 2011. The following subsections summarize the results of these evaluations.

6.1.6.1 Archaeological Resources

The archaeological portion of the assessment was conducted in accordance with the standards of the Connecticut SHPO's *Environmental Primer for Connecticut's Archaeological Resources*. The assessment of potential visual effects on historic structures was performed in accordance with Connecticut General Statutes Section 16-50p(a)(4)(C) and in compliance with the regulations of the federal Advisory Council on Historic Preservation (36 CFR Section 800.5).

The archaeological assessment included an extensive review of documentary sources, consultations with the SHPO and the Connecticut State Archaeologist, and selective visual inspections of the existing transmission line structure locations and ROWs to assess the potential for Native American and Euro-american archaeological resources. The identification of archaeologically-sensitive areas was based primarily on environmental characteristics of similar sites in the Project area vicinity. The *Cultural Resources Assessment* determined that approximately 23 miles of the Proposed Route appeared sensitive for undocumented Native American archaeological resources.

After the preparation of the 2008 *Cultural Resources Assessment* report, subsurface archaeological reconnaissance and surface inspections were performed along approximately 90% of the Proposed Route subject to potential disturbance. These reconnaissance investigations identified approximately 115 Native American sites, seven Euro-american sites, and five unidentified human-built stone piles, walls, or rings.

As planning for the proposed Project continues, CL&P expects to conduct additional archaeological reconnaissance investigations and thereafter to develop appropriate intensive survey testing and other research measures needed to determine the eligibility of any discovered sites to the NRHP/SRHP. This additional work will be performed based on consultations with the Connecticut SHPO and interested

Native American tribes, as well as in consultation with the USACE and with the Quinebaug-Shetucket Rivers Valley National Heritage Corridor, Inc.

Any sites determined eligible for the NRHP/SRHP would be avoided, if possible, using methods such as the adjustment of construction pad or construction road locations, low-impact forest vegetation removal with no subsurface disturbance, etc. Avoidance methods can also include placement of fill material sufficient to resist the effects of construction equipment, but marked with geotextile fabric wherever fill is removed following construction to preclude subsurface disturbance during fill removal. If avoidance of eligible resources is not possible, mitigation strategies would be developed for review and approval by the SHPO, in consultation with interested Native American tribes. Mitigation would include data recovery sufficient to document significant information which may be lost to adverse Project effects.

6.1.6.2 Historic Resources

As a result of the initial cultural resource investigations, 12 significant historic resources and a National Scenic Byway (i.e., State Route 169) were identified within approximately 0.25 mile of the Proposed Route. Based on previous studies of transmission lines in Connecticut, the 0.25-mile distance was selected to evaluate the possible visual effects of a new overhead transmission line on historic resources.

However, some of these 12 resources are designated historic districts that encompass multiple historic structures, some of which are located more than 0.25 mile from the Proposed Route. Thus, a total of 21 individual historic sites or structures are within approximately 0.25 mile of the Proposed Route.

Based on digital topographic profiles and simulations shown on photographs of possible new transmission structures, adverse visual effects on these resources appear unlikely (simulations are shown in the 2008 *Cultural Resources Assessment* report). The simulations in the *Cultural Resources Assessment* report may not account for all possible conditions of future ROW tree removal, but together with digital profiles, the simulations may identify conditions under which future remaining forest cover would continue to create conditions of no likely adverse visual effects.

6.1.7 Air Quality

The construction of the proposed Project would result in short-term, minor, highly localized effects on air quality, primarily from fugitive dust (as a result of soil disturbance at work sites and from vehicular movements on access roads along the ROWs) and from vehicular emissions associated with operating construction equipment. No long-term effects on air quality would result from the operation of the proposed 345-kV transmission lines.

To minimize short-term adverse effects to air quality during construction, as necessary, access roads and other sites would be watered to suppress fugitive dust emissions. Additionally, crushed stone aprons would be installed at all access road entrances to public roadways, minimizing tracking of soil onto the road pavement. Vehicular emissions would be limited by requiring contractors to properly maintain construction equipment and vehicles and by minimizing diesel construction equipment idling time, in accordance with regulatory standards.

Unlike other criteria pollutants, greenhouse gas (GHG) impacts are global in nature, not local or regional. Consumption of fuel from construction equipment or vehicles is only a part of the global GHG emission sources. The global consumption of fuel would remain the same whether it is combusted during this Project or elsewhere in the world. Since the construction of the proposed Project will be short-term, actual emissions of GHGs would be very small when compared to the carbon footprint of vehicles or permanent emission sources such as a refinery.

6.1.8 Noise

The construction of the new 345-kV transmission lines would cause localized, short-term, and generally minor increases in ambient noise levels in the immediate vicinity of work sites. Construction-related noise would generally stem from construction equipment operation, truck traffic, earth-moving vehicles and equipment, jackhammers, and structure erection equipment (cranes), etc. Overall, these sound levels would be typical of construction projects.

The temporary increase in construction-related noise could potentially raise ambient sound levels at certain receptors near work sites, including residences, schools, and designated recreational areas. The extent of a noise effect 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 effect of construction-generated noise would also depend on the noise source location because sound attenuates with distance and with the presence of vegetative buffers or other barriers.

Noise levels diminish at a rate of approximately 6 dBA per doubling of distance from a localized noise source. For example, a noise level of 84 dBA measured at 50 feet from the noise source to the receptor would reduce to 78 dBA at 100 feet from the source to the receptor, and reduce to 72 dBA at 200 feet from the source to the receptor.

Table 6-9 summarizes noise level data compiled for various types of construction equipment and measured at 50 feet from the source. Such construction-generated noise would be localized to the vicinity of construction work sites along the ROW.

In general, construction activities would typically occur during the daytime (between 7:00 A.M. to 7:00 P.M.), when human sensitivity to noise is lower. During the Council’s review process, CL&P expects to further define appropriate work hours for construction activities. Work hour specifications would be included in the D&M Plan(s) for the Project.

Table 6-9: Noise Ranges of Typical Construction Equipment

Equipment	Noise Levels (Leq, dBA) at 50 feet[1]
Backhoe	73-95
Compressors	75-87
Concrete Mixers	75-88
Concrete Pumps	81-85
Cranes (moveable)	75-88
Cranes (derrick)	86-89
Front Loader	73-86
Generators	71-83
Jackhammers	81-98
Paver	85-88
Pile Driving (peaks)	95-107
Pneumatic Impact Equipment	83-88
Pumps	68-72
Saws	72-82
Scraper/Grader	80-93
Tractor	77-98
Trucks	82-95
Vibrator	68-82

[1]Modern machinery equipped with noise control devices or other noise-reducing design features do not generate the same level of noise emissions as shown in this table. Source: USEPA Office of Noise Abatement and Control, 1971 and U.S. Department of Transportation, Federal Highway Administration (http://www.fhwa.dot.gov/environment/noise/construction_noise/special_report/hcn06.cfm, updated 5/20/2010)

Note: Leq is the equivalent constant sound level for a varying sound level measured over a period of time. Also referred to as the *Equivalent Average Sound Level*. The standard measure of the sound pressure level that approximates the sensitivity of the human ear at moderate sound levels. A-Weighted Sound Level de-emphasizes high and low frequencies because the ear poorly perceives these.

The operation of the 345-kV lines also can result in audible noise under certain weather conditions causing corona on the line conductors or hardware. Transmission line (345 kV) corona noise can vary from inaudible levels during fair weather through barely audible levels in relatively dry snow or light fog, to distinctly audible levels in rain or wet snow. The noise level is relatively low to begin with, as it attenuates quickly with distance from the line, and may be most noticeable during foul weather when not masked by the sound of rainfall striking the ground or objects on the ground. However, during these conditions, few receptors would typically be near the lines to hear this noise. The sound levels are also significantly attenuated by the walls of homes or structures.

6.2 SUBSTATION AND SWITCHING STATION MODIFICATIONS

The Project would require modifications to two existing substations (Card Street Substation and Killingly Substation) and one existing switching station (Lake Road Switching Station). The proposed modifications at these stations would all occur within the fence lines (i.e., the already developed portions) of the existing station sites. As a result, most environmental effects would be minor, localized on-site, and short-term (lasting only for the duration of construction). Further, CL&P has incorporated measures to mitigate the potential for adverse environmental effects into the initial plans for the substation and switching station modifications.

The proposed modifications would result in a long-term, but incremental, change in the appearance of each station. However, these effects would be negligible because each site is already developed for electric transmission utility use.

The following subsections review the potential environmental effects associated with the construction and operation of the substation and switching station modifications, as well as the mitigation measures that CL&P has identified to date. These effects and associated mitigation measures would be generally the same for each station and thus are discussed jointly. The planned modifications to each station, along with the proposed construction procedures expected to be used at each site are discussed in detail in Sections 3 and 4.

6.2.1 Geology, Topography, and Soils

The modifications to Card Street Substation, Lake Road Switching Station, and Killingly Substation would require site preparation work, including grading and other soil disturbance (e.g., excavations) to install the foundations and erect the new 345-kV transmission line facilities. Mechanical methods would be used to install foundations into bedrock, if encountered. As a result, no blasting is anticipated. Grading and filling, if required, would permanently alter the topography and soils on the station sites.

To avoid or minimize the potential for erosion and surface water runoff outside of the existing station fence lines, construction work would be performed in accordance with an *Erosion and Sedimentation Control Plan*, in conformance with the 2002 *Connecticut Guidelines for Soil Erosion and Sediment Control* and CT DEEP storm water regulatory requirements. Typically, excess soil resulting from the construction of the station modifications would be removed from the station property, rather than stockpiled on site. In addition, construction activities typically would be sequenced to the extent possible, thereby minimizing the amount of time that soils are exposed. Further, after the installation of the new 345-kV facilities, disturbed areas at each station would be stabilized with trap rock or another type of crushed stone.

6.2.2 Water Resources

All of the proposed station modifications would occur in upland areas, within the fenced-in portions of each station site. As a result, the proposed modifications would not result in any direct adverse effects on water resources.

The proposed modifications to Card Street Substation would be near three wetlands located on undeveloped portions of CL&P's property surrounding the fenced portion of the substation. These wetlands, which are depicted on the maps in Volume 9 and discussed in the *Wetlands and Watercourse Delineation Report* (Volume 2), are W21-14 (a PFO wetland), W21-15 (a PFO wetland); and W21-16 (a PFO wetland).

No wetlands, watercourses, or floodplains are located within 200 feet of either the Lake Road Switching Station or Killingly Substation. However, a 1.3-acre storm-water detention basin is located east of and adjacent to Killingly Substation.

During the construction of the station modifications, appropriate temporary soil erosion and sedimentation controls would be installed and maintained, pursuant to CL&P's Project permits and best management practices. These erosion and sedimentation control measures would minimize the potential for off-site sedimentation into nearby water resources at Card Street and Killingly Substations. Similarly, appropriate spill prevention, control, and countermeasure procedures would be implemented during construction to minimize the potential for inadvertent spills or leaks from construction equipment. Such procedures would be specified in the D&M Plan governing the station modification work.

The operation of the modified substations and switching station would not affect water resources. CL&P would apply standard operation and maintenance procedures to avoid or minimize the potential for off-site erosion and sedimentation. During facility operation, CL&P also would conform to standards for minimizing the potential for spills or leaks from electrical equipment.

6.2.3 Biological Resources

Because the proposed Project modifications would occur within each of the existing station fence lines, no vegetation or wildlife resources would be affected. In addition, none of the proposed station modifications has the potential to affect any state- or federally listed threatened or endangered wildlife species.

6.2.4 Land Use, Recreational / Scenic Resources, and Land-Use Plans

The proposed modifications to all three existing stations would be consistent with the existing uses of each site for utility purposes and would not conflict with any land use plans. Although the proposed modifications would slightly alter the appearance of each station, the changes would be minimal and would generally be similar in appearance to the existing structures at each site. None of the proposed modifications would be visible from any designated scenic or recreational resources.

The closest recreational resource to any of the stations is the Tracey Road Trail, a paved (sidewalk type) bicycle / walking path, that extends along the east side of Tracy Road / Park Road approximately 0.2 mile east of Killingly Substation. However, to users of this urban trail, the various existing transmission facilities (e.g., Tracy Substation, the existing 345-kV ROW) and other industrial/commercial uses are dominant landscape elements. As a result, the modifications to the Killingly Substation would have minimal, if any, incremental effects on the visual environment.

6.2.5 Transportation and Access

The development of the substation and switching station modifications would not adversely affect long-term transportation or access patterns. During construction, minor and short-term effects on vehicular traffic may occur as construction vehicles use local public roads leading to the sites. The operation of the modified stations would have no effect on transportation patterns or traffic.

Card Street provides primary access to the Card Street Substation and would be the principal public road used for ingress / egress to the site during construction. Similarly, Louisa Veins Drive, Old Trolley Road, and Lake Road are the principal local roads in the vicinity of the Lake Road Switching Station and would likely be the primary access routes to and from the switching station during construction. Park Road and Tracy Road provide primary access to Killingly Substation.

At times during construction, localized traffic congestion may occur when heavy construction equipment or electric components are transported to these stations. The movement of construction workers and equipment in general also would temporarily cause minor increased traffic on local public roads leading to the sites. However, such effects would be minor, localized, and limited to only certain periods during the construction of the station modifications. Construction activities would be staged on CL&P property, within the fenced stations or on other previously disturbed CL&P-owned property or similar parcels in the vicinity of each station.

Construction activities are typically expected to occur during normal work hours; however, some work will depend on the scheduling of allowable line outages and thus may have to be performed at other times. However, such effects would be minor and localized.

6.2.6 Archaeological and Historic (Cultural) Resources

No known cultural resource sites (standing historic structures or recorded archaeological sites) are located in the immediate vicinity of any of the three station sites (refer to the discussion of cultural resources in Volume 3). Because all construction activities associated with the modifications to the Card Street Substation, Lake Road Switching Station, and Killingly Substation would be within the stations' existing fenced areas, where soils have been disturbed by past activities, the potential for encountering intact, previously unrecorded, significant archaeological resources is negligible. As a result, no adverse effects to cultural resources would occur from the proposed station modifications.

6.2.7 Air Quality

The proposed construction at the station sites would result in short-term, minor, and highly localized effects on air quality, primarily from limited fugitive dust (as a result of soil disturbance at the work sites and from construction-related vehicular movements) and from vehicular emissions associated with operating construction equipment. No long-term effects on air quality will result from the operation of the modified station facilities. Vehicular emissions would be minimized by requiring contractors to properly maintain construction equipment and vehicles and by minimizing diesel construction equipment idling, pursuant to regulatory standards.

6.2.8 Noise

The station modifications would result in short-term increases in noise, which would emanate from the on-site work activities and from construction-related vehicular traffic on local roads. The operation of the station facilities would cause a long-term, but minor change in the ambient noise environment.

Both Lake Road Switching Station and Killingly Substation are located in commercial / industrial areas where there are no nearby residential noise receptors and where the ambient sound environment is influenced by the surrounding land uses and by other activities, such as traffic on Interstate 395. Residential uses are situated along Card Street in the vicinity of the Card Street Substation.

However, during construction, noise-generating activities would be generally short-term and would emanate from activities such as the operation of equipment, truck traffic, earth excavation and moving operations, and installation of electric components (refer to Table 6-9 for a summary of noise emissions from typical construction equipment). Such construction-generated noise would be localized to the vicinity of each of the stations and would typically occur during the daytime (between 7:00 A.M. to 7:00 P.M.), when human sensitivity to noise is lower. At the Card Street Substation, existing forested vegetation around the developed portion of the station would assist in attenuating construction-related noise.

The proposed modifications to the stations would result in minor changes to the operational noise environment in the immediate vicinity of each site. However, CL&P has incorporated measures into the initial design of the modified substation and switching station facilities, such as installing quieter equipment, to minimize noise.

Under certain circumstances, especially when circuit outages are required, night work and weekend work could be necessary at the stations. Night construction would require lighting and may result in localized, temporary increases in noise levels.

During operation of a substation, noise is generated primarily from three sources: the transformers, the transformer cooling fans, and the control house air conditioning units. However, these sources do not operate simultaneously for any duration of time.

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Table 6-3
Summary of Potential Wetland Effects along the Proposed Line Route

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Table 6-3: Summary of Potential Wetland Effects along the Proposed Line Route

Town/Wetland Number	Wetland Classification*	Potential Type of Wetland Effect
Lebanon		
W20-1	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW
W20-2	PFO / PSS	--
W20-3	PSS / PFO	Proposed Access Road
W20-4	PSS	Vegetation Removal in Existing Managed ROW
W20-5	PSS / PFO	Vegetation Removal in Existing Managed ROW, State Wetland -- Vegetation Removal in Existing Managed ROW
Columbia		
W20-5	PSS / PFO	Vegetation Removal in Existing Managed ROW
W20-6	PFO / PSS	--
W20-7	PSS / PFO	Vegetation Removal in Existing Managed ROW
W20-8	PSS / PFO	Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Temporary Poles for Conductor Stringing
W20-9	PSS / PFO	Vegetation Removal in Existing Managed ROW, Temporary Poles for Conductor Stringing
W20-10	PFO / PSS	Proposed Access Road
W20-11	PSS / PFO	Proposed Access Road. Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Proposed Structure
W20-12	PSS	Proposed Access Road
W20-13	PSS / PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW
W20-14	PSS	Vegetation Removal in Existing Managed ROW
W20-15	PSS	Vegetation Removal in Existing Managed ROW, Temporary Poles for Conductor Stringing
W20-16	PSS	Vegetation Removal in Existing Managed ROW
W20-17	PFO / PEM	Vegetation Removal in Existing Managed ROW
W20-18	PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW
W20-19	PSS	--
W20-20	PSS	--
W20-21	PFO / PSS	--
W20-22	PSS	Proposed Crane Pad
W20-23	PSS / PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW
Columbia/Coventry		
W20-24	PSS / PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Proposed Structure
Coventry		
W20-25	PFO	--
W20-26	PSS / PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-27	PEM / PFO	--
W20-28	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-29	PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines

Table 6-3: Summary of Potential Wetland Effects along the Proposed Line Route

Town/Wetland Number	Wetland Classification*	Potential Type of Wetland Effect
W20-30	PEM / PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-31	PEM / PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
Mansfield		
W20-32	PEM	Additional Vegetation Removal for new 345-kV lines
W20-33	PFO / PSS	--
W20-34	PFO	-
W20-35	PSS / PFO	Proposed Access Road, Proposed Crane Pad
W20-36	PFO	--
W20-37	PFO	Proposed Access Road, Additional Vegetation Removal for new 345-kV lines
W20-38	PSS / PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-39	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-39A	PSS / PFO	--
W20-40	PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-41	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-42	PFO / PSS	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-43	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines
W20-44	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, , Additional Vegetation Removal for new 345-kV lines
W20-45	PFO	--
W20-45A	PEM / PFO	Vegetation Removal in Existing Managed ROW
W20-46	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-47	PFO / PSS	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-48	PFO / PSS	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-49	PEM	--
W20-50	PFO / PSS	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-51	PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW
W20-52	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines

Table 6-3: Summary of Potential Wetland Effects along the Proposed Line Route

Town/Wetland Number	Wetland Classification*	Potential Type of Wetland Effect
W20-53	PFO / PSS	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kv lines
W20-54	PSS / PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW
W20-55	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad , Additional Vegetation Removal for new 345-kV lines
W20-56	PFO / PSS	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kv lines
W20-57	PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kv lines
W20-58	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-59	PFO	--
W20-60	PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kv lines
W20-61	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-62	PEM	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kv lines
W20-62A	POW	-
W20-62B	POW	--
W20-62C	POW	--
W20-63	PFO / PSS	Proposed Access Road
W20-64	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-65	PUB / PFO	--
W20-66	PUB / PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kv lines
W20-67	PFO	--
W20-68	PEM / PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
Chaplin		
W20-69	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-70	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-71	PSS	--
W20-72/73	PSS / PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-74	PFO	Additional Vegetation Removal for new 345-kV lines
W20-75	PSS / PFO	Proposed Access Road

Table 6-3: Summary of Potential Wetland Effects along the Proposed Line Route

Town/Wetland Number	Wetland Classification*	Potential Type of Wetland Effect
W20-76	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines, Proposed Structure
W20-77	POW / PSS / PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines, Temporary Poles for Conductor Stringing
W20-78	PFO	--
W20-79	PFO	--
W20-80	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-81	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines, Proposed Structure
W20-82	PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW
W20-83	PSS / PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-84	PSS / PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines
W20-85	POW / PFO / PSS	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-86	PUB / PEM / PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-87	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-88	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-89	PFO / PSS / POW	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-90	PFO	Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines
W20-91	POW / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad , Additional Vegetation Removal for new 345-kV lines
Hampton		
W20-92	PFO / PSS	Proposed Guy Easement, Additional Vegetation Removal for new 345-kV lines
W20-93	PSS	Vegetation Removal in Existing Managed ROW
W20-94	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines

Table 6-3: Summary of Potential Wetland Effects along the Proposed Line Route

Town/Wetland Number	Wetland Classification*	Potential Type of Wetland Effect
W20-95	PFO / PSS	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-95A	PFO	Proposed Access Road, Additional Vegetation Removal for new 345-kv lines
W20-96	PSS	Proposed Access Road
W20-97	PFO / PSS	Proposed Access Road
W20-98	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-99	PFO / PEM	Additional Vegetation Removal for new 345-kV lines
W20-100	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines, Proposed Structure
W20-101	PFO	Proposed Access Road
W20-102	PFO / PSS	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-103	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines, Temporary Poles for Conductor Stringing
W20-104	PFO / PSS	Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines, Proposed Structure
W20-105	PEM	--
W20-106	PFO	Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines, Temporary Poles for Conductor Stringing
W20-107	PEM / PFO	--
W20-108	PSS / PFO	Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines, Temporary Poles for Conductor Stringing
W20-109	PSS / PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-110	PSS / PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-111	PSS	--
W20-112	PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW
W20-112A	PFO	--
W20-113	PFO	Additional Vegetation Removal for new 345-kV lines
W20-114	PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-115	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines
W20-116	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines

Table 6-3: Summary of Potential Wetland Effects along the Proposed Line Route

Town/Wetland Number	Wetland Classification*	Potential Type of Wetland Effect
W20-117	PSS / PFO / PEM	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Proposed Structure, Additional Vegetation Removal for new 345-kV lines, Temporary Poles for Conductor Stringing
W20-118	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines
W20-119	PSS	Proposed Access Road
W20-121	PSS	--
Hampton/Brooklyn		
W20-120	PFO/PSS	Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Proposed structure, Additional Vegetation Removal for new 345-kV lines
Brooklyn		
W20-122	PFO / PSS / PEM	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Proposed Guy Easement, Proposed Structure, Additional Vegetation Removal for new 345-kV lines
W20-123	PFO / PSS	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-124	PFO / PSS	Proposed Access Road
W20-125	PSS / PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-126	PFO	--
W20-127	PSS / PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-128	PFO	Proposed Access Road, Additional Vegetation Removal for new 345-kV lines
W20-129	PSS / PFO	Proposed Access Road
W20-130	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-131	PFO	Additional Vegetation Removal for new 345-kV lines
W20-132	PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-133	PEM / PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines, Temporary Poles for Conductor Stringing
W20-134	PSS	--
W20-135	PFO	--
W20-136	PFO	Additional Vegetation Removal for new 345-kV lines
W20-137	PFO / PSS	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-138	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Proposed Guy Easement, Additional Vegetation Removal for new 345-kV lines

Table 6-3: Summary of Potential Wetland Effects along the Proposed Line Route

Town/Wetland Number	Wetland Classification*	Potential Type of Wetland Effect
W20-139	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-140	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Proposed Structure, Additional Vegetation Removal for new 345-kV lines
W20-141	PFO	-
W20-142	PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines, Temporary Poles for Conductor Stringing
W20-143	PSS / PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines
W20-144	PFO / POW	Additional Vegetation Removal for new 345-kV lines
W20-145	PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-146	PFO	--
W20-147	PFO / POW	--
W20-148	PUB / PEM / PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-149	PFO / PSS	Proposed Access Road
W20-150	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-151	PEM / PUB / PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-152	PSS	--
W20-153	PEM / PUB / PSS / PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines
W20-154	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines
W20-154A	PSS / PFO	Proposed Guy Easement, Additional Vegetation Removal for new 345-kv lines
W20-155	PEM	Proposed Access Road, Additional Vegetation Removal for new 345-kV lines
W20-156	PSS	--
W20-157	PEM / PSS / PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines
W20-158	PSS / PUB / PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-159	PSS / PFO / POW	Proposed Access Road
W20-159A	PEM / PFO	Additional Vegetation Removal for new 345-kv lines
W20-160/W20-160A	PSS / PFO	Proposed Access Road, Additional Vegetation Removal for new 345-kV lines / Proposed Access Road
W20-160B	PFO	--

Table 6-3: Summary of Potential Wetland Effects along the Proposed Line Route

Town/Wetland Number	Wetland Classification*	Potential Type of Wetland Effect
Pomfret		
W20-161	PFO	--
W20-161A	PFO	Additional Vegetation Removal for new 345-kv lines
W20-162	PSS / PFO / POW	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Proposed Structure, Additional Vegetation Removal for new 345-kV lines
Killingly/Pomfret		
W20-163/W20-164	PSS / PEM / PFO / POW	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines / State Wetland -- Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Proposed Structure
Killingly		
W20-165	PSS / PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW
W20-166	PSS	--
W20-167	PFO	--
W20-168	PSS / PFO	Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Proposed Structure
W20-169	PSS / PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Temporary Poles for Conductor Stringing
W20-170	PFO / PEM	--
W20-170A	PSS / PFO	Proposed Crane Pad, Vegetation Removal in Existing Managed ROW
W20-171	PSS / PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW
W20-171A	PSS	Proposed Access Road
Putnam		
W20-172	PSS / PFO	Proposed Crane Pad, Vegetation Removal in Existing Managed ROW
W20-173	PSS	--
W20-174	PSS / PFO	-
W20-175	PSS / POW	--
W20-176	PSS / POW	Vegetation Removal in Existing Managed ROW
Killingly		
W20-177	PSS / PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kv lines
W20-178	PSS / PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW, State Wetland -- Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Proposed Structure, Additional Vegetation Removal for new 345-kv lines
Putnam		
W20-179	PSS	Additional Vegetation Removal for new 345-kV lines
W20-180	PFO / PSS	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-181	PSS	--
W20-181A	PSS / PEM	--
W20-181B	PFO	--
W20-182	PSS / PFO	--

Table 6-3: Summary of Potential Wetland Effects along the Proposed Line Route

Town/Wetland Number	Wetland Classification*	Potential Type of Wetland Effect
W20-182A	PSS / PEM	--
W20-183	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-184	PSS / PEM / PFO	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-185	PSS	--
W20-186	PFO / PSS	--
W20-187	PFO / PSS / PUB	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Proposed Structure, Additional Vegetation Removal for new 345-kV lines
W20-188	PFO / PSS	Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Proposed Structure, Additional Vegetation Removal for new 345-kV lines
W20-189	PFO / PEM	--
W20-190	PSS / PFO	--
W20-191	PFO / PSS / PEM	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Proposed Structure, Additional Vegetation Removal for new 345-kV lines, Temporary Poles for Conductor Stringing
W20-192	PFO / POW	Additional Vegetation Removal for new 345-kV lines
W20-193	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-194	PSS / PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-195	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Proposed Structure, Additional Vegetation Removal for new 345-kV lines
W20-196	PSS	Proposed Crane Pad
W20-197	PFO / PSS / PEM	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Proposed Structure, Additional Vegetation Removal for new 345-kV lines, Existing Structure Removal
W20-198	PUB / PEM / PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-199	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-200/W20-201	PFO / PSS / POW	Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines / Vegetation Removal in Existing Managed ROW

Table 6-3: Summary of Potential Wetland Effects along the Proposed Line Route

Town/Wetland Number	Wetland Classification*	Potential Type of Wetland Effect
Thompson		
W20-202	PSS	--
W20-203	PEM	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines
W20-204	PSS / PFO	Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines
W20-205	PFO	--
W20-206	PSS / PFO	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-207	PFO / PSS	Proposed Access Road, Vegetation Removal in Existing Managed ROW, Proposed Crane Pad, Additional Vegetation Removal for new 345-kV lines
W20-208	PFO	Proposed Access Road
W20-209	PEM	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines
W20-210	PFO	Additional Vegetation Removal for new 345-kV lines
W20-211	PFO / PSS	Vegetation Removal in Existing Managed ROW, Additional Vegetation Removal for new 345-kV lines

* Wetlands were classified according to Cowardin et al. PEM = palustrine emergent wetland; PSS = palustrine scrub-shrub wetland; PFO = palustrine forested wetland; POW = palustrine open water; PUB = palustrine unconsolidated bottom.

"Additional Vegetation Removal for new 345-kV lines" refers to the vegetation that would have to be cleared from wetlands located within the limits of clearing for the proposed 345-kV lines, along the presently un-managed portions of CL&P's ROWs. "Limits of clearing" refers to the area within which vegetation must be cut during construction and subsequently managed in low-growth species to maintain required clearances from the transmission line conductors. Across the federally-owned properties in the Mansfield Hollow area, forested vegetation within portions of wetlands W20-70, W20-72/73, W20-74, and W20-76 (all in the Town of Chaplin) also would have to be removed, assuming that the USACE grants CL&P expanded easement rights.

Potential effects are estimated based on currently available Project design information. Exact locations of crane pads and access roads have not yet been defined. As Project planning proceeds, CL&P continues to perform Project design studies and constructability reviews to minimize and avoid impacts to wetlands and streams that occur along the proposed Project route.

Table 6-5
Potential Effects to Vernal Pool and Amphibian Breeding Habitats

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Table 6-5: Summary of Potential Effects to Vernal Pool and Amphibian Breeding Habitats

Municipality / Volume 11 Mapsheet #	Wetland Number	Vernal Pool / Amphibian Breeding Habitat (ABH) No.[23]	Existing Conditions				Proposed Project Facilities and Vegetation Removal				
			Structures Located in Wetland Providing Habitat	Structures Located Directly in Vernal Pool or ABH	Access Roads Located in Wetland Providing Habitat	Access Roads Located Directly in Vernal Pool or ABH	Structures Located in Wetland Providing Habitat	Structures Located Directly in Vernal Pool or ABH	Access Roads Located in Wetland Providing Habitat	Access Roads Located Directly in Vernal Pool or ABH	Vegetation Removal Required in Vernal Pool / Amphibian Breeding Habitat (acres)
Columbia											
5	W20-9	CO-2-VP									<0.01
Coventry											
12	W20-30	CV-1-ABH									0.58
	W20-31	CV-2-ABH									0.30
Mansfield											
18	W20-41	MA-1-VP							Yes		
18	W20-43	MA-2-VP	9045		Yes						<0.01
18	W20-43	MA-3-VP	9045		Yes						0.05
19	W20-43	MA-5-VP	9045		Yes						<0.01
19	W20-43	MA-6-VP	9045		Yes	Yes					<0.01
19	W20-43	MA-7-VP	9045		Yes						<0.01
19	W20-44	MA-8-VP			Yes¥	Yes¥					0.05
22	W20-50	MA-9-VP									0.01
23	W20-53	MA-10-VP									0.10
31	W20-64	MA-17-VP			Yes						<0.01
36	W20-68	MA-2/CH-1-ABH		9091					Yes		
Chaplin											
38	W20-70	CH-1-VP								Yes	0.16
38	W20-72/73	CH-2-VP							Yes		<0.01
40	W20-77	CH-2-ABH		9099 and 9100							0.59
41	W20-81	CH-6-VP	9103				Yes		Yes¥		0.29
41	W20-81	CH-7-VP	9103		Yes¥	Yes¥	Yes		Yes¥		
41	W20-81	CH-3-ABH	9103		Yes¥	Yes¥	Yes		Yes¥		
41	W20-83	CH-9-VP				Yes					
42	W20-84	CH-10-VP							Yes	Yes	
44	W20-86	CH-4-ABH									1.36
45	W20-87	CH-13-VP			Yes						0.03
46	W20-88	CH-5-ABH			Yes	Yes					
46	W20-89	CH-14-VP			Yes	Yes					<0.01
47	W20-89	CH-6-ABH			Yes	Yes					
47	W20-91	CH-7-ABH*		9119							2.20

[23] "*" denotes vernal pool or amphibian breeding habitat potentially affected by possible crane pads or guy easements. "¥" denotes potential impact due to alternative access road only

Table 6-5: Summary of Potential Effects to Vernal Pool and Amphibian Breeding Habitats

Municipality / Volume 11 Mapsheet #	Wetland Number	Vernal Pool / Amphibian Breeding Habitat (ABH) No.[23]	Existing Conditions				Proposed Project Facilities and Vegetation Removal				
			Structures Located in Wetland Providing Habitat	Structures Located Directly in Vernal Pool or ABH	Access Roads Located in Wetland Providing Habitat	Access Roads Located Directly in Vernal Pool or ABH	Structures Located in Wetland Providing Habitat	Structures Located Directly in Vernal Pool or ABH	Access Roads Located in Wetland Providing Habitat	Access Roads Located Directly in Vernal Pool or ABH	Vegetation Removal Required in Vernal Pool / Amphibian Breeding Habitat (acres)
Hampton											
50	W20-94	HA-1-VP									0.17
53	W20-98	HA-2-VP			Yes				Yes		
54	W20-100	HA-1-ABH	9135		Yes		Yes		Yes		0.17
54	W20-100	HA-2-ABH	9135		Yes		Yes		Yes		0.03
53	W20-100	HA-3-VP	9135		Yes		Yes		Yes		0.20
58	W20-112	HA-3-ABH			Yes	Yes					<0.01
58	W20-113	HA-7-VP									0.02
59	W20-116	HA-4-ABH							Yes		0.01
60	W20-117	HA-5-ABH*	9152		Yes		Yes		Yes	Yes	0.01
61	W20-118	HA-12-VP	9154		Yes	Yes			Yes		<0.01
63	W20-120	HA-6/BR-1-ABH*					Yes	Yes			1.57
Brooklyn											
63	W20-120	HA-6/BR-1-ABH*					Yes	Yes			0.68
65	W20-122	BR-2-ABH			Yes	Yes	Yes		Yes		
65	W20-122	BR-3-ABH			Yes	Yes	Yes		Yes		0.44
66	W20-123	BR-1-VP									0.02
66	W20-125	BR-3-VP	9166						Yes	Yes	0.15
68	W20-127	BR-4-VP			Yes[¥]						0.03
69	W20-129	BR-5-VP			Yes	Yes					
70	W20-130	BR-6-VP	9175		Yes						0.53
70	W20-130	BR-7-VP	9175		Yes	Yes					
72	W20-137	BR-8-VP									0.01
72	W20-137	BR-9-VP									<0.01
72	W20-138	BR-11-VP			Yes						0.11
73	W20-139	BR-4-ABH			Yes						0.10
74	W20-140	BR-13-VP*			Yes		Yes				0.03
74	W20-140	BR-14-VP*			Yes		Yes				0.05
74	W20-143	BR-15-VP	9186		Yes						0.12
81	W20-153	BR-5-ABH			Yes				Yes	Yes[¥]	2.11
83	W20-154	BR-17-VP			Yes				Yes		0.07
85	W20-157	BR-18-VP							Yes		
86	W20-158	BR-19-VP									0.09
Pomfret											
95	W20-162	PO-1-ABH*	7328, 7329A, 9235 and 9236				Yes		Yes		0.52

Table 6-5: Summary of Potential Effects to Vernal Pool and Amphibian Breeding Habitats

Municipality / Volume 11 Mapsheet #	Wetland Number	Vernal Pool / Amphibian Breeding Habitat (ABH) No.[23]	Existing Conditions				Proposed Project Facilities and Vegetation Removal				
			Structures Located in Wetland Providing Habitat	Structures Located Directly in Vernal Pool or ABH	Access Roads Located in Wetland Providing Habitat	Access Roads Located Directly in Vernal Pool or ABH	Structures Located in Wetland Providing Habitat	Structures Located Directly in Vernal Pool or ABH	Access Roads Located in Wetland Providing Habitat	Access Roads Located Directly in Vernal Pool or ABH	Vegetation Removal Required in Vernal Pool / Amphibian Breeding Habitat (acres)
Killingly											
99	W20-169	KI-1-ABH	7341		Yes						0.29
105	W20-177	KI-2-VP									<0.01
106	W20-178	KI-3-VP			Yes						0.07
Putnam											
103	W20-174	PU-2-VP[¥]									
116	W20-187	PU-5-VP					Yes		Yes		
118	W20-188	PU-1-ABH	9289/9290				Yes		Yes		0.08
118	W20-188	PU-6-VP					Yes		Yes		0.04
119	W20-191	PU-3-ABH*	9294				Yes	Yes	Yes	Yes	2.13
122	W20-192	PU-8-VP									0.16
122	W20-194	PU-9-VP			Yes	Yes					
122	W20-195	PU-10-VP	9303				Yes		Yes		0.43
124	W20-196	PU-12-VP									0.01
124	W20-197	PU-13-VP	9306/9307				Yes		Yes		0.03
124	W20-197	PU-14-VP	9306/9307				Yes			Yes	0.71
126	W20-198	PU-4-ABH									0.28
126	W20-199	PU-15-VP							Yes		0.04
Thompson											
127	W20-203	TH-1-ABH*			Yes	Yes			Yes	Yes	2.50
130	W20-207	TH-1-VP			Yes	Yes			Yes		

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SECTION 7

ELECTRIC AND MAGNETIC FIELDS

7. ELECTRIC AND MAGNETIC FIELDS

This section provides electric and magnetic fields (EMF) information for the Project along the Proposed Route, presenting projections of future EMF levels associated with the existing and proposed lines in each segment of the route. The base case overhead 345-kV line that was modeled for these projections is a horizontally configured line using H-frame structures, except along one segment of the Proposed Route. This segment is along the ROW in Mansfield Hollow State Park and Mansfield Hollow WMA (i.e., Mansfield Hollow Segment 1, located in the Town of Mansfield) where the existing line employs a delta configuration on steel monopoles, and CL&P's proposal for the new line is to match that delta configuration.[1]

Section 7.1 provides general background information about EMF – what it is and the typical levels encountered in the environment. Section 7.2 describes the Council's requirements for addressing EMF. Section 7.3 outlines the methods for measuring and calculating fields. Section 7.4 summarizes the magnetic field (MF) measurements and calculations that were developed by CL&P's consultant, Exponent, to comply with key requirements of the Council's *Best Management Practices for the Construction of Electric Transmission Lines* (Best Management Practices [BMPs]) with respect to the 345-kV transmission lines proposed for the Connecticut portion of the Interstate Reliability Project. Specifically, these proposed transmission lines are as follows:

(a) A new 345-kV transmission line on the 29.3-mile Proposed Route from Card Street Substation to the Lake Road Switching Station; and

(b) A new 345-kV transmission line on the 7.5-mile Proposed Route from the Lake Road Switching Station through the Killingly Substation to the Connecticut/Rhode Island

[1] As described in this section and in Appendix 7B, along three ROW segments, located along portions of the Proposed Route in the Towns of Coventry / Mansfield, Brooklyn, and Putnam (within portions of the ROW represented by XS-2, XS-6, and XS-12), CL&P proposes a delta 345-kV line configuration instead of H-frame structures to comply with the Council's EMF *Best Management Practices for the Construction of Electric Transmission Lines* (Best Management Practices [BMPs]). However, the base-case design in these three BMP segments is still H-frame.

border in Thompson, where the new Connecticut 345-kV line would connect to a new 345-kV line segment to West Farnum Substation in North Smithfield, Rhode Island, to be constructed and operated by National Grid.

Section 7.5 summarizes new developments in EMF health research since the adoption of the Council's latest BMP in December 2007, while Section 7.6 reviews CL&P's actions demonstrating consistency with Council guidelines.

The Council's BMP is provided in Appendix 7A for reference. Appendix 7B, the *Field Management Design Plan* (Plan or FMD Plan), presents design alternatives that could be used to reduce magnetic fields in certain areas along the Proposed Route, and provides an evaluation of magnetic field levels for each alternative. Detailed tabular data for electric and magnetic field levels for each ROW cross-section are presented in Appendix 7C, and a comprehensive review of current literature regarding health issues related to EMF exposures is presented in Appendix 7D.

7.1 ELECTRIC AND MAGNETIC FIELDS FROM POWER LINES AND OTHER SOURCES

Electricity used in homes and workplaces is transmitted over considerable distances from generation sources to distribution systems. Electricity is transmitted as alternating current (AC) to all homes and over electric lines delivering power to neighborhoods, factories, and commercial establishments. The power provided by electric utilities in North America oscillates 60 times per second (i.e., at a frequency of 60 hertz (Hz)).

Electric fields are the result of voltages applied to electrical conductors and equipment. The electric field is expressed in measurement units of volts per meter (V/m) or kilovolts per meter (kV/m); 1 kV/m is equal to 1,000 V/m. Most objects, including fences, shrubbery, and buildings, easily block electric fields. Therefore, certain appliances within homes and the workplace are the major sources of electric fields indoors, while power lines are the major sources of electric fields outdoors (Figure 7-1, lower panel).

Magnetic fields are produced by the flow of electric currents; however, unlike electric fields, most materials do not readily block magnetic fields. The level of a magnetic field is commonly expressed as magnetic flux density in units called gauss (G), or in milliGauss (mG), where 1 G = 1,000 mG.[2] The magnetic field level at any point depends on characteristics of the source, including the arrangement of conductors, the amount of current flow through the source, and its distance from the point of measurement. The levels of both electric fields and magnetic fields diminish with increasing distance from the source.

Background AC magnetic field levels in homes are generally less than 20 mG when not near a particular source, such as some appliances. Higher magnetic field levels can be measured outdoors in the vicinity of distribution lines, sub-transmission lines, and transmission lines (Figure 7-1, upper panel).

Electric appliances are among the strongest sources of AC magnetic fields encountered in indoor environments. Magnetic fields near appliances can reach 1,000 mG or more. For example, Gauger (1985) reports the maximum AC magnetic field at 3 cm from a sampling of appliances as follows: 3,000 mG (can opener), 2,000 mG (hair dryer), 5 mG (oven), and 0.7 mG (refrigerator). Similar measurements have shown that there is a tremendous variability among appliances made by different manufacturers. The potential contribution of different sources to overall exposure over long periods is not very well characterized, but both repeated exposure to higher fields for short times and longer exposure to lower intensity fields for a long time contribute to an individual's total exposure.

Considering EMF from a perspective of specific sources or environments, as illustrated in Figure 7-1, does not fully reflect the variations in an individual's personal exposure as encountered in everyday life. To illustrate this, magnetic field measurements were recorded, over a two-hour period, by a meter worn at the waist of an individual who conducted a range of typical daily activities in a Connecticut town.

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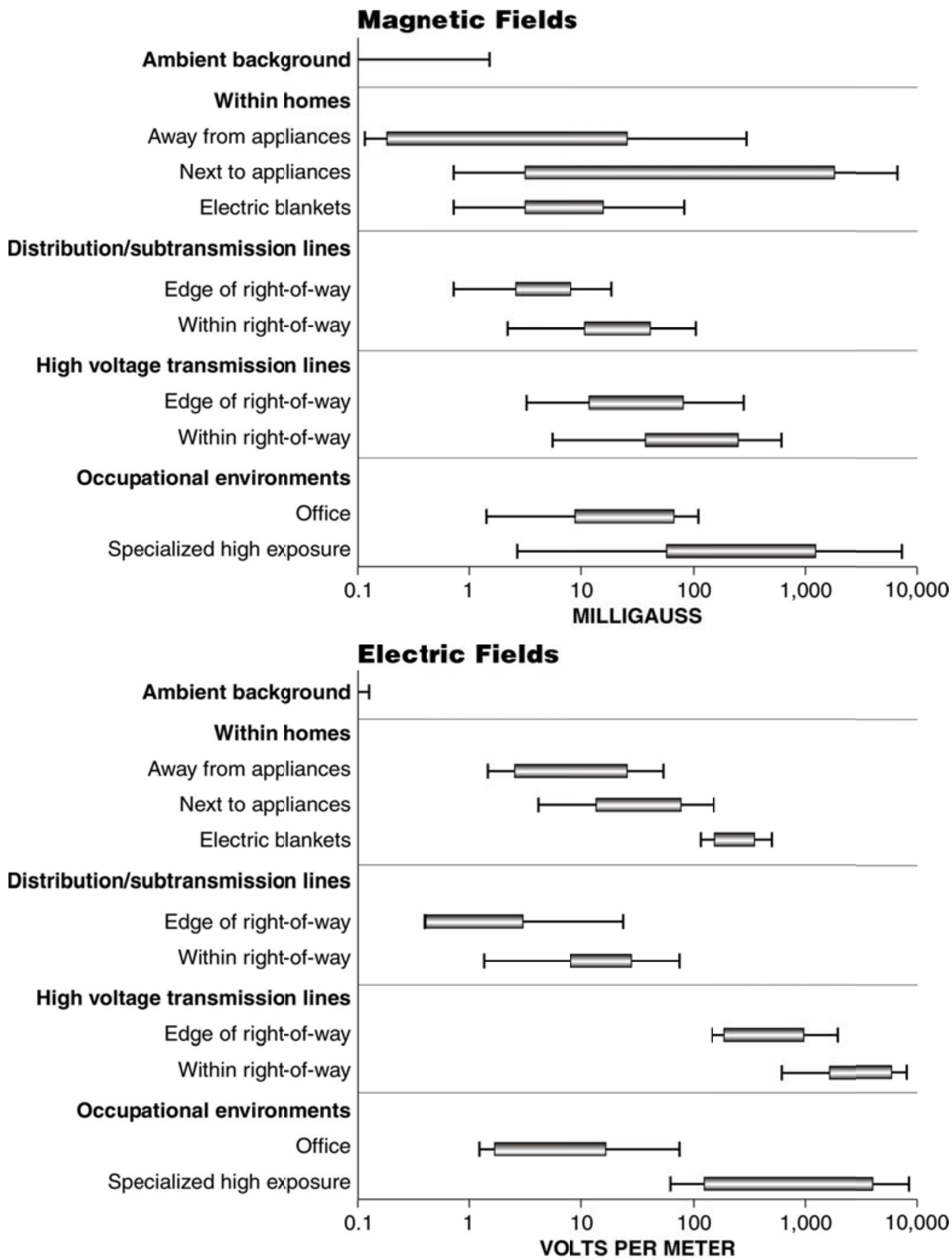
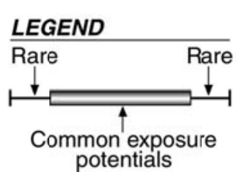
[2] Scientists more commonly refer to magnetic flux density at these levels in units of microTesla (μT). Magnetic flux density in milliGauss units can be converted to μT by dividing by 10, i.e., 1 milliGauss = 0.1 μT.

Figure 7-1: Electric and Magnetic Field Levels in the Environment

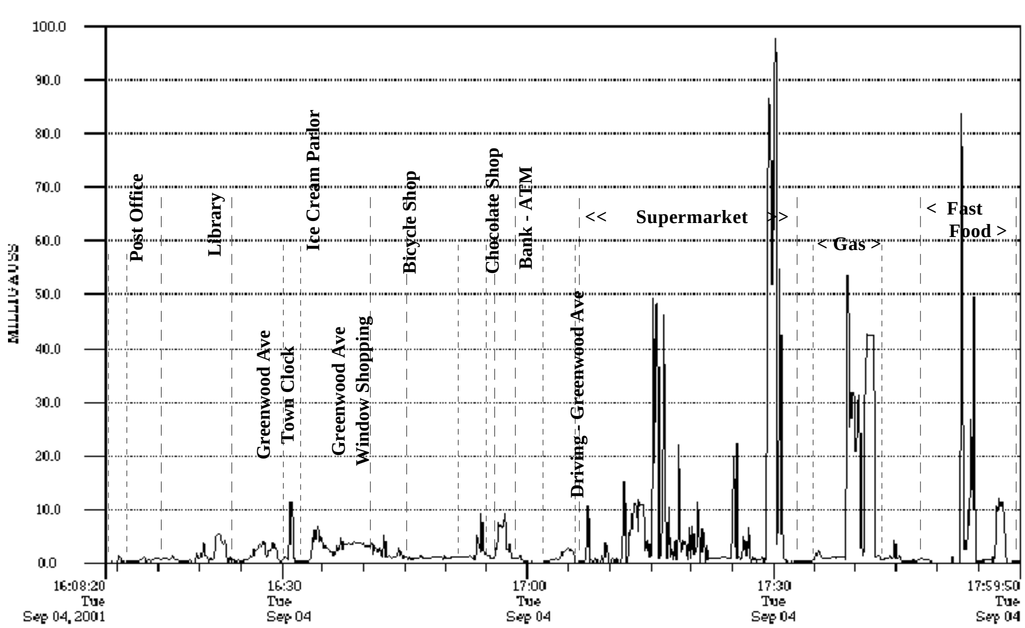




Source: Savitz et al. (1989)

As illustrated in Figure 7-2, these activities included a visit to the post office and the library, walking along the street, getting ice cream, browsing in a bicycle shop, stopping in a chocolate shop, going to the bank/ATM, driving along streets, shopping in a supermarket, stopping for gas, and purchasing food at a fast food restaurant.

Figure 7-2: Typical Magnetic Field Personal Exposures



During the course of the two-hours, a maximum magnetic field of 97.6 mG was measured in the supermarket (Table 7-1). As Figure 7-2 shows, from moment-to-moment in everyday life, magnetic fields are encountered that vary in intensity over a wide range. Other patterns of exposure to magnetic fields could well be very different. For example, a rider on commuter or long-distance electric trains in Connecticut would encounter higher average power-frequency magnetic fields of perhaps 14 to 50 mG during a trip, with peak values in the range of 100 to 400 mG (DOT/FRA, 2006).

Table 7-1: Summary of Magnetic Fields Measured in a Connecticut Town (Bethel)

Magnetic Field Levels (milligauss, mG)		
Maximum	Average	Median
97.55*	4.57	1.10

*Maximum occurred in the supermarket

7.2 EMF REGULATIONS AND GUIDELINES IN CONNECTICUT

Since 1993, the Council has required that proposed new electric transmission lines be designed in compliance with the EMF BMP. In December 2007, after a two-year proceeding, the Council adopted a complete revision of the BMP, adding new requirements based on policies previously implemented by the State of California (CSC, 2007a, hereafter referred to as "BMP"). The revised BMP document was supported by an independent scientist retained by the Council (Dr. Peter Valberg), by a panel of scientists presented by the Connecticut Department of Public Health and by the Commissioner of the Department of Public Health, and by scientists presented by CL&P and The United Illuminating Company, including Dr. Michael Repacholi, the then-recently retired Coordinator of the World Health Organization's Radiation and Environmental Health Unit. The BMP provides "precautionary guidelines" (BMP, p.4) for reduction of magnetic field levels associated with new electric transmission lines at the edges of electric transmission ROWs and beyond, especially where the new line would be adjacent to residential areas, public and private schools, licensed day-care centers, licensed youth camps, and public playgrounds.

In adopting the BMP, the Council recognized "the weight of scientific evidence indicates that exposure to electric fields, beyond levels traditionally established for safety, does not cause adverse health effects" and that scientific literature "reflects the lack of credible scientific evidence for a causal relationship between MF [magnetic field] exposure and adverse health effects" (BMP, pp. 2-3). Still, as part of its statutory duties, including its duty under Connecticut General Statutes § 16-50j *et seq*. to address public health and safety, the Council follows procedures to ensure a proposed transmission line would not pose an undue safety or health hazard to persons or property. These procedures and the BMP require that an applicant for approval of an electric transmission line provide:

1. Measurements and Calculations. An assessment of the effects of any electromagnetic fields produced by the proposed transmission line (Connecticut General Statutes §16-50*l*(a)(1)(A)(ix)), including a proposed line adjacent to "residential areas, private or public schools, licensed child day-care facilities, licensed youth camps, and public playgrounds," (BMP, p. 4) and "electromagnetic field effects on public health and safety" (Connecticut General Statutes §16-50 p(a)(3)(B)). This is to be met by taking measurements of existing electric and magnetic fields at the boundaries adjacent to the above facilities, with extrapolated calculations of exposure levels during expected normal and peak normal line loading. In particular, "an applicant shall provide design alternatives and calculations of MF for pre-project and post-project conditions, under 1) peak load conditions at the time of the application filing, and 2) projected seasonal maximum 24-hour average current load on the line anticipated within five years after the line is placed into operation" (BMP, p. 7).

2. The Council expects applicants will propose no-cost/low-cost measures to reduce magnetic fields by one or more engineering controls via a Field Management Design Plan (Plan). The Plan should "depict the proposed transmission line project designed according to standard good utility practice and incorporate "no-cost" MF mitigation design features. The Applicant shall then modify the base design by adding low-cost MF mitigation design features specifically where portions of the project are adjacent to residential areas, public or private schools, licensed child day-care facilities, licensed youth camps, or public playgrounds" (BMP, p. 4).

3. Administrative notice of completed and ongoing scientific and medical research on electromagnetic fields (Connecticut General Statutes §16-50o(b)) and "consider and review evidence of any new developments in scientific research addressing MF and public health effects or changes in scientific consensus group positions regarding MF" (BMP, p. 5).

4. A statement describing the consistency of the proposed mitigation design with the BMP (p. 6, 8), and buffer zone requirements (Connecticut General Statutes § 16-50p(a)(3)(D).

7.2.1 Statement of Compliance with the BMP and Buffer Zone Requirements

Section 7.4 provides measurements and calculations, developed pursuant to the Council's *Application Guide for an Electric and Fuel Transmission Line Facility* (April 2010) and the BMP, for the proposed Project transmission lines. This includes the 345-kV transmission line from Card Street Substation to Lake Road Switching Station and the Connecticut portion of the 345-kV transmission line from Lake Road Switching Station to West Farnum Substation.

Appendix 7B contains the Plan for the proposed transmission line improvements based in part on these calculations. In compliance with the BMP, the Plan begins with a "base" design of the proposed new transmission lines incorporating standard utility practice with "no-cost" magnetic field management features. The Plan then examines modified line designs incorporating "low-cost" magnetic field management features at five locations (referred to herein as "focus areas") where the proposed transmission lines could be considered by the Council to be adjacent to residential areas, public or private schools, licensed child day-care facilities, licensed youth camps, or public playgrounds. After examining multiple potential "BMP" designs to lower magnetic field levels at the edges of the ROW, compared to those associated with the base design, the Plan recommends one BMP design for each of the five focus areas as best fitting the Council's guidelines.[3] These guidelines seek to achieve magnetic field reductions at ROW edges of 15% or more as compared to the levels associated with a base line design, with an investment of up to 4% of the estimated project cost using the base line design, including the cost of the Project's related substation and switching station work.

The Plan recommendations, if adopted by the Council, reduce magnetic field levels at the edges of the Project ROWs by more than the 15% goal of the BMP in the areas where BMP designs have been incorporated into the proposed design, and produces magnetic field levels less than those commonly encountered by the U.S. population along many electric transmission ROWs, near many electric distribution lines, and in everyday settings. The lines on the ROW will also be in full compliance with the conductor height and spacing requirements of the National Electrical Safety Code. Accordingly, the ROW provides an adequate buffer zone between any new or modified lines and any adjacent residential areas, public or private schools, licensed child day-care facilities, licensed youth camps, or public playgrounds.

[3] In two of the five focus areas, CL&P's recommended BMP design is the base-case H-frame line. In the three other focus areas, CL&P recommends and proposes a delta line design; this design is reflected in the proposed Project configurations as depicted on XS-2 BMP, XS-6 BMP and XS-12 BMP. For XS-12 BMP, a portion of the existing 345-kV line would also be rebuilt in a delta line design.

Underground line variations were also evaluated in the event that the Council deems that an underground 345-kV line segment is required to replace short sections of CL&P's proposed overhead line that it may consider as adjacent to listed facilities or putative residential areas. Refer to Volume 1A, Section 15 for details regarding these underground variations.

Section 7.5 provides updated information concerning scientific research constituting the final component considered in determining compliance with the BMP and related buffer zone requirements listed above.

7.3 METHODS FOR EMF MEASUREMENTS AND CALCULATIONS

The major sources of EMF associated with the Project are the proposed and existing transmission lines on the existing ROWs. Transformers and other equipment within the associated substations and switching station are also potential EMF sources, but would have little or no effect on exposure to the general public. For a substation or switching station, the strongest fields around the perimeter fence come from the transmission and distribution lines entering and leaving the station. The strength of fields from equipment inside the fence decreases rapidly with distance, reaching very low levels at relatively short distances beyond substation fences (IEEE Std. 1127-1998). Experience indicates that EMF levels from substations and switching stations "attenuate sharply with distance and will often be reduced to a general ambient level at the substation property lines. The exception is where transmission and distribution lines enter the substation" (Institute of Electrical and Electronics Engineers [IEEE] Std. 1127-1990). Hence, addressing the EMF associated with transmission lines effectively addresses potential EMF exposures from substations or switching stations.

7.3.1 Field Measurements of EMF from Existing Sources

CL&P retained Exponent, Inc., an independent consulting firm with expertise in the measurement and characterization of transmission line magnetic fields, to take field measurements of EMF at selected locations along and adjacent to the existing ROWs along the Proposed Route and sections of the potentially viable route variations described in Volume 1A, Section 15. The measurements were taken at a height of 1 meter (3.28 feet) above ground, in accordance with the industry standard protocol for taking measurements near power lines (IEEE Std. 644-1994, R2008). Both electric and magnetic fields were expressed as the total field, i.e., the resultant of field vectors measured along vertical, transverse, and longitudinal axes.[4]

The electric field was measured in units of kV/m with a single-axis field sensor and meter (Electric Field Measurements, Inc.). The magnetic field was measured in units of mG by orthogonally mounted sensing coils with output logged by a digital recording meter (EMDEX II). These instruments meet the IEEE instrumentation standard for obtaining valid and accurate field measurements at power line frequencies (IEEE Std.1308-1994, R2001, R2010). The meters were calibrated by the manufacturers by methods like those described in IEEE Std. 644-1994, R2008.

Measurements of the magnetic field present a ‘snapshot’ of the conditions at a point in time. Within a day, and over the course of days, months, and even seasons, the magnetic field changes at any given location, depending on the amount and the patterns of power supply and demand within the state and surrounding region. In contrast, the unperturbed electric field is quite stable over time.

7.3.2 Calculations of EMF from Transmission Lines

Exponent calculated pre- and post-construction electric and magnetic field levels using computer algorithms developed by the Bonneville Power Administration, an agency of the U.S. Department of Energy (BPA, 1991). These algorithms have been shown to accurately predict electric and magnetic fields measured near power lines. The inputs to the program are data regarding voltage, current flow, line phasing, and conductor configurations. The fields associated with power lines were estimated along profiles perpendicular to lines at the point of lowest conductor sag, i.e., closest to the ground or opposite points of interest. All calculations were referenced to a height of 1 meter (3.28 feet) above ground, in

[4] Measurements along the vertical, transverse, and longitudinal axes were recorded as root-mean-square (rms) magnitudes. “Root mean square” refers to the common mathematical method of defining the effective voltage, current, or field of an AC system.

accordance with standard practice (IEEE Std. 644-1994, R2008). The program assumed balanced currents on all phases, and that all overhead transmission line conductors were at the mid-span height above ground of a typical span over flat terrain for the entire distance between structures. Since the line conductors will be higher above ground than the modeled height at most locations along the ROW, actual magnetic fields will be lower than the calculated values, especially within the ROW, all else equal.

The calculation of magnetic fields requires determining the currents that will flow on the lines of interest under each set of conditions to be studied. For the Connecticut transmission system, these currents are determined by various factors, including system configuration, system load level, generation dispatch, the level and direction of transfers of power into and/or from Connecticut, and assumptions about transmission line load flows as described below. This determination was done in a conservative way so as to lead to calculation results that would be higher than actual values under an assumed loading condition, all else equal.

For the base designs, Exponent evaluated all possible phasing combinations of the new and existing lines to identify a phasing of these lines that would minimize the magnetic field level at the edge of the ROW.

7.3.2.1 System Configuration

CL&P determined the system to be modeled in 2015 (the last pre-Project year) would reflect transmission system changes that are already approved by ISO-NE and included in the ISO-NE system reliability models as of December 2010, and which have expected in-service dates before 2015. CL&P therefore obtained base-case power-flow models from ISO-NE representing this assumed New England transmission grid topology for the years 2015 and 2020, with all lines in service. The 2015 models represent the system in the summer just before the Interstate Reliability Project is placed in-service, and include the system changes associated with the Rhode Island Reliability Project, the Greater Springfield Reliability Project, and the Manchester to Meekville Junction Project. The 2020 models represent the New England transmission grid in the summer five years following completion of the Interstate

Reliability Project (assumed in-service date of 2015). The 2020 models also include proposed system changes associated with the Central Connecticut Reliability Project, the remaining NEEWS Project.

All-overhead lines on the Proposed Route of the Interstate Reliability Project were assumed for this system modeling. Significant lengths of underground cables following line-route variations would change the electrical impedance of the grid and hence affect system load flows. However, for purposes of magnetic field calculations for the Proposed Route and for short underground line variations, the circuit currents were assumed in all but one case not to change. On the other hand, for the Willimantic South Underground Variation, which would involve the construction and operation of a 10.7-mile underground cable system segment in lieu of 11.6 miles of overhead line, changes in the system load flows were modeled for the purpose of calculating magnetic fields that would be associated with the underground variation and with the existing line. (Refer to Volume 1A, Section 15.5.)

7.3.2.2 System Load Level

The BMP require transmission line applicants to "provide design alternatives and calculations of MF for pre-project and post-project conditions, under 1) peak load conditions at the time of the application filing, and 2) projected seasonal maximum 24-hour average current load on the line anticipated within five years after the line is placed into operation." An applicant may also present calculations based on other loading conditions more typical throughout the year and thus more representative of time-weighted MF levels near or on a transmission line ROW.

CL&P elected to provide magnetic field calculations for the year 2015 to represent the pre-Project conditions and for the year 2020 to represent the forecasted post-Project conditions five years later. CL&P chose to:

- Estimate an **annual peak load (APL)** from the ISO-NE's projected 90/10 system peak loads for the peak load condition on the transmission system in 2015, and estimate 2020 peak loads by scaling ISO-NE's projected 90/10 level in 2019 to 2020 using the load-growth rates in their

2010-2019 Forecast Report of Capacity, Energy, Loads and Transmission, i.e., 31,810 MW in 2015 and 33, 555 MW in 2020. These projected peak loads were then each reduced, as in system planning studies, by forecasted Demand Response resources (active and passive) of 3,008 MW.

- Estimate **peak daily average loads (PDAL)** over a 24-hour period at 80% of the system's hourly peak load, i.e., 25,448 MW in 2015 and 26,844 MW in 2020. These projected peak daily average loads were then each reduced by forecasted passive Demand Response resources of 1,439 MW.

- Estimate **annual average loads (AAL)** using a 60% annual load factor for the New England Transmission System, i.e., 19,086 MW in 2015 and 20,133 MW in 2020. These projected annual average loads were then each reduced by forecasted passive Demand Response resources of 1,439 MW.

CL&P supplied the results of system load-flow modeling of APL, PDAL, and AAL to its consultant, Exponent, for the modeling of magnetic fields in 2015 and 2020.

Additionally, where distribution lines are located on the Project ROWs, their peak loads in 2015 and 2020 were estimated by applying an annual 1.2 % growth rate to June 2008 peak values. Their non-peak loading conditions were then estimated using the same percentages indicated above for the transmission lines.

In summary, CL&P obtained magnetic field calculations for three (APL, PDAL, AAL) pre-Interstate Reliability Project loading conditions in the year 2015 and three (APL, PDAL, AAL) post-NEEWS Projects loading conditions in the year 2020. For these calculations, CL&P directed its consultant to use conservatively low conductor heights, conservatively high system load projections in each of the six future cases, and relatively high New England East-West and Connecticut Import interface power transfers (refer to the discussion in the following section). The latter assumption in particular could only be realized if Connecticut greatly increased its annual power imports compared to typical power-import levels in the previous decade. With these conductor height and power-flow assumptions, Exponent's magnetic field calculations in each case will yield conservatively high values for each condition. Therefore, the AAL cases should not be construed as indicative of expected annual average magnetic field levels at a location, but rather a conservatively high estimate of such a case.

7.3.2.3 Generation Dispatch, Connecticut Import Level, and Connecticut East-West Transfer Level

The NEEWS projects would enable an increase in the Connecticut Import limit and in the New England east-west transfer capability. With all lines in service, the transfer of power into Connecticut at each of the six assumed future load levels will be determined by the New England generation dispatch.

For purposes of conservatively modeling magnetic fields along the Interstate Reliability Project ROWs in Connecticut under these assumed future load levels, CL&P developed generation dispatch assumptions for power-flow modeling that would cause unusually high power flows over the 345-kV circuits between Connecticut and Rhode Island. As in the power-flow simulations used to determine the need for and the design of the Project, the Vermont Yankee nuclear power plant was assumed to be off-line in all cases. This assumption added to the New England east-to-west power flows that would cause higher currents on the transmission lines in the Project corridor. For each model case, generation was adjusted to keep flows between New England and New York State close to zero. These generation dispatch assumptions are reasonable and conservative for this EMF calculation purpose.

Table 7-2 provides the modeled generation output levels and certain New England regional interface transfer levels for each assumed 2015 and 2020 load condition. The Connecticut Import interface transfer is at the upper limit of the interface transfer capability for the peak hour (APL cases), at about 75% of the upper limit of the interface transfer capability for the PDAL cases, and at about 60% of the upper limit of the interface transfer capability for the AAL cases.

Table 7-2: Generation Dispatches and Transfers (in MW) Assumed for Load-Flow Models

Generation	Pre-Interstate (MW)			Post-NEEWS (MW)		
	APL	PDAL	AAL	APL	PDAL	AAL
Stony Brook	441	441	441	441	441	441
Berkshire Power	229	229	229	229	229	229
West Springfield	169	169	0	169	169	0
Mt Tom	144	0	0	144	0	0
MASSPOWER	238	238	238	238	238	238
Northfield Mountain	830	550	550	1110	830	550
Bear Swamp	569	284	0	569	284	0
South Meadow	85	110	73	73	110	73
Middletown	211	211	0	236	258	0
Montville	488	81	0	488	81	0
Millstone	2102	2102	2102	2102	2102	2102
Kleen Energy	619	461	461	619	461	461
New Haven Harbor	448	448	142	250	350	0
Lake Road	745	497	497	745	497	497
Norwalk Harbor	100	100	100	100	100	100
Bridgeport Energy	300	300	0	148	148	0
Wallingford	8	8	8	8	8	8
Milford and Devon	94	30	0	94	59	0
AES Thames	184	184	0	184	184	0
Rise	529	353	353	529	353	353
ANP Blackstone	444	444	221	444	444	221
Canal	547	547	0	1092	547	0
Ocean State OSP	541	541	541	541	541	541
NEA Bellingham	274	274	183	274	274	183
ANP Bellingham	475	475	236	475	475	236
Millenium	326	326	326	326	326	326
Manchester-Franklin Sq	443	443	149	443	443	149
Brayton Point	1301	866	254	1545	866	254
East-West Transfer	2485	1858	1143	3175	2331	1703
NY-NE Transfer	21	12	-11	25	-7	29
Connecticut Import Level	2820	2132	1692	3584	2695	2179

7.4 MAGNETIC FIELD MEASUREMENTS AND CALCULATIONS DEVELOPED TO COMPLY WITH THE BMP AND TO DEVELOP THE FIELD MANAGEMENT DESIGN PLAN: CONNECTICUT PORTION OF THE INTERSTATE RELIABILITY PROJECT TRANSMISSION LINES

Spot measurements of existing magnetic and electric field levels were taken along each of the ROWs where construction is proposed or could occur with a focus on sections where groups of residences are near the ROW or where potential Statutory Facilities are nearby, as described in the Council's *Application Guide* (revised April 2010). Calculations of magnetic fields for existing lines under pre-Project conditions in 2015 and post-NEEWS conditions in 2020 for proposed new and existing lines were performed for the Plan at the AAL. These calculations are most useful for predicting field levels for any 'typical' day, and these values are presented below in profiles and tables. Additionally, magnetic field levels at the edges of the ROWs and at 25-foot intervals are also presented for the base design and alternative designs at AAL, APL and PDAL, together with associated electric field levels, in Appendix 7C.

7.4.1 EMF Associated with Proposed Line Designs

The configurations of the transmission lines currently on the ROWs and the proposed Project 345-kV transmission lines are described by different cross-sections between Card Street Substation and the Connecticut/Rhode Island border. Additional details regarding these ROW sections are presented in Section 3 of this volume, and cross-section drawings of each configuration are included in Appendix 3A, as well as in Volumes 9 and 10.

The proposed overhead 345-kV line that was modeled for EMF projections is a base-case horizontally configured line using H-frame structures, except along four segments of the Proposed Route. One of those three segments is in Mansfield Hollow State Park and WMA (in the Town of Mansfield), where the existing line employs a delta configuration on steel monopoles. CL&P's proposal for the new 345-kV line is to match that delta configuration. In the other three segments, located in the Towns of Coventry / Mansfield, Brooklyn, and Putnam, CL&P proposes a delta 345-kV line configuration to comply with the

Council's EMF BMPs. Refer to Section 7.4.2 and Appendix 7B for information on the three BMP exceptions. (Section 10 reviews the proposed transmission line configuration across the Mansfield Hollow area compared to two configuration options. EMF data are provided for these options in Section 10.)

7.4.1.1 Card Street Substation to Babcock Hill Junction – XS-1

7.4.1.1.1 Existing Line Configuration

The segment of ROW between Card Street Substation and the Babcock Hill Junction (Cross-Section No. 1 or XS-1) is 2.8 miles long and 350 feet wide. Currently on this section of ROW are: (a) a 345-kV transmission line supported on wood- or steel-pole H-frame structures; and (b) a double-circuit 69-kV transmission line supported on steel monopoles.

While no Statutory Facilities were identified in the vicinity of this ROW segment, some homes are located nearby. A summary of magnetic and electric field measurements taken at the southwest edge of the XS-1 ROW in the vicinity of these homes is shown in Table 7-3. Field measurements were taken on July 7, 2011, at approximately 4 p.m.

Table 7-3: Measured Electric and Magnetic Fields for Card Street Substation to Babcock Hill Junction – XS-1 in the Vicinity of Residences

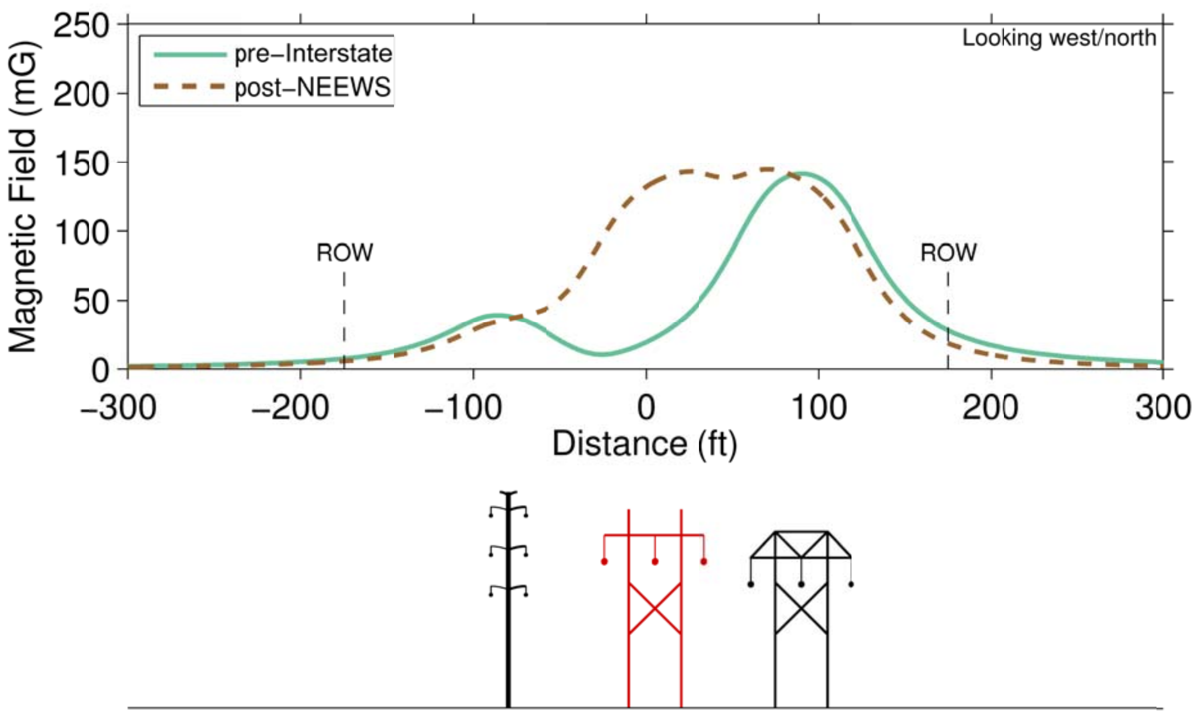
Location Name/Address	Town	Volume 9 Mapsheet	Magnetic Field (mG)	Electric Field (kV/m)	Approximate distance from centerline of new 345-kV transmission line to measurement location (ft)
4 Scalise Dr	Columbia	2 of 40	5.8	0.005 *	190

* Shielding by vegetation provides some level of reduction in the apparent electric field.

7.4.1.1.2 Proposed Line Configuration and Magnetic Fields

Along this ROW segment, the new 345-kV transmission line would be supported on H-frame structures, located between the existing 69-kV double-circuit line and the existing 345-kV H-frame line (refer to the proposed configuration in XS-1). Magnetic field profiles across the ROW produced by both the existing and proposed lines along this section of the ROW at AAL were calculated as shown in Figure 7-3. *(Note: The proposed 345-kV line type and location is shown in red beneath all such magnetic field profile figures included in this section.)*

Figure 7-3: Profile XS-1: Card Street Substation to Babcock Hill Junction – Magnetic Fields under Pre-Interstate (2015) and Post-NEEWS (2020) Conditions at AAL



Existing and New Lines (Structures not drawn to scale)

The calculated levels of the magnetic and electric fields at the ROW edges before and after construction of this segment of the Project at AAL are summarized in Table 7-4.

Table 7-4: Summary of Pre-Interstate (2015) and Post-NEEWS (2020) EMF Levels at the Edge of the ROW at Annual Average Loading (AAL) – Card Street Substation to Babcock Hill Junction – XS-1

Cross-Section	Magnetic Field (mG)		Electric Field (kV/m)	
	West/South ROW	East/North ROW	West/South ROW	East/North ROW
XS-1 – Pre	7.6	28.2	0.06	1.20
XS-1 – Post	5.8	18.7	0.06	1.18

7.4.1.2 Babcock Hill Junction to Vicinity of Highland Road – XS-2 BMP

7.4.1.2.1 Existing Line Configuration

Along this 300-foot-wide, 2.8-mile segment of ROW (referred to as XS-2 BMP), one existing 345-kV transmission line is supported on wood-pole H-frame structures. A collection of homes (i.e., a residential focus area) is located near portions of this ROW. Table 7-5 summarizes the magnetic and electric field measurements taken at the northwest edge of the XS-2 BMP ROW in the vicinity of one of these home locations. Field measurements were taken on July 7, 2011 at approximately 5 p.m.

Table 7-5: Measured Electric and Magnetic Fields for Babcock Hill Junction to Vicinity of Highland Road – XS-2 BMP in the Vicinity of the Focus Area

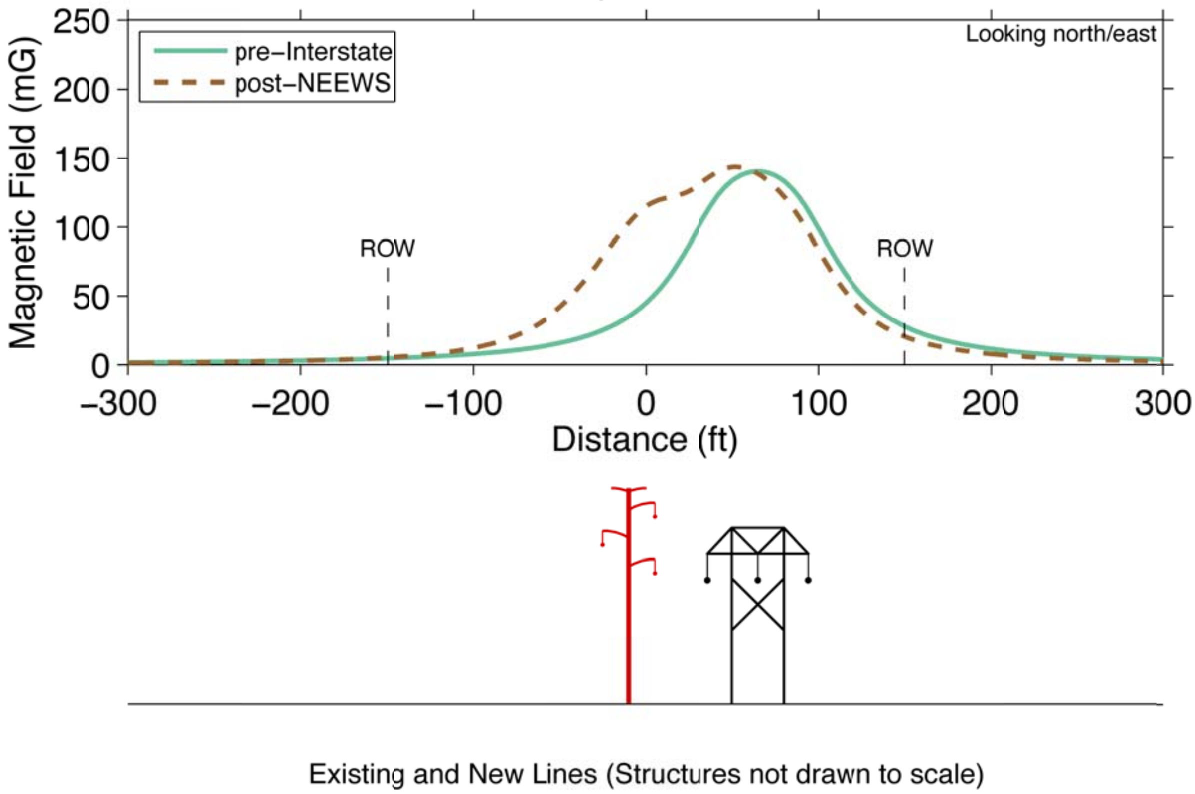
Location Name/Address	Town	Volume 9 Mapsheet	Magnetic Field (mG)	Electric Field (kV/m)	Approximate distance from centerline of new 345-kV transmission line to measurement location (ft)
164 Stafford Rd	Mansfield	5 of 40	8.2	0.017 *	150

* Shielding by vegetation provides some level of reduction in the apparent electric field.

7.4.1.2.2 Proposed Line Configuration and Magnetic Fields

Along this segment of ROW, the new 345-kV transmission line would be supported on steel-pole structures with the conductors arranged in a delta configuration. The configuration of the proposed cross-section is shown as the “Proposed Configuration” in XS-2 BMP. Magnetic field profiles across the ROW produced by the existing and proposed lines along this section of the ROW at AAL were calculated as shown in Figure 7-4.

Figure 7-4: Profile XS-2 BMP: Babcock Hill Junction to Vicinity of Highland Road – Magnetic Fields under Pre-Interstate (2015) and Post-NEEWS (2020) Conditions at AAL



The calculated levels of the magnetic and electric fields at the ROW edges before and after construction of this section of the Project at AAL are summarized in Table 7-6.

Table 7-6: Summary of Pre-Interstate (2015) and Post-NEEWS (2020) EMF Levels at the Edge of the ROW at Annual Average Loading (AAL) - Babcock Hill Junction to Vicinity of Highland Road (XS-2 BMP)

Cross-Section	Magnetic Field (mG)		Electric Field (kV/m)	
	West/North ROW	East/South ROW	West/North ROW	East/South ROW
XS-2 BMP – Pre	4.6	28.0	0.09	1.20
XS-2 BMP – Post	5.2	20.6	0.28	1.21

7.4.1.3 Vicinity of Highland Road to Mansfield Hollow State Park – XS-2

Along this 3.3-mile segment of the ROW (Town of Mansfield), which is 300 feet wide, one existing 345-kV transmission line is supported on wood-pole H-frame structures. Two focus areas, one containing two home day-care facilities and a school, and another containing a collection of homes (i.e., a residential focus area) are near the ROW in Cross-Section No. 2, or XS-2. Table 7-7 summarizes the magnetic and electric field measurements taken at the edge of the XS-2 ROW in the vicinity of three of these locations. Field measurements were taken on July 7, 2011, between 6 p.m. and 9 p.m.

Table 7-7: Measured Electric and Magnetic Fields for Babcock Hill Junction to Mansfield Hollow State Park – XS-2 in the Vicinity of the Focus Area

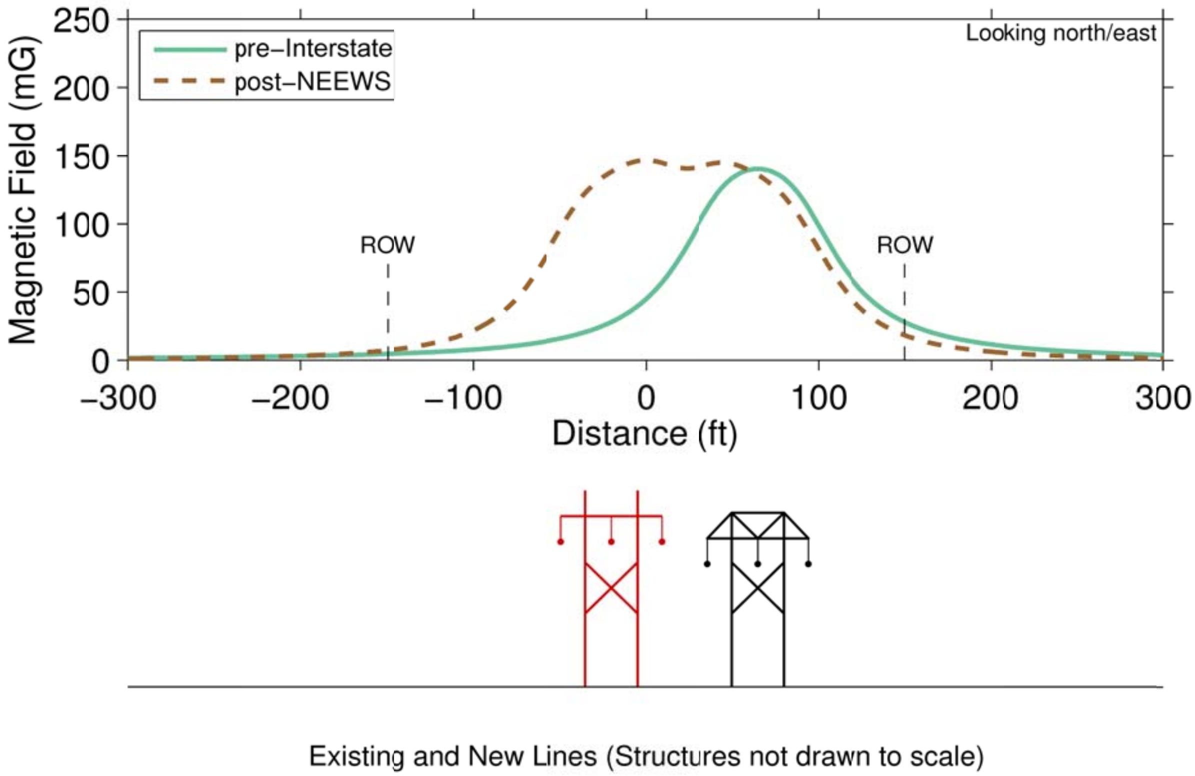
Location Name/Address	Town	Volume 9 Mapsheet	Magnetic Field (mG)	Electric Field (kV/m)	Approximate distance from centerline of new 345-kV transmission line to measurement location (ft)
Come Play With Me Day Care 385 Storrs Rd	Mansfield	8 of 40	38.8	--	170
Mount Hope Montessori School 48 Bassetts Bridge Rd	Mansfield	8 of 40	6.6	0.107 *	150
Green Dragon Day Care 87 Bassetts Bridge Rd	Mansfield	9 of 40	28.4	0.007 *	160

* Shielding by vegetation provides some level of reduction in the apparent electric field.
--Shielding by vegetation prevented the collection of measurable electric field levels at this location.

7.4.1.3.1 Proposed Line Configuration and Magnetic Fields

Along this segment of ROW, the new 345-kV transmission line would be supported on H-Frame structures. The configuration of the proposed cross-section is shown as the "Proposed Configuration" in XS-2. Magnetic field profiles across the ROW produced by the existing and proposed lines along this section of the ROW at AAL were calculated as shown in Figure 7-5.

Figure 7-5: Profile XS-2: Vicinity of Highland Road to Mansfield Hollow State Park – Magnetic Fields under Pre-Interstate (2015) and Post-NEEWS (2020) Conditions at AAL



The calculated levels of the magnetic and electric fields at the ROW edges before and after construction of this section of the Project at AAL are summarized in Table 7-8.

Table 7-8: Summary of Pre-Interstate (2015) and Post-NEEWS (2020) EMF Levels at the Edge of the ROW at Annual Average Loading (AAL) - Vicinity of Highland Road to Mansfield Hollow Reservoir (XS-2)

Cross-Section	Magnetic Field (mG)		Electric Field (kV/m)	
	West/North ROW	East/South ROW	West/North ROW	East/South ROW
XS-2 – Pre	4.6	28.0	0.09	1.20
XS-2 – Post	7.2	18.4	0.39	1.19

7.4.1.4 Mansfield Hollow State Park to Bassetts Bridge Road – XS-3

7.4.1.4.1 Existing Line Configuration

The segment of ROW, referred to as Mansfield Hollow State Park (Cross-Section No. 3 or XS-3), is approximately 1 mile long and 150 feet wide[5], and extends through federally-owned property that is managed by the CT DEEP. The 150-foot-wide ROW extends across Mansfield Hollow State Park, Mansfield Hollow Lake, and the Mansfield Hollow WMA. This ROW segment currently includes a 345-kV transmission line supported on steel-monopole structures. No Statutory Facilities were identified in the vicinity of this segment of ROW.

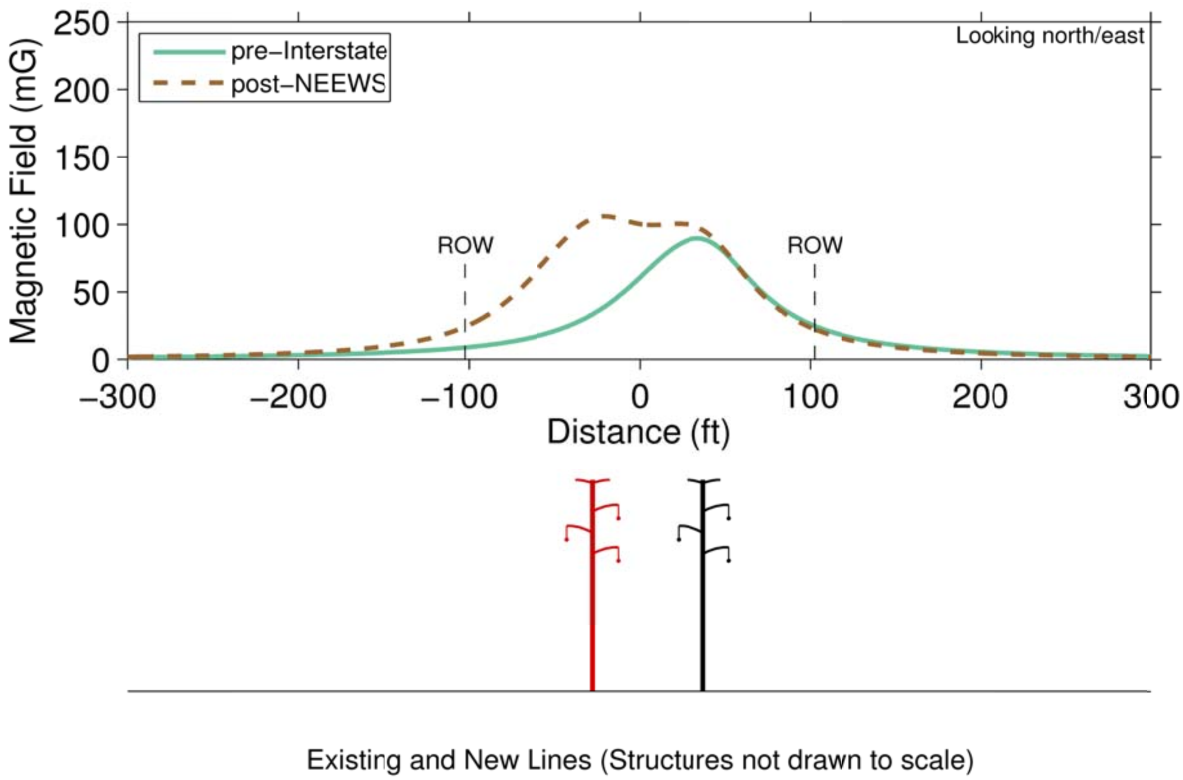
7.4.1.4.2 Proposed Line Configuration and Magnetic Fields

Along this segment of ROW, in order to accommodate the new 345-kV line adjacent to the existing line, CL&P proposes to expand the ROW by 55 feet, by acquiring additional easements from the federal government.[6] The new 345-kV transmission line structures would be self-supported steel monopoles that would match the appearance of the existing structures. Magnetic field profiles across the ROW produced by the existing and proposed lines along this section of the ROW at AAL were calculated as shown in Figure 7-6.

[5] Approximately 0.9 mile of the 1-mile segment extends across federally-owned properties through which CL&P's ROW is only 150 feet wide. The western portion of this cross-section includes an approximately 0.1-mile segment of 300-foot-wide ROW across privately-owned property that abuts the federal lands.

[6] CL&P also has identified two feasible configuration options to this proposed design and ROW expansion. These configuration options are discussed in Section 10, which includes EMF projections for each design.

Figure 7-6: Profile XS-3– Mansfield Hollow State Park to Bassetts Bridge Road - Magnetic Fields under Pre-Interstate (2015) and post-NEEWS (2020) Conditions at AAL



The calculated levels of the magnetic and electric fields at the ROW edges before and after construction along this section of the Project at AAL are summarized in Table 7-9. Note that the EMF values given for "XS-3-Pre" in Table 7-9 were calculated at the edges of the proposed (i.e., expanded) ROW.

Table 7-9: Summary of Pre-Interstate (2015) and Post-NEEWS (2020) EMF Levels at the Edge of the ROW at Annual Average Loading (AAL) - Mansfield Hollow State Park (XS-3)

Cross-Section	Magnetic Field (mG)		Electric Field (kV/m)	
	West/North ROW	East/South ROW	West/North ROW	East/South ROW
XS-3 – Pre	8.8	24.7	0.33	0.86
XS-3 – Post	24.1	22.3	1.47	0.93

7.4.1.5 Bassetts Bridge Road to Shuba Lane – XS-4

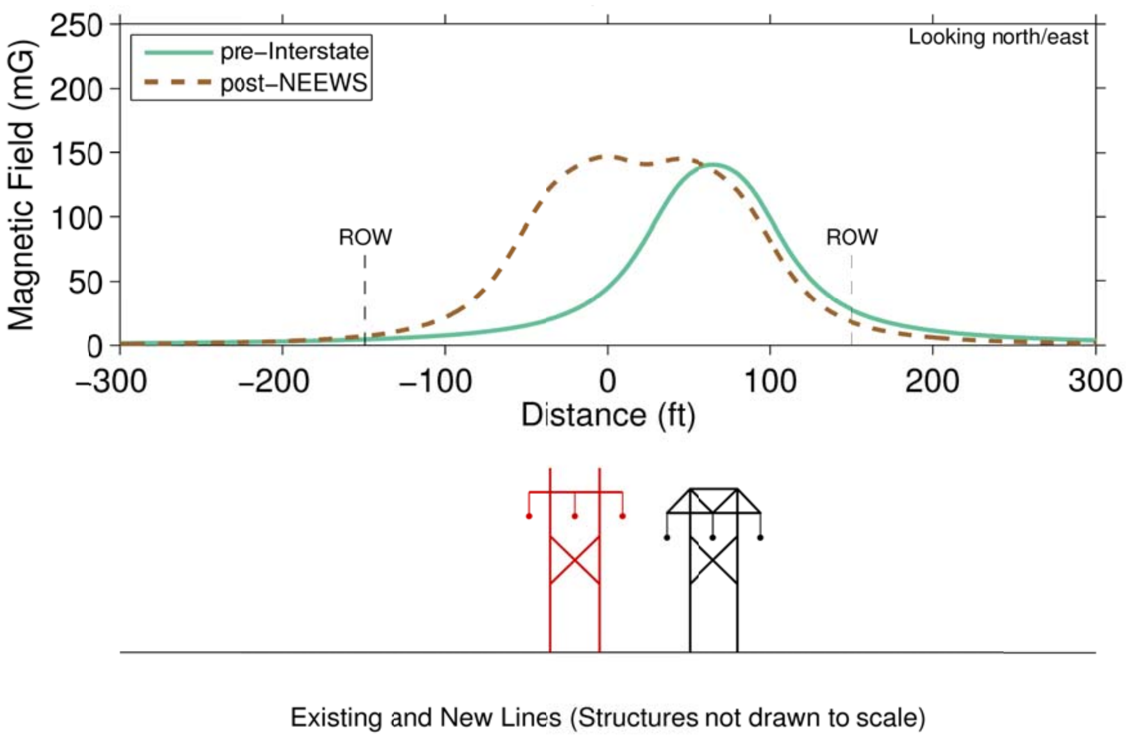
7.4.1.5.1 Existing Line Configuration

The ROW between Bassetts Bridge Road and Shuba Lane (Cross Section No. 4 or XS-4) is 0.8 mile long and 300 feet wide. This ROW segment currently is occupied by CL&P's existing 345-kV transmission line supported on wood-pole H-frame structures. No Statutory Facilities were identified in the vicinity of this ROW section.

7.4.1.5.2 Proposed Line Configuration and Magnetic Fields

The new 345-kV transmission line would be supported on H-frame structures. The configuration of the proposed cross-section is shown as the proposed configuration in XS-4. Magnetic field profiles across the ROW produced by the existing and proposed lines along this section of the ROW at AAL were calculated as shown in Figure 7-7.

Figure 7-7: Profile XS-4 Bassetts Bridge Road to Shuba Lane – Magnetic Fields under Pre-Interstate (2015) and Post-NEEWS (2020) Conditions at AAL



The calculated levels of the magnetic and electric fields at the ROW edges before and after construction of this section of the Project at AAL are summarized in Table 7-10.

Table 7-10: Summary of Pre-Interstate (2015) and Post-NEEWS (2020) EMF levels at the Edge of the ROW at Annual Average Loading (AAL) - Bassetts Bridge Road to Shuba Lane (XS-4)

Cross-Section	Magnetic Field (mG)		Electric Field (kV/m)	
	West/North ROW	East/South ROW	West/North ROW	East/South ROW
XS-4 – Pre	4.6	28.0	0.09	1.20
XS-4 – Post	7.2	18.4	0.39	1.19

7.4.1.6 Vicinity of Shuba Lane through Mansfield Hollow WMA to Vicinity of Willimantic Road– XS-5

7.4.1.6.1 Existing Line Configuration

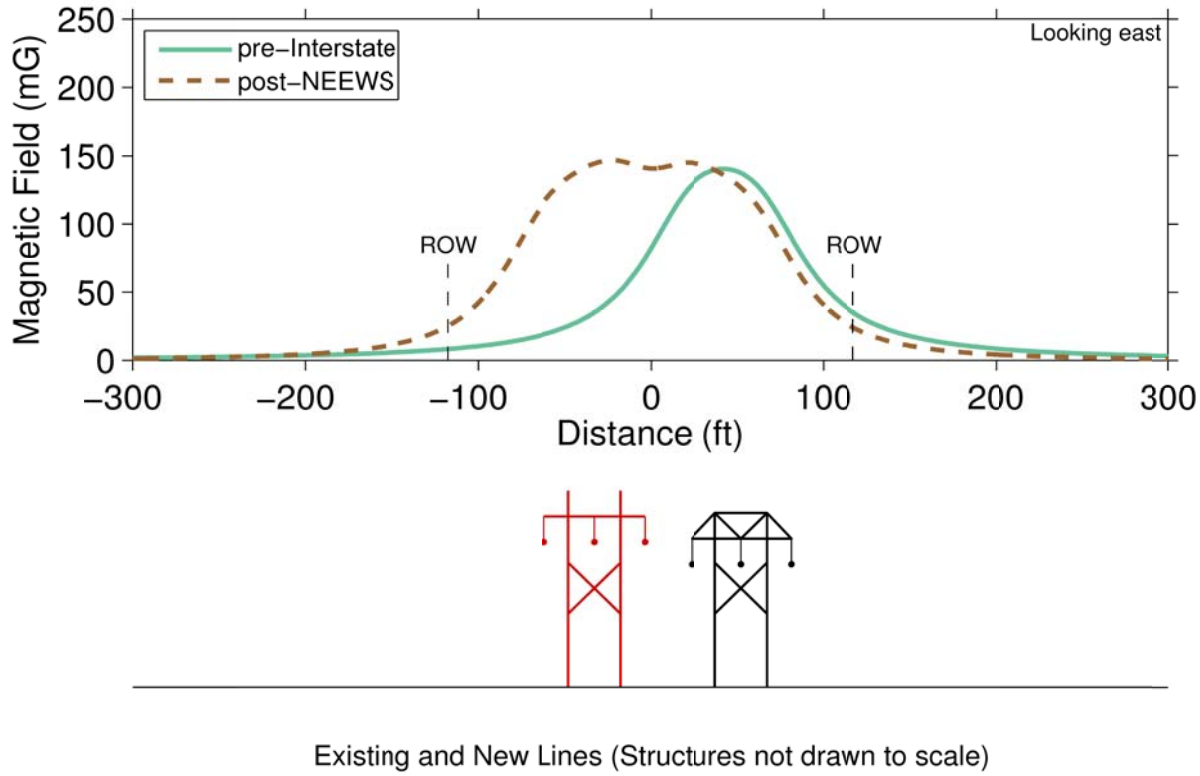
The section of ROW that traverses the federally-owned Mansfield Hollow WMA in the Town of Chaplin (Cross-Section No. 5 or XS-5) is 0.5 mile long and 150 feet wide. The existing CL&P 345-kV transmission line is supported on wood-pole H-frame structures. No Statutory Facilities or focus areas were identified in the vicinity of this ROW section.

7.4.1.6.2 Proposed Line Configuration and Magnetic Fields

To match the existing 345-kV line's structures in appearance, the new 345-kV transmission line would be supported on H-frame structures. To accommodate this type of line, CL&P proposes to expand the ROW by approximately 85 feet[7]. The configuration of the proposed cross-section is shown as the proposed configuration in XS-5. Magnetic field profiles across the ROW produced by the existing and proposed lines along this section of the ROW at AAL were calculated as shown in Figure 7-8.

[7] As described for the 150-foot-wide ROW across Mansfield Hollow State Park and WMA in the Town of Mansfield, CL&P also has identified two feasible configuration options for aligning the new 345-kV line across this 0.5-mile segment of the WMA in Chaplin. EMF projections for these options are presented in Section 10.

Figure 7-8: Profile XS-5– Vicinity of Shuba Lane through Mansfield Hollow WMA to Vicinity of Willimantic Road - Magnetic Fields Under Pre-Interstate (2015) and Post-NEEWS (2020) Conditions at AAL



The calculated levels of the magnetic and electric fields at the ROW edges before and after construction of this section of the Project at AAL are summarized in Table 7-11. Note that the EMF values given for "XS-5–Pre" in Table 7-11 were calculated at the edges of the proposed (i.e., expanded) ROW.

Table 7-11: Summary of Pre-Interstate (2015) and Post-NEEWS (2020) EMF Levels at the Edge of the ROW at Annual Average Loading (AAL) - Vicinity of Shuba Lane through Mansfield Hollow WMA to Vicinity of Willimantic Road (XS-5)

Cross-Section	Magnetic Field (mG)		Electric Field (kV/m)	
	West/North ROW	East/South ROW	West/North ROW	East/South ROW
XS-5– Pre	8.3	35.2	0.21	1.63
XS-5 – Post	25.1	24.1	1.66	1.62

7.4.1.7 Willimantic Road to Vicinity of Day Street Junction – XS-6

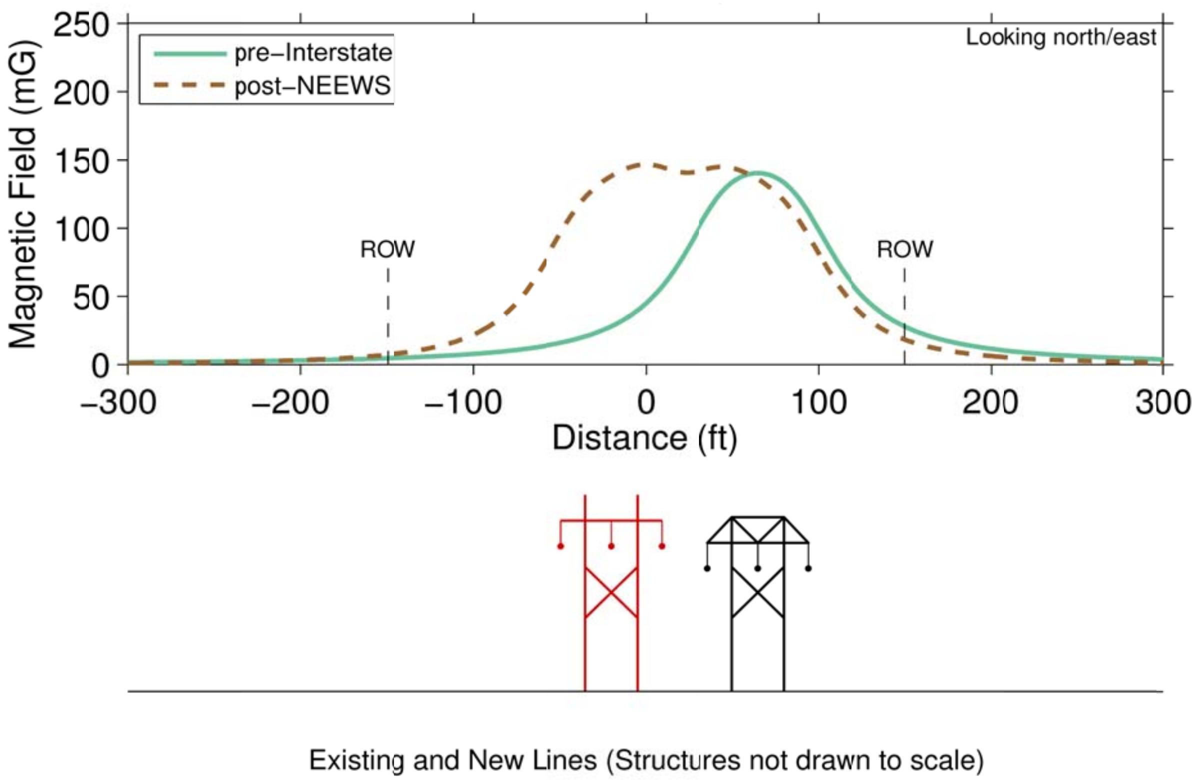
7.4.1.7.1 Existing Line Configuration

The segment of ROW between Willimantic Road and Day Street Junction (Cross-Section No. 6 or XS-6) is 12.6 miles long and 300 feet wide. One existing 345-kV transmission line is supported on wood-pole H-frame structures.

7.4.1.7.2 Proposed Line Configuration and Magnetic Fields

As show in XS-6, the new 345-kV transmission line would be supported on H-frame structures. Magnetic field profiles across the ROW produced by the existing and proposed lines along this segment of the ROW at AAL were calculated as shown in Figure 7-9.

Figure 7-9: Profile XS-6 – Willimantic Road to Vicinity of Day Street Junction - Magnetic Fields under Pre-Interstate (2015) and Post-NEEWS (2020) Conditions at AAL



The calculated levels of the magnetic and electric fields at the ROW edges before and after construction of this section of the Project at AAL are summarized in Table 7-12.

Table 7-12: Summary of Pre-Interstate (2015) and Post-NEEWS (2020) EMF Levels at the Edge of the ROW at Annual Average Loading (AAL) - Willimantic Road to Vicinity of Day Street Junction (XS-6)

Cross-Section	Magnetic Field (mG)		Electric Field (kV/m)	
	West/North ROW	East/South ROW	West/North ROW	East/South ROW
XS-6 – Pre	4.6	28.0	0.09	1.20
XS-6 – Post	7.2	18.4	0.39	1.19

7.4.1.8 Vicinity of Day Street Junction – XS-6 BMP

7.4.1.8.1 Existing Line Configuration

The Vicinity of Day Street Junction segment of ROW is 1 mile long and 300 feet wide, extending from west of Church Street to Day Street Junction in the Town of Brooklyn (Cross-Section No. 6 BMP or XS-6 BMP). One existing 345-kV transmission line is supported on wood-pole H-frame structures. XS-6 BMP illustrates the existing and proposed structures for this cross-section. Along this segment of the route, two home day-care facilities and several homes are situated near the ROW. A summary of magnetic and electric field measurements taken at the north edge of the XS-6 BMP ROW near these locations is shown in Table 7-13. Field measurements were taken on July 8, 2011, at approximately 10 a.m.

Table 7-13: Measured Electric and Magnetic Fields in the Vicinity of Day Street Junction – XS-6 BMP Near Residential Day-Care

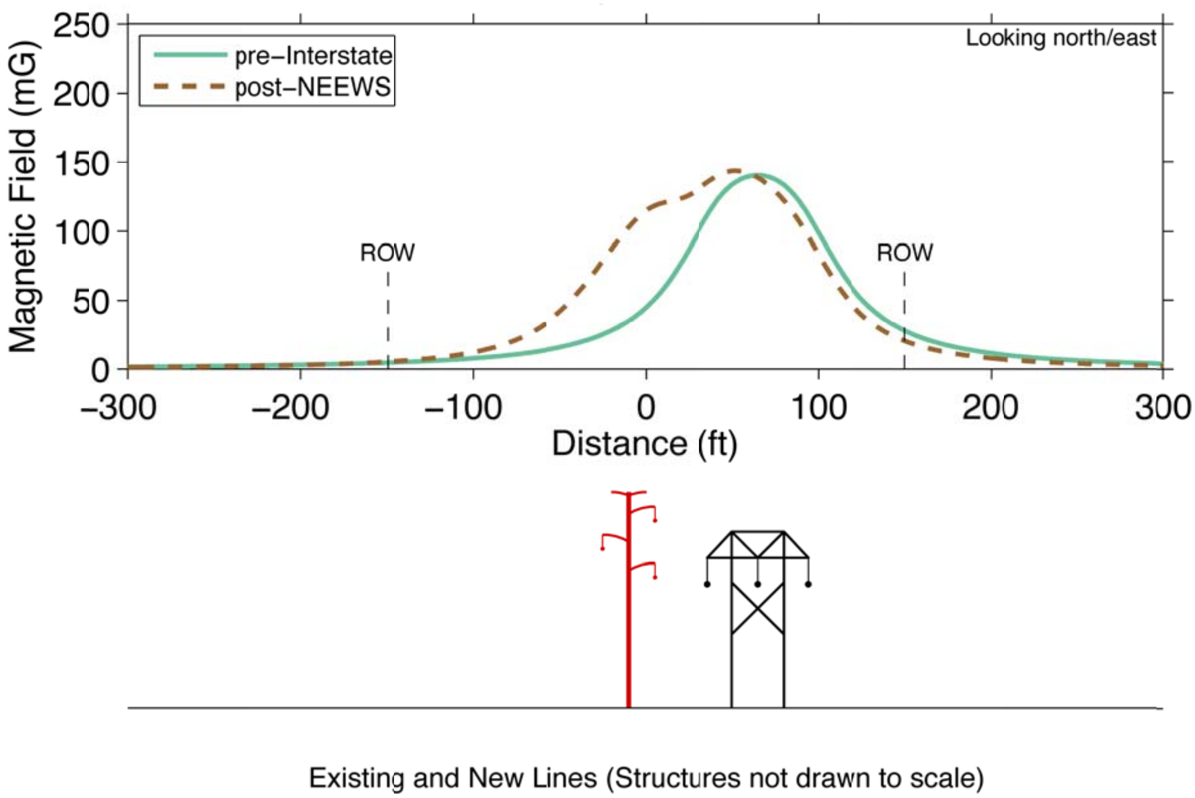
Location Name/Address	Town	Volume 9 Mapsheet	Magnetic Field (mG)	Electric Field (kV/m)	Approximate distance from centerline of new 345-kV transmission line to measurement location (ft)
Residential day care 350 Church St	Brooklyn	24 of 40	8.1	0.053	145

* Shielding by vegetation provides some level of reduction in the apparent electric field.

7.4.1.8.2 Proposed Line Configuration and Magnetic Fields

As shown on XS-6 BMP, the new 345-kV transmission line would be supported on steel-pole structures with conductors in a delta configuration. Magnetic field profiles across the ROW produced by the existing and proposed lines along this section of the ROW at AAL were calculated as shown in Figure 7-10.

Figure 7-10: Profile XS-6 BMP – Vicinity of Day Street Junction - Magnetic Fields Under Pre-Interstate (2015) and Post-NEEWS (2020) Conditions at AAL



The calculated levels of the magnetic and electric fields at the ROW edges before and after construction of this section of the Project at AAL are summarized in Table 7-14.

Table 7-14: Summary of Pre-Interstate (2015) and Post-NEEWS (2020) EMF Levels at the Edge of the ROW at Annual Average Loading (AAL) - Vicinity of Day Street Junction (XS-6 BMP)

Cross-Section	Magnetic Field (mG)		Electric Field (kV/m)	
	West/North ROW	East/South ROW	West/North ROW	East/South ROW
XS-6 BMP – Pre	4.6	28.0	0.09	1.20
XS-6 BMP – Post	5.2	20.6	0.28	1.21

7.4.1.9 Day Street Junction to Hartford Turnpike – XS-7

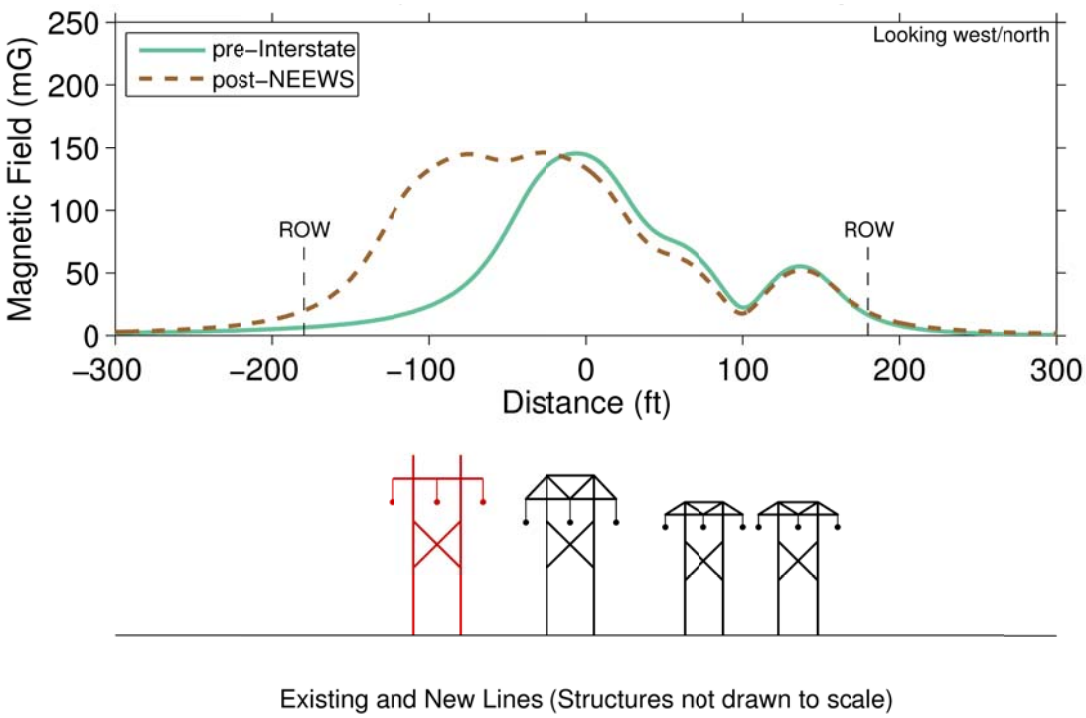
7.4.1.9.1 Existing Line Configuration

The segment of ROW between Day Street Junction and Hartford Turnpike (Cross Section No. 7 or XS-7) is 2.3 miles long and 360 feet wide. As illustrated in XS-7, this ROW segment includes an existing 345-kV transmission line supported on wood-pole H-frame structures and two existing 115-kV transmission lines, each supported on wood-pole H-frame structures. No Statutory Facilities were identified in the vicinity of this ROW segment.

7.4.1.9.2 Proposed Line Configuration and Magnetic Fields

The new 345-kV transmission line would be supported on H-frame structures alongside the existing 115-kV and 345-kV lines, as shown in XS-7. Magnetic field profiles across the ROW produced by the existing and proposed lines along this section of the ROW at AAL were calculated as shown in Figure 7-11.

Figure 7-11: Profile XS-7: Day Street Junction to Hartford Turnpike – Magnetic fields under Pre-Interstate (2015) and Post-NEEWS (2020) conditions at AAL



The calculated levels of the magnetic and electric fields at the ROW edges before and after construction of this section of the Project at AAL are summarized in Table 7-15.

Table 7-15: Summary of Pre-Interstate (2015) and Post-NEEWS (2020) EMF Levels at the Edge of the ROW at Annual Average Loading (AAL) - Day Street Junction to Hartford Turnpike (XS-7)

Cross-Section	Magnetic Field (mG)		Electric Field (kV/m)	
	West/South ROW	East/North ROW	West/South ROW	East/North ROW
XS-7– Pre	6.4	16.6	0.18	0.68
XS-7 – Post	20.0	18.7	1.22	0.67

7.4.1.10 Hartford Turnpike to Lake Road Junction – XS-8

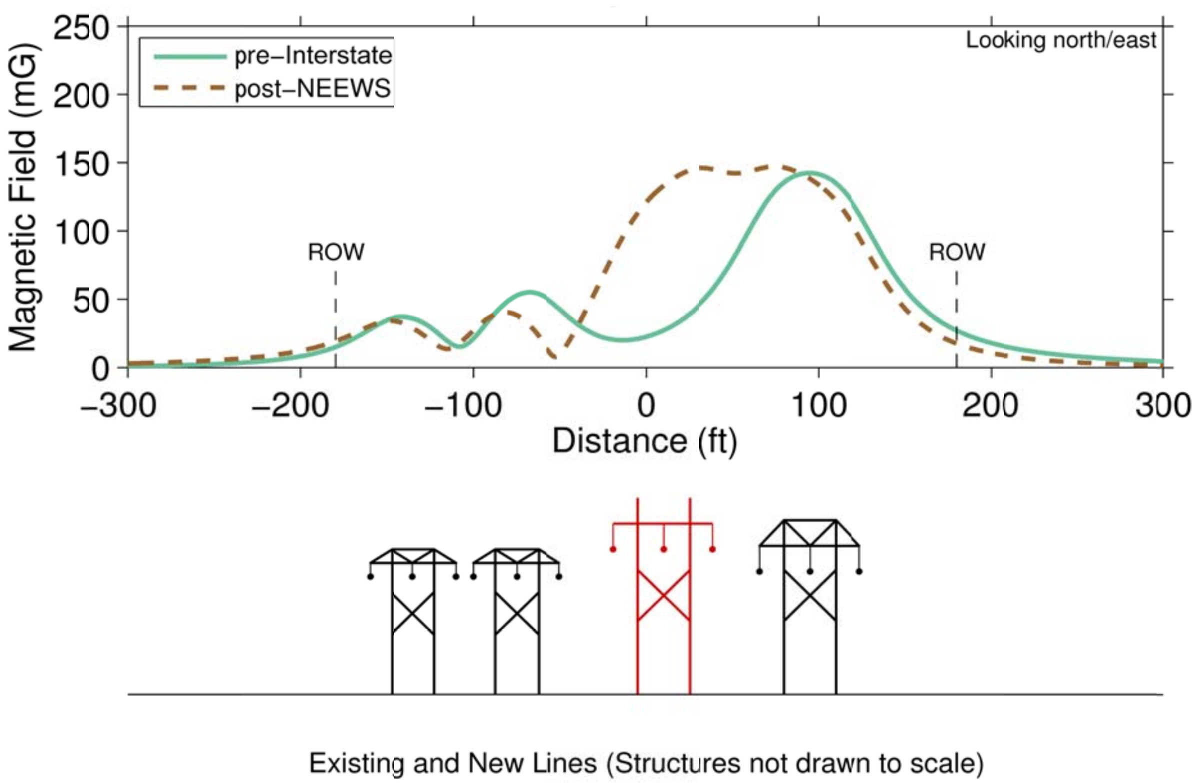
7.4.1.10.1 Existing Line Configuration

The ROW segment between Hartford Turnpike and Lake Road Junction (Cross-Section No. 8 or XS-8) is 2.6 miles long and 360 feet wide. It is currently occupied by one 345-kV transmission line supported on wood-pole H-frame structures, and two 115-kV transmission lines, each supported on wood-pole H-frame structures. XS-8 illustrates the configuration of the existing and proposed lines within the ROW. No Statutory Facilities were identified in the vicinity of this segment of ROW.

7.4.1.10.2 Proposed Line Configuration and Magnetic Fields

The new 345-kV transmission line would be supported on H-frame structures, as shown in XS-8. Magnetic field profiles across the ROW produced by the existing and proposed lines along this section of the ROW at AAL were calculated as shown in Figure 7-12.

Figure 7-12: Profile XS-8: Hartford Turnpike to Lake Road Junction – Magnetic Fields under Pre-Interstate (2015) and Post-NEEWS (2020) Conditions at AAL



The calculated levels of the magnetic and electric fields at the ROW edges before and after construction of this section of the Project at AAL are summarized in Table 7-16.

Table 7-16: Summary of Pre-Interstate (2015) and Post-NEEWS (2020) EMF Levels at the Edge of the ROW at Annual Average Loading (AAL) - Hartford Turnpike to Lake Road Junction (XS-8)

Cross-Section	Magnetic Field (mG)		Electric Field (kV/m)	
	West/North ROW	East/South ROW	West/North ROW	East/South ROW
XS-8– Pre	15.1	27.1	0.68	1.19
XS-8 – Post	19.3	17.6	0.73	1.18

7.4.1.11 Lake Road Junction to Lake Road Switching Station – XS-9

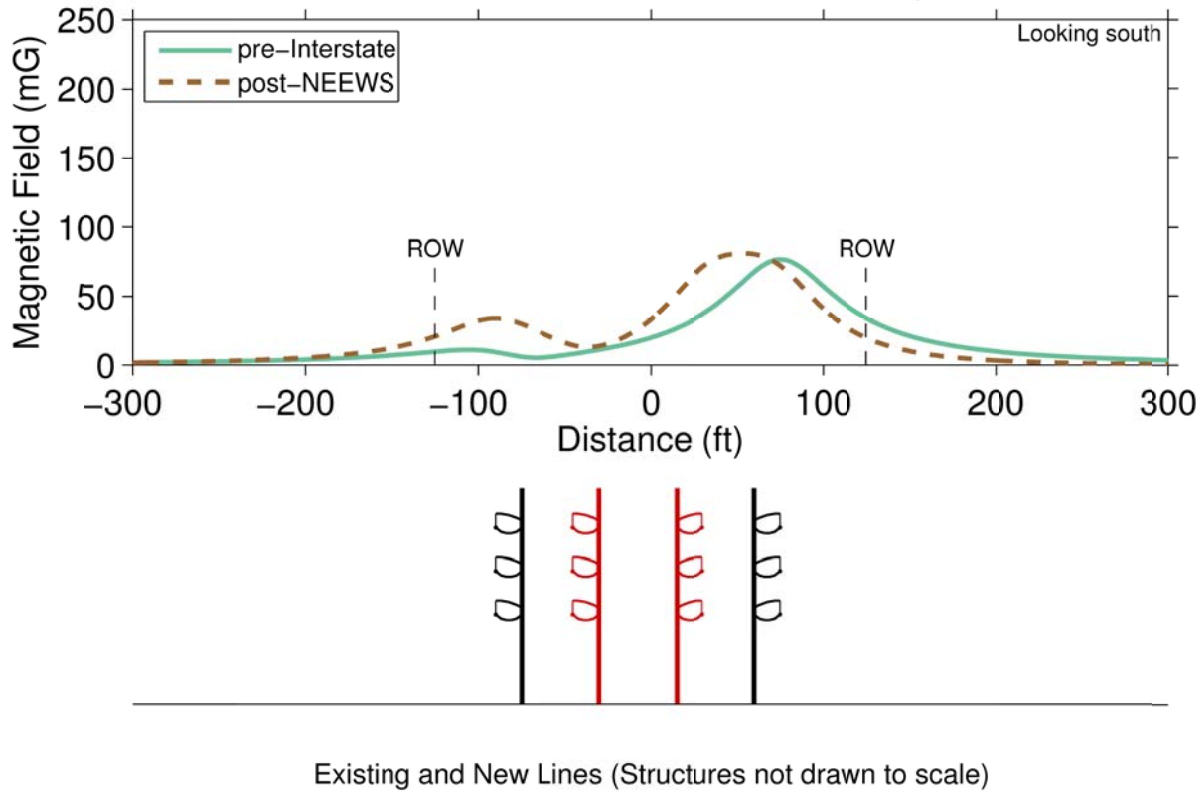
7.4.1.11.1 Existing Line Configuration

The 0.2-mile segment of the ROW between Lake Road Junction and Lake Road Switching Station (Cross-Section No. 9 or XS-9) currently includes two existing 345-kV transmission lines supported on steel- monopole structures on a 250-foot-wide ROW. No Statutory Facilities were identified in the vicinity of this ROW segment.

7.4.1.11.2 Proposed Line Configuration and Magnetic Fields

Two new 345-kV transmission lines would be supported on steel-monopole structures. XS-9 illustrates the configuration of the proposed lines in relation to the existing lines along this ROW section. Magnetic field profiles across the ROW produced by the existing and proposed lines along this portion of the ROW at AAL were calculated as shown in Figure 7-13.

Figure 7-13: Profile XS-9: Lake Road Junction to Lake Road Switching Station - Magnetic Fields under Pre-Interstate (2015) and Post-NEEWS (2020) Conditions at AAL



The calculated levels of the magnetic and electric fields at the ROW edges before and after construction of this section of the Project at AAL are summarized in Table 7-17.

Table 7-17: Summary of Pre-Interstate (2015) and Post-NEEWS (2020) EMF Levels at the Edge of the ROW at Annual Average Loading (AAL) - Lake Road Junction to Lake Road Switching Station (XS-9)

Cross-Section	Magnetic Field (mG)		Electric Field (kV/m)	
	West/North ROW	East/South ROW	West/North ROW	East/South ROW
XS-9– Pre	9.7	34.3	1.36	0.44
XS-9 – Post	20.8	19.9	1.43	0.58

7.4.1.12 Lake Road Junction to Killingly Substation – XS-10

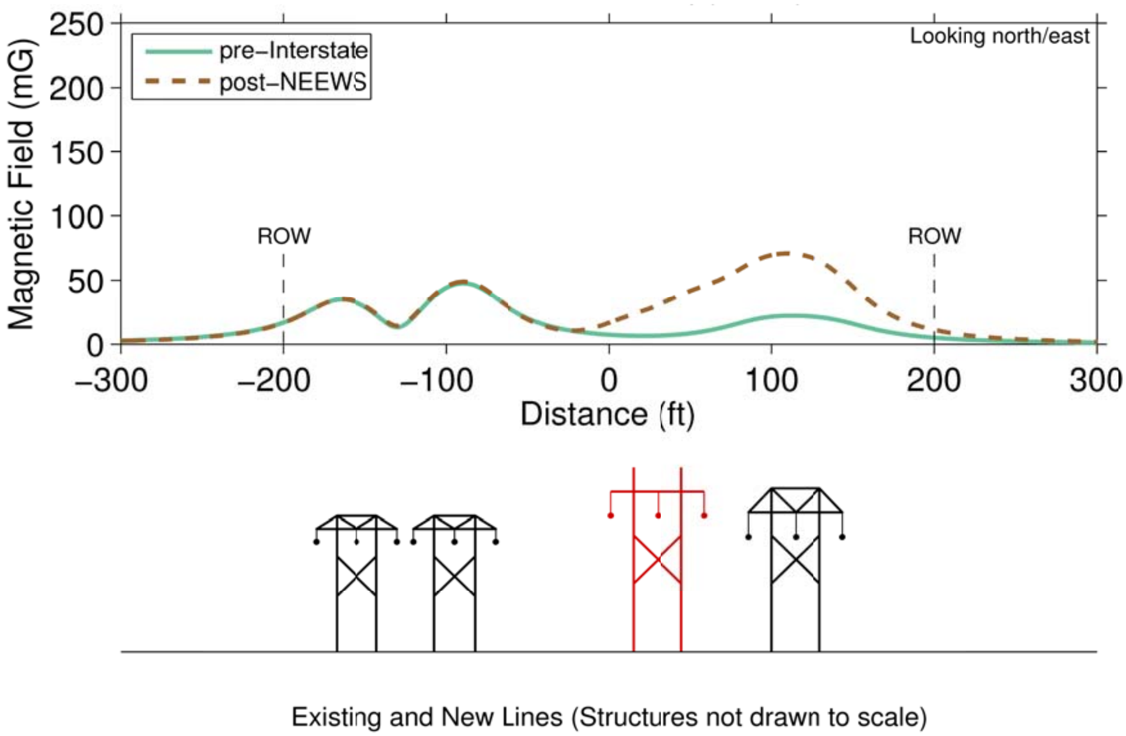
7.4.1.12.1 Existing Line Configuration

The 0.7-mile ROW segment between Lake Road Junction and Killingly Substation (Cross-Section No. 10 or XS-10) is 400 feet wide. It is currently occupied by one 345-kV transmission line supported on wood-pole H-frame structures and two 115-kV transmission lines supported on wood-pole H-frame structures. No Statutory Facilities were identified in the vicinity of this ROW segment.

7.4.1.12.2 Proposed Line Configuration and Magnetic Fields

One new 345-kV transmission line would be supported on H-frame structures. The proposed line would be installed between the existing 115-kV and 345-kV transmission lines. XS-10 illustrates this proposed configuration. Magnetic field profiles across the ROW produced by the existing and proposed lines along this segment of the ROW at AAL were calculated as shown in Figure 7-14.

Figure 7-14: Profile XS-10: Lake Road Junction to Killingly Substation – Magnetic Fields under Pre-Interstate (2015) and Post-NEEWS (2020) Conditions at AAL



The calculated levels of the magnetic and electric fields at the ROW edges before and after construction of this section of the Project at AAL are summarized in Table 7-18.

Table 7-18: Summary of Pre-Interstate (2015) and Post-NEEWS (2020) EMF Levels at the Edge of the ROW at Annual Average Loading (AAL) - Lake Road Junction to Killingly Substation (XS-10)

Cross-Section	Magnetic Field (mG)		Electric Field (kV/m)	
	West/North ROW	East/South ROW	West/North ROW	East/South ROW
XS-10 – Pre	17.0	5.1	0.69	1.19
XS-10 – Post	16.7	11.2	0.72	1.18

7.4.1.13 Killingly Substation to Heritage Road – XS-11

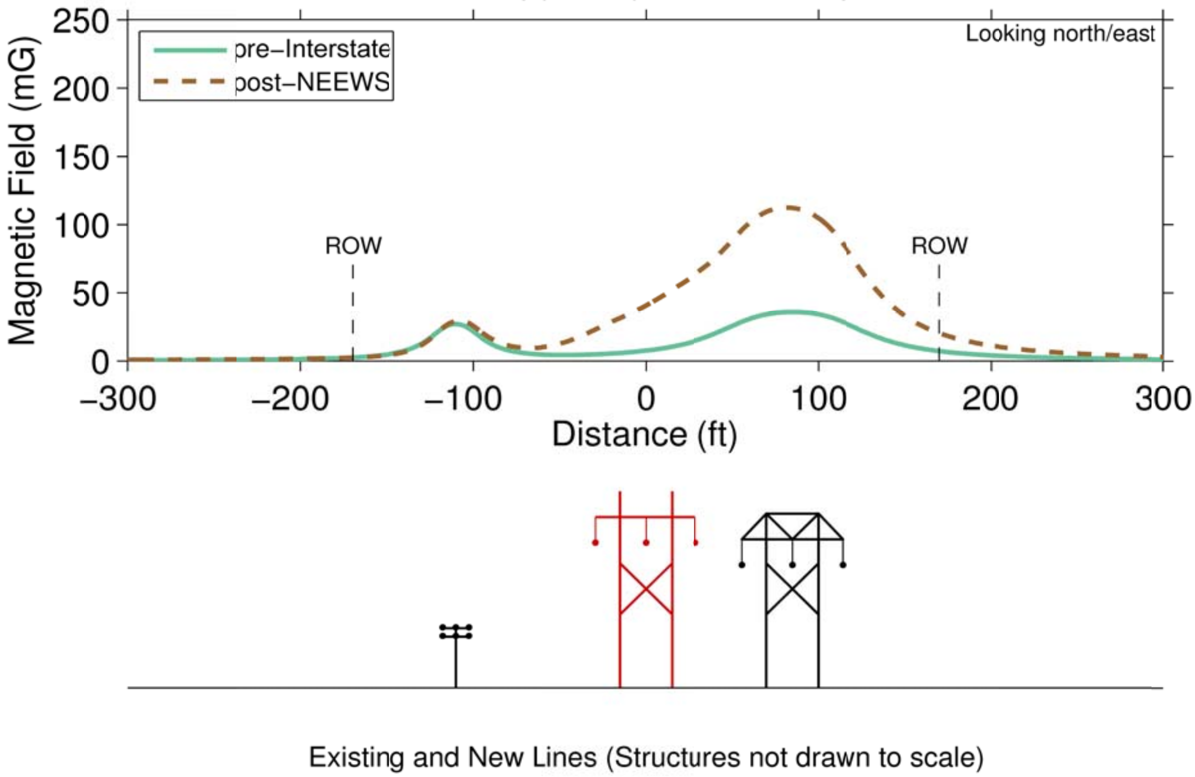
7.4.1.13.1 Existing Line Configuration

Along the 340-foot-wide, 1.7-mile ROW segment between the Killingly Substation and Heritage Road (Cross Section No. 11 or XS-11) in the Town of Putnam, are an existing 345-kV transmission line supported on wood-pole H-frame structures and a double-circuit 23-kV distribution line supported on single wood-pole structures. The existing and proposed line structures are shown in XS-11.

7.4.1.13.2 Proposed Line Configuration and Magnetic Field

One new 345-kV transmission line will be supported on H-frame structures. The new line will be installed between the existing 345-kV transmission line and distribution line, as illustrated in XS-11. Magnetic field profiles across the ROW produced by the existing and proposed lines along this segment of the ROW at AAL were calculated as shown in Figure 7-15.

Figure 7-15: Profile XS-11: Killingly Substation to Heritage Road – Magnetic Fields under Pre-Interstate (2015) and Post-NEEWS (2020) Conditions at AAL



The calculated levels of the magnetic and electric fields at the ROW edges before and after construction of this section of the Project at AAL are summarized in Table 7-19.

Table 7-19: Summary of Pre-Interstate (2015) and Post-NEEWS (2020) EMF Levels at the Edge of the ROW at Annual Average Loading (AAL) - Killingly Substation to Heritage Road (XS-11)

Cross-Section	Magnetic Field (mG)		Electric Field (kV/m)	
	West/North ROW	East/South ROW	West/North ROW	East/South ROW
XS-11– Pre	2.5	7.2	0.03	1.20
XS-11 – Post	2.5	20.4	0.17	1.19

7.4.1.14 Heritage Road to Connecticut/Rhode Island State Border, Excluding Elvira Heights – XS-12

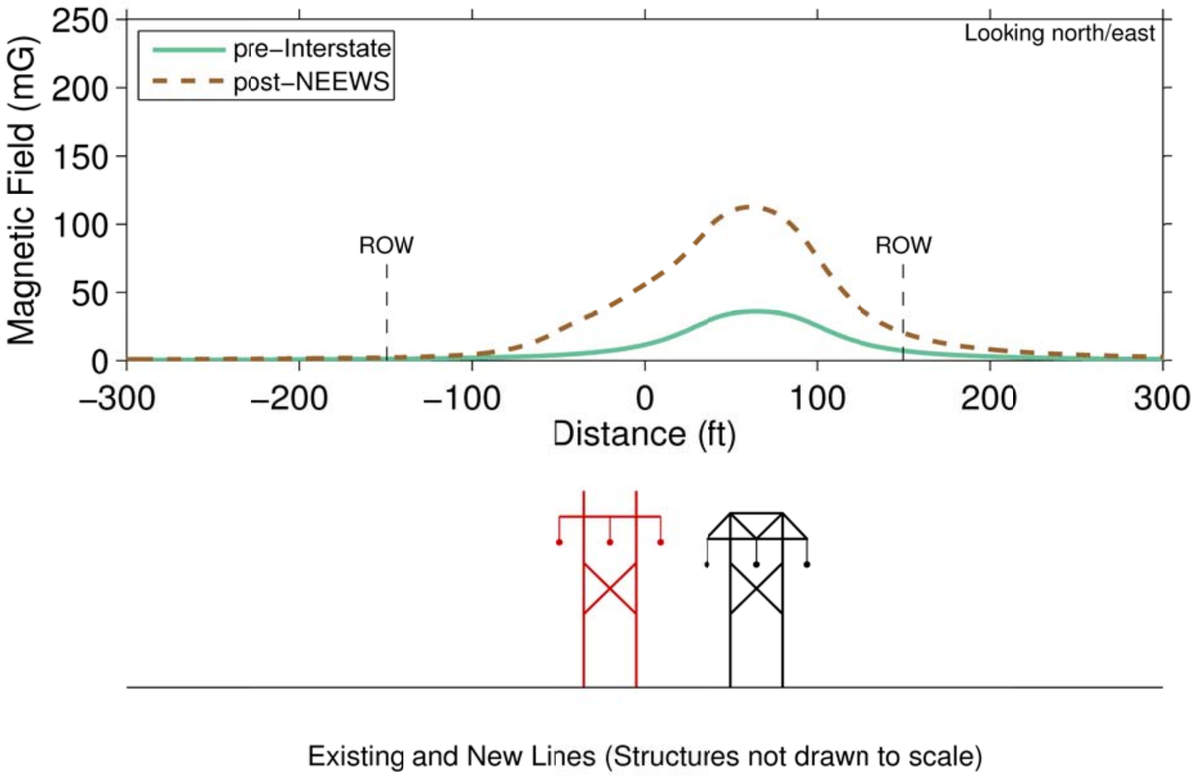
7.4.1.14.1 Existing Line Configuration

This 4.5-mile segment of 300-foot-wide ROW that traverses the towns of Putnam and Thompson between Heritage Road and the Connecticut/Rhode Island border (Cross-Section No. 12 or XS-12), excluding the Elvira Heights area near U.S. Route 44. The ROW segment currently includes one 345-kV transmission line supported on wood-pole H-frame structures. No Statutory Facilities were identified in the vicinity of this 4.5-mile ROW segment.

7.4.1.14.2 Proposed Line Configuration and Magnetic Fields

One new 345-kV transmission line would be supported on H-frame structures. This proposed configuration is shown in XS-12. Magnetic field profiles across the ROW produced by the existing and proposed lines along this section of the ROW at AAL were calculated as shown in Figure 7-16.

Figure 7-16: Profile XS-12: Heritage Road to Connecticut/Rhode Island Border, Excluding Elvira Heights – Magnetic Fields under Pre-Interstate (2015) and Post-NEEWS (2020) Conditions at AAL



The calculated levels of the magnetic and electric fields at the ROW edges before and after construction of this section of the Project at AAL are summarized in Table 7-20.

Table 7-20: Summary of Pre-Interstate (2015) and Post-NEEWS (2020) EMF Levels at the Edge of the ROW at Annual Average Loading (AAL) - Heritage Road to Connecticut/Rhode Island Border, Excluding Elvira Heights (XS-12)

Cross-Section	Magnetic Field (mG)		Electric Field (kV/m)	
	West/North ROW	East/South ROW	West/North ROW	East/South ROW
XS-12– Pre	1.2	7.2	0.09	1.20
XS-12 – Post	2.2	20.4	0.39	1.19

7.4.1.15 EMF BMP – Focus Area E (Elvira Heights) – XS-12 BMP

7.4.1.15.1 Existing Line Configuration

This 0.6-mile segment of 300-foot-wide ROW extends from just south of U.S. Route 44 and traverses adjacent to a natural gas transmission pipeline located along the northwest side of the Elvira Heights residential development in the Town of Putnam (Cross-Section No. 12 BMP or XS-12 BMP). Along this segment of ROW (like the rest of the ROW along XS-12), one existing 345-kV transmission line is supported on wood-pole H-frame structures. No Statutory Facilities were identified in the vicinity of this ROW segment. However, some homes are located nearby (i.e., along Elvira Heights Court, which is situated southeast of and generally parallels the ROW). A summary of magnetic and electric field measurements taken at the southeast edge of the XS-12 BMP ROW in the vicinity of these homes is shown in Table 7-21. Field measurements were taken on July 8, 2011, at approximately 8 a.m.

Table 7-21: Measured Electric and Magnetic Fields for Elvira Heights – XS-12 BMP in the Vicinity of Residences

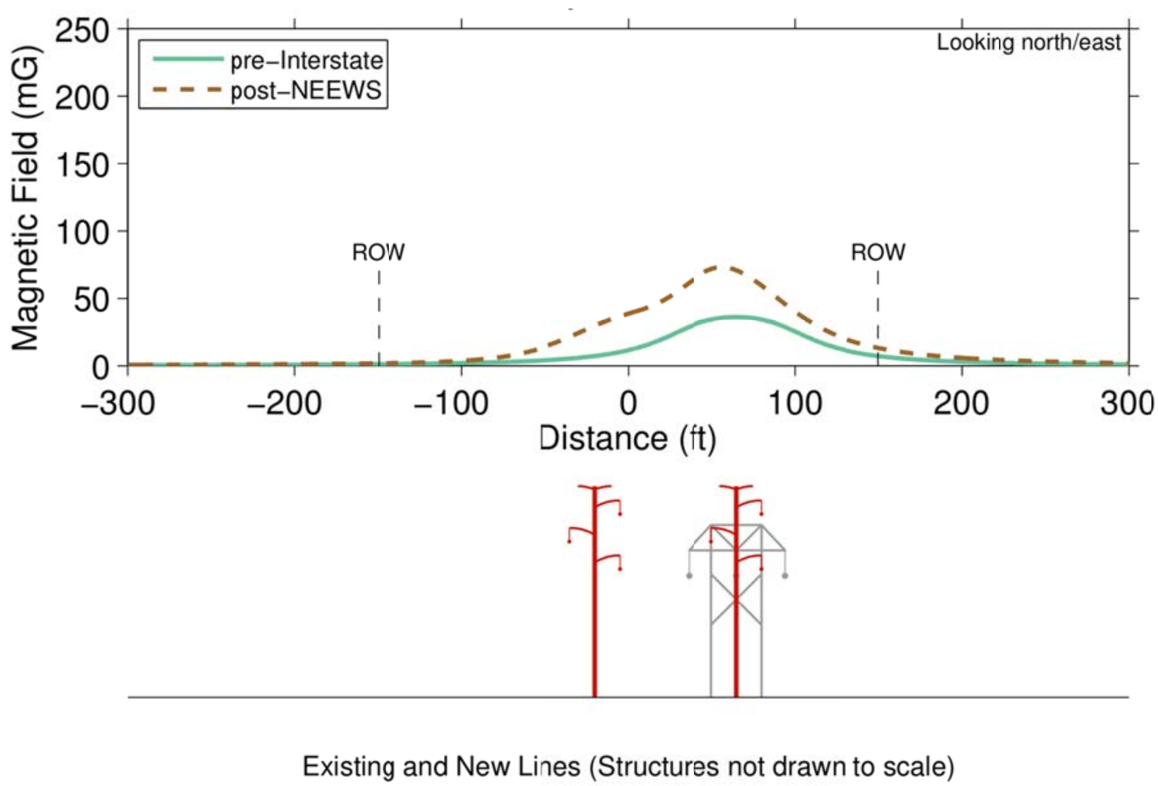
Location Name/Address	Town	Volume 9 Mapsheet	Magnetic Field (mG)	Electric Field (kV/m)	Approximate distance from centerline of new 345-kV transmission line to measurement location (ft)
12 Elvira Heights	Putnam	37 of 40	25.4	--	155

--Shielding by vegetation prevented the collection of measurable electric field levels at this location.

7.4.1.15.2 Proposed Line Configuration and Magnetic Fields

The existing and new 345-kV transmission lines would each be supported in delta conductor configurations on steel monopoles. This proposed configuration is shown in XS-12 BMP. Magnetic field profiles across the ROW produced by the existing and proposed lines along this section of the ROW at AAL were calculated as shown in Figure 7-17.

Figure 7-17: Profile XS-12 BMP: Elvira Heights – Magnetic Fields under Pre-Interstate (2015) and Post-NEEWS (2020) Conditions at AAL



The calculated levels of the magnetic and electric fields at the ROW edges before and after construction of this section of the Project at AAL are summarized in Table 7-22.

Table 7-22: Summary of Pre-Interstate (2015) and Post-NEEWS (2020) EMF Levels at the Edge of the ROW at Annual Average Loading (AAL) – Elvira Heights (XS-12 BMP)

Cross-Section	Magnetic Field (mG)		Electric Field (kV/m)	
	West/North ROW	East/South ROW	West/North ROW	East/South ROW
XS-12– BMP Pre	1.2	7.2	0.09	1.20
XS-12 BMP–Post	1.8	13.3	0.33	0.84

7.4.2 BMP Focus Areas

CL&P identified five sections (referred to as Focus Areas A through E) of the proposed line that might be considered by the Council as adjacent to public or private schools, licensed child day-care facilities, public playgrounds, licensed youth camps and groups of residences as focus areas for applications of low-cost magnetic field management designs. For each of these five focus areas, the *Field Management Design Plan* (Appendix 7B) presents and evaluates the effects that alternative designs would have on magnetic field levels, compared to the base line design.

In three of the five BMP focus areas, one located in XS-2 (Focus Area A), one located in XS-6 (Focus Area D), and one located in XS-12 (Focus Area E), the Plan proposes an alternate delta design for the proposed 345-kV line in lieu of the base H-frame line design. In XS-12 Focus Area E, the Plan also proposes that the existing line be rebuilt with the delta design. This delta line design has been incorporated into the proposed Project as reflected in XS-2 BMP, XS-6 BMP and XS-12 BMP herein. In the remaining two BMP focus areas (B and C), both also located in XS-2, CL&P proposes that the base H-frame line be built.

Project cost increases associated with each of the three BMP design recommendations presented in the Plan are summarized in Table 7-23. The estimated total cost increase associated with the XS-2 BMP, XS-6 BMP and XS-12 BMP line consumes the entire 4% guideline budget in the Council's BMP, largely due to the $4.3 million of extra cost to implement the Focus Area E proposal (XS-12 BMP). Were the Council to approve the base-case H-frame line design for any of these focus areas in lieu of CL&P's preferred designs, the estimated total cost increase associated with CL&P's remaining recommendations in the other focus areas would be well within the 4% guideline budget. As explained in Section II.6 of Appendix 7B, CL&P has strong reservations with respect to implementing the BMP design for Focus Area E. Refer to Appendix 7B for additional information regarding costs associated with all design alternatives for BMP focus areas.

Table 7-23: Estimated Project Cost Increases for BMP Design Implementation

Focus Area	**A**	**D**	**E**
BMP Cross-Section	XS-2BMP	XS-6 BMP	XS-12 BMP
Project Cost Increase ($)	$2,720,300	$1,410,800	$4,274,000
Project Cost Increase (%)	1.3%	0.7%	2.0%

7.5 UPDATE ON EMF HEALTH RESEARCH

In its BMP issued on December 14, 2007, the Council recognized the consistent conclusions of "a wide range of public health consensus groups," as well as their own commissioned weight-of-evidence review (p. 4). The Council summarized the current scientific consensus by noting the conclusions of these public health groups, including the most recent review by the World Health Organization (WHO) in 2007 and previously published reviews by the National Institute for Environmental and Health Sciences (NIEHS, 1999), the International Agency for Research on Cancer (IARC, 2002), the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA, 2003),[8] the National Radiological Protection Board of Great Britain (NRPB, 2004), and the Health Council of the Netherlands (HCN, 2005). The Council summarized the current scientific consensus as follows: there is limited evidence from epidemiology studies of a statistical association between estimated, average exposures greater than 3-4 mG and childhood leukemia; the cumulative research, however, does not indicate that magnetic fields are a cause of childhood leukemia, as animal and other experimental studies do not suggest that magnetic fields are carcinogenic. The Council also noted the WHO's recent conclusion with respect to other diseases: "the scientific evidence supporting an association between ELF magnetic field exposure and all of these health effects is much weaker than for childhood leukemia" (BMP, p. 2).

[8] ARPANSA released an updated evaluation of EMF research and a draft standard in 2006, which is largely consistent with those of WHO and other national and international health agencies.

Based on this scientific consensus, the Council concluded that proportional precautionary measures for the siting of new transmission lines include “the use of effective no-cost and low-cost technologies and management techniques on a project-specific basis to reduce MF exposure to the public while allowing for the development of efficient and cost-effective electrical transmission projects” (p. 11). The BMP also stated that the Council will “consider and review evidence of any new developments in scientific research addressing MF and public health effects or changes in scientific consensus group positions regarding MF” (p. 5).

Accordingly, in its March 16, 2010 decision approving the Greater Springfield Reliability Project, the Siting Council evaluated extensive evidence concerning recent developments in EMF health effects research, including commentary from the Connecticut DEP’s Radiation Division, and concluded that: “There is no new evidence that might alter the scientific consensus articulated in the Council’s 2007 EMF BMP document.” (Docket 370, Opinion at 12; *and see* Findings of Fact par. 284-286)

To assist the Council in evaluating the most up-to-date research, CL&P commissioned William H. Bailey, Ph.D. and colleagues at Exponent to provide a report that systematically evaluates recent peer-reviewed research and reviews by scientific panels, specifically including any published since those considered in the Council’s Docket 370 proceeding (i.e., June 16, 2008). Exponent’s report, which is provided in Appendix 7D, also includes a review of research and reviews published from December 14, 2007 through June 10, 2011. This report demonstrates that the conclusion reached by the Council in the BMP Proceeding in 2007 and in Docket 370 in 2010 remains sound. As the Executive Summary of this report states:

“This report contains a systematic literature review and a critical evaluation of epidemiology and *in vivo* studies published after the WHO report (Section 6). These recent studies did not provide sufficient evidence to alter the basic conclusion of the WHO: the research does not suggest that electric fields or magnetic fields are a cause of cancer or any other disease at the levels we encounter in our everyday environment" (Appendix 7D, p. 2).

7.6 SUMMARY OF ACTIONS DEMONSTRATING CONSISTENCY WITH COUNCIL GUIDELINES

CL&P has provided EMF measurements and calculations, alternative transmission line designs where appropriate, and an update of EMF research to address the Council's application guideline and the BMP for the proposed transmission line route from Card Street Substation to the Connecticut-Rhode Island border, where a new line would connect to a new line being constructed by National Grid.

This Application presents spot measurements of existing electric and magnetic fields at the boundaries of adjacent schools, child day-care facilities, and playgrounds as specified in the Council's *Application Guide For Electric and Fuel Transmission Line Facilities* (April 2010) in Section 7.4, and along underground cable route variations (as presented in Volume 1A, Section 15). Calculated fields that represent the existing, pre-construction magnetic fields and post-construction magnetic fields along proposed routes in existing ROWs at APL and PDAL are presented as called for by the BMP.

Calculated fields at AAL are also presented for proposed base-case transmission designs incorporating "no-cost" line configurations and optimized phasing to reduce magnetic fields along the entire route. Additionally, calculations of magnetic fields for alternative routings of the overhead 345-kV line are presented (refer to Volume 1A, Section 15) that could reduce magnetic fields at the edge of the ROW on two sections of the route along the cross-section from where Statutory Facilities and nearby groupings of homes were identified as residential focus areas. These include the Willimantic South Overhead Variation which avoids homes and Statutory Facilities along Cross-Section XS-2 as well as the Mansfield Hollow federal properties (Cross-Sections XS-3 and XS-5), and the Brooklyn Overhead Variation which avoids homes and Statutory Facilities along Cross-Section XS-6. The magnetic fields associated with four underground line variations in the ROW, or in streets bypassing EMF focus areas, are also modeled and presented in Volume 1A, Section 15. These four underground variations are the Mansfield Underground Variation, the Mount Hope Underground Variation, the Brooklyn Underground Variation and the Willimantic South Underground Variation.

In summary, the data provided in this section and in the related Field Management Design Plan provided in Appendix 7B, in Section 10 on potential design options in Mansfield Hollow, and in Section 15 on potential transmission line route variations fully comply with the Council's Application guideline and BMP requirements as summarized in Section 7.2, and provide a basis for the determination that both the base line designs and the proposed BMP alternatives to the base design line provide an adequate buffer zone in the vicinity of Statutory Facilities.

7.7 REFERENCES

Connecticut Siting Council (CSC). Electric and Magnetic Field Best Management Practices for the Construction of Electric Transmission Lines in Connecticut. December 14, 2007 (2007b). Accessed on-line August 20, 2008 http://www.ct.gov/csc/lib/csc/emf_bmp/emf_bmp_12-14-07.doc

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Savitz DA, Pearce NE, Poole C. Methodological issues in the epidemiology of electromagnetic fields and cancer. Epidemiol Rev, 11:59-78, 1989.

Appendix 7A –Council's EMF *Best Management Practices*

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Electric and Magnetic Fields Best Management Practices
For the Construction of Electric Transmission Lines in Connecticut

Approved on December 14, 2007

I. Introduction

To address a range of concerns regarding potential health risks from exposure to transmission line electric and magnetic fields (EMF), whether from electric transmission facilities or other sources, the Connecticut Siting Council (Council) (in accordance with Public Act 04-246) issues this policy document "*Best Management Practices for the Construction of Electric Transmission Lines in Connecticut*." It references the latest information regarding scientific knowledge and consensus on EMF health concerns; it also discusses advances in transmission-facility siting and design that can affect public exposure to EMF.

Electric and magnetic fields (EMF) are two forms of energy that surround an electrical device. The strength of an electric field (EF) is proportional to the amount of electric voltage at the source, and decreases rapidly with distance from the source, diminishing even faster when interrupted by conductive materials, such as buildings and vegetation. The level of a magnetic field (MF) is proportional to the amount of electric current (not voltage) at the source, and it, too, decreases rapidly with distance from the source; but magnetic fields are not easily interrupted, as they pass through most materials. EF is often measured in units of kilovolts per meter (kV/m). MF is often measured in units of milligauss (mG).

Transmission lines are common sources of EMF, as are other substantial components of electric power infrastructure, ranging from transformers at substations to the wiring in a home. However, any piece of machinery run by electricity can be a source of EMF: household objects as familiar as electric tools, hair dryers, televisions, computers, refrigerators, and electric ovens.

In the U.S., EMF associated with electric power have a frequency of 60 cycles per second (or 60 Hz). Estimated average background levels of 60-Hz MF in most homes, away from appliances and electrical panels, range from 0.5 to 5.0 mG (NIEHS, 2002). MF near operating appliances such as an oven, fan, hair dryer, television, etc. can range from 10's to 100's of mG. Many passenger trains, trolleys, and subways run on electricity, producing MF: for instance, MF in a Metro-North Railroad car averages about 40-60 mG, increasing to 90-145 mG with acceleration (Bennett Jr., W. 1994). As a point of comparison to these common examples, the Earth itself has an MF of about 570 mG (USGS 2007). Unlike the MF associated with power lines, appliances, or computers, the Earth's MF is steady; in every other respect, however, the Earth's MF has the same characteristics as MF emanating from man-made sources.

Concerns regarding the health effects of EMF arise in the context of electric transmission lines and distribution lines, which produce time-varying EMF, sometimes called extremely-low frequency electric and magnetic fields, or ELF-EMF. As the weight of scientific evidence indicates that exposure to electric fields, beyond levels traditionally established for safety, does not cause adverse health effects, and as safety concerns for electric fields are sufficiently addressed by adherence to the National Electrical Safety Code, as amended, health concerns regarding EMF focus on MF rather than EF.

MF levels in the vicinity of transmission lines are dependent on the flow of electric current through them and fluctuate throughout the day as electrical demand increases and decreases. They can range from about 5 to 150 mG, depending on current load, height of the conductors, separation of the conductors, and distance from the lines. The level of the MF produced by a transmission line decreases with increasing distance from the conductors, becoming indistinguishable from levels found inside or outside homes (exclusive of MF emanating from sources within the home) at a distance of 100 to 300 feet, depending on the design and current loading of the line (NIEHS, 2002).

In Connecticut, existing and proposed transmission lines are designed to carry electric power at voltages of 69, 115, or 345 kilovolts (kV). Distribution lines, i.e. those lines directly servicing the consumer's building, typically operate at voltages below 69 kV and may produce levels of MF similar to those of transmission lines. The purpose of this document is to address engineering practices for proposed electric transmission lines with a design capacity of 69 kV or more and MF health concerns related to these projects, but not other sources of MF.

II. Health Concerns from Power-Line MF

While more than 40 years of scientific research has addressed many questions about EMF, the continuing question of greatest interest to public health agencies is the possibility of an association between time weighted MF exposure and demonstrated health effects. The World Health Organization (WHO) published its latest findings on this question in an Electromagnetic Fields and Public Health fact sheet, June 2007. (http://www.who.int/mediacentre/factsheets/fs322/en/index.html) The fact sheet is based on a review by a WHO Task Group of scientific experts who assessed risks associated with ELF-EMF. As part of this review, the group examined studies related to MF exposure and various health effects, including childhood cancers, cancers in adults, developmental disorders, and neurobehavioral effects, among others. Particular attention was paid to leukemia in children. The Task Group concluded "that scientific evidence supporting an association between ELF magnetic field exposure and all of these health effects is much weaker than for childhood leukemia". (WHO, 2007) For childhood leukemia, WHO concluded recent studies do not alter the existing position taken by the International Agency for Research on Cancer (IARC) in 2002, that ELF-MF is "possibly carcinogenic to humans."

Some epidemiology studies have reported an association between MF and childhood leukemia, while others have not. Two broad statistical analyses of these studies as a pool reported an association with estimated average exposures greater than 3 to 4 mG, but at this level of generalization it is difficult to determine whether the association is significant. In 2005, the National Cancer Institute (NCI) stated, "Among more recent studies, findings have been mixed. Some have found an association; others have not . . . . Currently, researchers conclude that there is limited evidence that magnetic fields from power lines cause childhood leukemia, and that there is inadequate evidence that these magnetic fields cause other cancers in children." The NCI stated further: "Animal studies have not found that magnetic field exposure is associated with increased risk of cancer. The absence of animal data supporting carcinogenicity makes it biologically less likely that magnetic field exposures in humans, at home or at work, are linked to increased cancer risk."

The American Medical Association characterizes the EMF health-effect literature as "inconsistent as to whether a risk exists." The National Institute of Environmental Health Sciences (NIEHS) concluded in 1999 that EMF exposure could not be recognized as "*entirely safe*" due to some statistical evidence of a link with childhood leukemia. Thus, although no public health agency has found that scientific research suggests a causal relationship between EMF and cancer, the NIEHS encourages "inexpensive and safe reductions in exposure" and suggests that the power industry continue its current practice of siting power lines to reduce exposures" rather than regulatory guidelines (NIEHS, 1999, pp. 37-38). In 2002 NIEHS restated that while this evidence was "weak" it was "still sufficient to warrant limited concern" and recommended "continued education on ways of reducing exposures" (NIEHS, 2002, p. 14).

Reviews by other study groups, including IARC (2002), the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) (2003), the British National Radiation Protection Board (NRPB) (2004a), and the Health Council of the Netherlands ELF Electromagnetic Fields Committee (2005), are similar to NIEHS and NCI in their uncertainty about reported associations of MF with childhood leukemia. In 2004, the view of the NRPB was:

> "[T]he epidemiological evidence that time-weighted average exposure to power frequency magnetic fields above 0.4 microtesla [4 mG] is associated with a small absolute raised risk of leukemia in children is, at present, an observation for which there is no sound scientific explanation. There is no clear evidence of a carcinogenic effect of ELF EMFS in adults and no plausible biological explanation of the association can be obtained from experiments with animals or from cellular and molecular studies. Alternative explanations for this epidemiological association are possible…Thus: any judgments developed on the assumption that the association is causal would be subject to a very high level of uncertainty." (NRPB, 2004a, p. 15)

Although IARC classified MF as "possibly carcinogenic to humans" based upon pooling of the results from several epidemiologic studies, IARC further stated that the evidence suggesting an association between childhood leukemia and residential MF levels is "limited," with "inadequate" support for a relation to any other cancers. The WHO Task Group concluded "the evidence related to childhood leukemia is not strong enough to be considered causal" (WHO, 2007).

The Connecticut Department of Public Health (DPH) has produced an EMF Health Concerns Fact Sheet (May 2007) that incorporates the conclusions of national and international health panels. The fact sheet states that while "the current scientific evidence provides no definitive answers as to whether EMF exposure can increase health risks, there is enough uncertainty that some people may want to reduce their exposure to EMF."
[http://www.dph.state.ct.us/Publications/brs/eoha/emf_2004.pdf]

In the U.S., there are no state or federal exposure standards for 60-Hz MF based on demonstrated health effects. Nor are there any such standards world-wide. Among those international agencies that provide guidelines for acceptable MF exposure to the general public, the International Commission on Non-Ionizing Radiation Protection established a level of 833 mG, based on an extrapolation from experiments involving transient neural stimulation by MF at much higher exposures. Using a similar approach, the International Committee on Electromagnetic Safety calculated a guideline of 9,040 mG for exposure to workers and the general public (ICNIRP, 1998; ICES/IEEE, 2002). This situation reflects the lack of credible scientific evidence for a causal relationship between MF exposure and adverse health effects.

III. Policy of the Connecticut Siting Council

The Council recognizes that a causal link between power-line MF exposure and demonstrated health effects has not been established, even after much scientific investigation in the U.S. and abroad. Furthermore, the Council recognizes that timely additional research is unlikely to prove the safety of power-line MF to the satisfaction of all. Therefore, the Council will continue its cautious approach to transmission line siting that has guided its Best Management Practices since 1993. This continuing policy is based on the Council's recognition of and agreement with conclusions shared by a wide range of public health consensus groups, and also, in part, on a review which the Council commissioned as to the weight of scientific evidence regarding possible links between power-line MF and adverse health effects. Under this policy, the Council will continue to advocate the use of effective no-cost and low-cost technologies and management techniques on a project-specific basis to reduce MF exposure to the public while allowing for the development of efficient and cost-effective electrical transmission projects. This approach does not imply that MF exposure will be lowered to any specific threshold or exposure limit, nor does it imply MF mitigation will be achieved with no regard to cost.

The Council will develop its precautionary guidelines in conjunction with Section 16-50p(i) of the Connecticut General Statutes, enacted by the General Assembly to call special attention to their concern for children. The Act restricts the siting of overhead 345-kV transmission lines in areas where children congregate, subject to technological feasibility. These restrictions cover transmission lines adjacent to "residential areas, public or private schools, licensed child day-care facilities, licensed youth camps, or public playgrounds."

Developing Policy Guidelines

One important way the Council seeks to update its Best Management Practices is to integrate policy with specific project development guidelines. In this effort, the Council has reviewed the actions of other states. Most states either have no specific guidelines or have established arbitrary MF levels at the edge of a right-of-way that are not based on any demonstrated health effects. California, however, established a no-cost/low-cost precautionary-based EMF policy in 1993 that was re-affirmed by the California Public Utilities Commission in 2006. California's policy aims to provide significant MF reductions at no cost or low cost, a precautionary approach consistent with the one Connecticut has itself taken since 1993, consistent with the conclusions of the major scientific reviews, and consistent with the policy recommendations of the Connecticut Department of Public Health and the WHO. Moreover, California specifies certain benchmarks integral to its policy. The benchmark for "low-cost/no-cost" is an increase in aggregate project costs of zero to four percent. The benchmark for "significant MF reduction" is an MF reduction of at least 15 percent. With a policy similar to Connecticut's, and concrete benchmarks as well, California offers the Council a useful model in developing policy guidelines.

No-Cost/Low-Cost MF Mitigation

The Council seeks to continue its precautionary policy, in place since 1993, while establishing a standard method to allocate funds for MF mitigation methods. The Council recognizes California's cost allotment strategy as an effective method to achieve MF reduction goals; thus, the Council will follow a similar strategy for no-cost/low-cost MF mitigation.

The Council directs the Applicant to initially develop a Field Management Design Plan that depicts the proposed transmission line project designed according to standard good utility practice and incorporating "no-cost" MF mitigation design features. The Applicant shall then modify the base design by adding low-cost MF mitigation design features specifically where portions of the project are adjacent to residential areas, public or private schools, licensed child day-care facilities, licensed youth camps, or public playgrounds.

The overall cost of low-cost design features are to be calculated at four percent of the initial Field Management Design Plan, including related substations. Best estimates of the total project costs during the Council proceedings should be employed, and the amounts proposed to be incurred for MF mitigation should be excluded. It is important to note that the four percent guideline is not an absolute cap, because the Council does not want to eliminate prematurely a potential measure that might be available and effective but would cost more than the four percent, or exclude arbitrarily an area adjacent to the ROW that might be suitable for MF mitigation. Nor is the four percent an absolute threshold, since the Council wants to encourage the utilities to seek effective field reduction measures costing less than four percent. In general, the Council recognizes that projects can vary widely in the extent of their impacts on statutory facilities, necessitating some variance above and below the four percent figure.

The four percent guideline for low-cost mitigation should aim at a magnetic field reduction of 15 percent or more at the edge of the utility's ROW. This 15 percent reduction should relate specifically to those portions of the project where the expenditures would be made. While experience with transmission projects in Connecticut since 1993 has shown that no-cost/low-cost designs can and do achieve reductions in MF on the order of 15 percent, the 15 percent guideline is no more absolute than the four percent one, nor must the two guidelines be correlated by rote. The nature of guidelines is to be constructive, rather than absolute.

The Council will consider minor increases above the four percent guideline if justified by unique circumstances, but not as a matter of routine. Any cost increases above the four percent guideline should result in mitigation comparably above 15 percent, and the total costs should still remain relatively low.

Undergrounding transmission lines puts MF issues out of sight, but it should not necessarily put them out of mind. With that said, soils and other fill materials do not shield MF, rather, MF is reduced by the underground cable design (refer to page 9 for further information). However, special circumstances may warrant some additional cost in order to achieve further MF mitigation for underground lines. The utilities are encouraged, prior to submitting their application to the Council, to determine whether a project involves such special circumstances. Note that the extra costs of undergrounding done for purposes other than MF mitigation should be counted in the base project cost and not as part of the four percent mitigation spending.

Additionally, the Council notes two general policies it follows in updating its EMF Best Management Practices and conducting other matters within its jurisdiction. One is a policy to support and monitor ongoing study. Accordingly, the Council, during the public hearing process for new transmission line projects, will consider and review evidence of any new developments in scientific research addressing MF and public health effects or changes in scientific consensus group positions regarding MF. The second is a policy to encourage public participation and education. The Council will continue to conduct public hearings open to all, update its website to contain the latest information regarding MF health effect research, and revise these Best Management Practices to take account of new developments in MF health effect research or in methods for achieving no-cost/low-cost MF mitigation.

The Council will also require that notices of proposed overhead transmission lines provided in utility bill enclosures pursuant to Conn. Gen. Stats. §16-50*l*(b) state the proposed line will meet the Council's Electric and Magnetic Fields Best Management Practices, specifying the design elements planned to reduce magnetic fields. The bill enclosure notice will inform residents how to obtain siting and MF information specific to the proposed line at the Council's website; this information will also be available at each respective town hall. Phone numbers for follow-up information will be made available, including those of DPH, and utility representatives. The project's final post-construction structure and conductor specifications including calculated MF levels shall also be available at the Council's website and each respective town hall.

Finally, we note that Congress has directed the Department of Energy (DOE) periodically to assess congestion along critical transmission paths or corridors and apply special designation to the most significant ones. Additionally, Congress has given the Federal Regulatory Commission supplemental siting authority in DOE designated areas. This means the Council must complete all matters in an expeditious and timely manner. Accordingly, the cooperation of all parties will be of particular importance in fulfilling the policies set forth above.

IV. MF Best Management Practices: Further Management Considerations

The Council's EMF Best Management Practices will apply to the construction of new electric transmission lines in the State, and to modifications of existing lines that require a certificate of environmental compatibility and public need. These practices are intended for use by public service utilities and the Council when considering the installation of such new or modified electric transmission lines. The practices are based on the established Council policy of reducing MF levels at the edge of a right-of-way (ROW), and in areas of particular interest, with no-cost/low-cost designs that do not compromise system reliability or worker safety, or environmental and aesthetic project goals.

Several practical engineering approaches are currently available for reducing MF, and more may be developed as technology advances. In proposing any particular methods of MF mitigation for a given project, the Applicant shall provide a detailed rationale to the Council that supports the proposed MF mitigation measures. The Council has the option to retain a consultant to confirm that the Field Management Design Plan and the proposed MF reduction strategies are consistent with these EMF Best Management Practices.

A. MF Calculations

When preparing a transmission line project, an applicant shall provide design alternatives and calculations of MF for pre-project and post-project conditions, under 1) peak load conditions at the time of the application filing, and 2) projected seasonal maximum 24-hour average current load on the line anticipated within five years after the line is placed into operation. This will allow for an evaluation of how MF levels differ between alternative power line configurations. The intent of requiring various design options is to achieve reduced MF levels when possible through practical design changes. The selection of a specific design will also be affected by other practical factors, such as the cost, system reliability, aesthetics, and environmental quality.

MF values shall be calculated from the ROW centerline out to a distance of 300 feet on each side of the centerline, at intervals of 25 feet, including at the edge of the ROW. In accordance with industry practice, the calculation shall be done at the location of maximum line sag (typically mid-span), and shall provide MF values at 1 meter above ground level, with the assumption of flat terrain and balanced currents. The calculations shall assume "all lines in" and projected load growth five years beyond the time the lines are expected to be put into operation, and shall include changes to the electric system approved by the Council and the Independent System Operator – New England.

As part of this determination, the applicant shall provide the locations of, and anticipated MF levels encompassing, residential areas, private or public schools, licensed child day care facilities, licensed youth camps, or public playgrounds within 300 feet of the proposed transmission line. The Council, at its discretion, may order the field measurement of post-construction MF values in select areas, as appropriate.

B. Buffer Zones and Limits on MF

As enacted by the General Assembly in Section 4 of Public Act No. 04-246, a buffer zone in the context of transmission line siting is deemed, at minimum, to be the distance between the proposed transmission line and the edge of the utility ROW. Buffer zone distances may also be guided by the standards presented in the National Electrical Safety Code (NESC), published by the Institute of Electrical and Electronic Engineers (IEEE). These standards provide for the safe installation, operation, and maintenance of electrical utility lines, including clearance requirements from vegetation, buildings, and other natural and man-made objects that may arise in the ROW. The safety of power-line workers and the general public are considered in the NESC standards. None of these standards include MF limits.

Since 1985, in its reviews of proposed transmission-line facilities, the Massachusetts Energy Facilities Siting Board has used an edge-of-ROW level of 85 mG as a benchmark for comparing different design alternatives. Although a ROW-edge level in excess of this value is not prohibited, it may trigger a more extensive review of alternatives.

In assessing whether a right-of-way provides a sufficient "buffer zone," the Council will emphasize compliance with its own Best Management Practices, but may also take into account approaches of other states, such as those of Florida, Massachusetts, and New York.

A number of states have general MF guidelines that are designed to maintain the 'status quo', i.e., that fields from new transmission lines not exceed those of existing transmission lines. In 1991, the New York Public Service Commission established an interim policy based on limits to MF. It required new high-voltage transmission lines to be designed so that the maximum magnetic fields at the edge of the ROW, one meter above ground, would not exceed 200 mG if the line were to operate at its highest continuous current rating. This 200 mG level represents the maximum calculated magnetic field level for 345 kV lines that were then in operation in New York State.

The Florida Environmental Regulation Commission established a maximum magnetic field limit for new transmission lines and substations in 1989. The MF limits established for the edge of 230-kV to 500-kV transmission line ROWs and the property boundaries for substations ranged from 150 mG to 250 mG, depending on the voltage of the new transmission line and whether an existing 500-kV line was already present.

Although scientific evidence to date does not warrant the establishment of MF exposure limits at the edge of a ROW, the Council will continue to monitor the ways in which states and other jurisdictions determine MF limits on new transmission lines.

C. Engineering Controls that Modify MF Levels

When considering an overhead electric transmission-line application, the Council will expect the applicant to examine the following Engineering Controls to limit MF in publicly accessible areas: distance, height, conductor separation, conductor configuration, optimum phasing, increased voltage, and underground installation. Any design change may also affect the line's impedance, corona discharge, mechanical behavior, system performance, cost, noise levels and visual impact. The Council will consider all of these factors in relation to the MF levels achieved by any particular Engineering Control. Thus, utilities are encouraged to evaluate other possible Engineering Controls that might be applied to the entire line, or just specific segments, depending upon land use, to best minimize MF at a low or no cost.

Consistent with these Best Management Practices and absent line performance and visual impacts, the Council expects that applicants will propose no-cost/low-cost measures to reduce magnetic fields by one or more engineering controls including:

Distance

MF levels from transmission lines (or any electrical source) decrease with distance; thus, increased distance results in lower MF. Horizontal distances can be increased by purchasing wider ROWs, where available. Other distances can be increased in a variety of ways, as described below.

Height of Support Structures

Increasing the vertical distance between the conductors and the edge of the ROW will decrease MF: this can be done by increasing the height of the support structures. The main drawbacks of this approach are an increase in the cost of supporting structures, possible environmental effects from larger foundations, potential detrimental visual effects, and the modest MF reductions achieved (unless the ROW width is unusually narrow).

Conductor Separation

Decreasing the distances between individual phase conductors can reduce MF. Because at any instant in time the sum of the currents in the individual phase conductors is zero, or close to zero, moving the conductors closer together improves their partial cancellation of each other's MF. In other words, the net MF produced by the closer conductors reduces the MF level associated with the line. Placing the conductors closer together has practical limits, however. The distance between the conductors must be sufficient to maintain adequate electric code clearance at all times, and to assure utility employees' safety when working on energized lines. One drawback of a close conductor installation is the need for more support structures per mile (to reduce conductor sway in the wind and sag at mid-span); in turn, costs increase, and so do visual impacts.

Conductor Configuration

The arrangement of conductors influences MF. Conductors arranged in a flat, horizontal pattern at standard clearances generally have greater MF levels than conductors arranged vertically. This is due to the wider spacing between conductors found typically on H-frame structure designs, and to the closer distance between all three conductors and the ground. For single-circuit lines, a compact triangular configuration, called a "delta configuration", generally offers the lowest MF levels. A vertical configuration may cost more and may have increased visual impact. Where the design goal is to minimize MF levels at a specific location within or beyond the ROW, conductor configurations other than vertical or delta may produce equivalent or lower fields.

Optimum Phasing

Optimum phasing applies in situations where more than one circuit exists in an overhead ROW or in a duct bank installed underground. Electric transmission circuits utilize a three-phase system with each phase carried by one conductor, or a bundle of conductors. Optimum phasing reduces MF through partial cancellation. For a ROW with more than two circuits, the phasing arrangement of the conductors of each circuit can generally be optimized to reduce MF levels under typical conditions. The amount of MF cancellation will also vary depending upon the relative loading of each circuit. For transmission lines on the same ROW, optimizing the phasing of the new line with respect to that of existing lines is usually a low-cost method of reducing MF.

MF levels can be reduced for a single circuit line by constructing it as a “split-phase” line with twice as many conductors, and arranging the conductors for optimum cancellation. Disadvantages of the split-phase design include higher cost and increased visual impact.

Increased Voltage

MF are proportional to current, so, for example, replacing a 69-kV line with a 138-kV line, which delivers the same power at half the current, will result in lower MF. This could be an expensive mitigation to address MF alone because it would require the replacement of transformers and substation equipment.

Underground Installation

Burying transmission lines in the earth does not, by itself, provide a shield against MF, since magnetic fields, unlike electric fields, can pass through soil. Instead, certain inherent features of an underground design can reduce MF. The closer proximity of the currents in the wires provides some cancellation of MF, but does not eliminate it entirely. Underground transmission lines are typically three to five feet below ground, a near distance to anyone passing above them, and MF can be quite high directly over the line. MF on either side of an underground line, however, decreases more rapidly with increased distance than the MF from an overhead line.

The greatest reduction in MF can be achieved by “pipe-type” cable installation. This type of cable has all of the wires installed inside a steel pipe, with a pressurized dielectric fluid inside for electrical insulation and cooling. Low MF is achieved through close proximity of the wires, as described above, and through partial shielding provided by the surrounding steel pipe. While this method to reduce MF is effective, system reliability and the environment can be put at risk if the cable is breached and fluid is released.

Lengthy high-voltage underground transmission lines can be problematic due to the operational limits posed by the inherent design. They also can have significantly greater environmental impacts, although visual impacts associated with overhead lines are eliminated. The Council recognizes the operational and reliability concerns associated with current underground technologies and further understands that engineering research regarding the efficiency of operating underground transmission lines is ongoing. Thus, in any new application, the Council may require updates on the feasibility and reliability of the latest technological developments in underground transmission line design.

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Appendix 7B – Field Management Design Plan

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I. INTRODUCTION

This Appendix summarizes an evaluation of engineering measures to reduce magnetic fields (MF) at right-of-way (ROW) edges from the new and reconstructed transmission lines that are part of The Connecticut Light and Power Company's (CL&P's) proposed Interstate Reliability Project (Project) in Connecticut. The goal of this evaluation is to set forth measures that meet the policy of the Connecticut Siting Council (Council) for incorporating magnetic field management in the siting and design of new transmission lines, as set forth in its *Electric and Magnetic Fields Best Management Practices for the Construction of Electric Transmission Lines in Connecticut*, December 14, 2007 (hereinafter referred to as "BMP"). A copy of the BMP is included in Appendix 7A.

In compliance with the Council policy, CL&P developed a Field Management Design Plan (Plan) for the Project. This Plan begins from a "base-case design" of the proposed overhead transmission line incorporating standard utility practice and "no-cost" magnetic field management design features (see Section 7). The Plan then examines modified overhead line designs incorporating low-cost magnetic field management features for consideration in "publicly accessible areas," particularly at locations where the transmission line routes could be considered by the Council to be adjacent to residential areas, public or private schools, licensed child day-care facilities, licensed youth camps, or public playgrounds.

The Council's BMP establishes a benchmark for additional Project spending on these modified designs of up to 4% of the estimated Project cost in Connecticut using the base-case line design, including the cost of the Project's related substation and switching station work in Connecticut. The BMP also specifies that this extra cost allowance should be used on measures that achieve magnetic field reductions at ROW edges of 15% or more, as compared to the levels associated with the base-case line design. The intention of the BMP is to achieve magnetic field reductions using some or all of the 4% allowance. However, the

BMP recognizes that projects can vary widely with regard to numbers of adjacent statutory facilities and magnetic field levels, justifying some variances above and below the Council's spending and field reduction guidelines.

In Section III of the BMP, the Council recommends an overall total of low-cost design features calculated at 4% of the initial "base design" project cost including substation costs. The estimated capital cost for the Project in Connecticut (including substation costs) is $213.7 million, assuming that CL&P's base-line design is used throughout. Under the Council's 4% guideline, $8.5 million ($213.7 million x 0.04) is the guideline budget for low-cost magnetic field mitigation on the Project.

CL&P anticipates that the Council will review CL&P's preferences for magnetic field mitigation spending in this Plan, and then, applying the guidelines of the BMP, designate specific field reduction strategies to be employed in specific Project locations.

Follow-up information on magnetic fields can be obtained by contacting Mr. Robert E. Carberry of Northeast Utilities Services Company at 860-665-6774, Dr. Gary Ginsberg of the Connecticut Department of Public Health (DPH) at 860-509-7750, or Dr. Brian Toal of the Connecticut DPH at 860-509-7741.

II. INTERSTATE RELIABILITY PROJECT

II.1 PROJECT DESCRIPTION AND BASE-CASE LINE DESIGN

The Project would construct new 345-kV transmission lines on existing CL&P ROWs between Card Street Substation, Lake Road Switching Station, and the Connecticut/Rhode Island border. The new transmission lines would extend for approximately 36.8 miles, and would be located adjacent to existing CL&P 345-kV lines. The new 345-kV transmission lines and modifications would be aligned along existing CL&P ROWs that extend in a generally west to east direction (see Figure 1). The new lines would be built adjacent to, and generally north or west of, the existing 345-kV transmission lines.

With the exception of two segments, totaling approximately 1.4 miles, across federally-owned properties in the towns of Mansfield and Chaplin[1], the proposed 345-kV lines would be located entirely within CL&P's existing 250- to 400-foot wide utility easements. The existing ROW is only 150 feet wide across the federally-owned properties. To accommodate the new line adjacent to the existing 345-kV line in these areas, CL&P proposes to acquire additional easements, totaling approximately 11 acres.[2]

In all other areas, the existing ROWs have sufficient unused width to construct the new 345-kV transmission lines on H-frame structures with the line conductors in a horizontal configuration. The existing line is built in essentially the same configuration, except along an approximately 0.9-mile ROW segment in the Town of Mansfield mentioned above where the conductors are in a delta configuration

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[1] The federally-owned properties, which are associated with the U.S. Army Corps of Engineers (USACE's) flood control efforts at and in the vicinity of Mansfield Hollow Dam and Lake, are managed by the Connecticut Department of Energy and Environmental Protection. These areas consist of an approximately 0.9-mile segment of ROW in the Town of Mansfield, including a crossing of Mansfield Hollow State Park, the lake, and Mansfield Hollow Wildlife Management Area (WMA), and a 0.5-mile segment of ROW in the Town of Chaplin across the WMA.

[2] This additional easement acreage calculation is estimated based on preliminary survey data and takes into consideration the configuration of the existing CL&P easement. Final easement acreages would be determined based on final legal surveys and agreements with the USACE. Alternate line designs requiring no additional easement of less easement expansion are described in Volume 1, Section 10 of the Project Application to the Council.

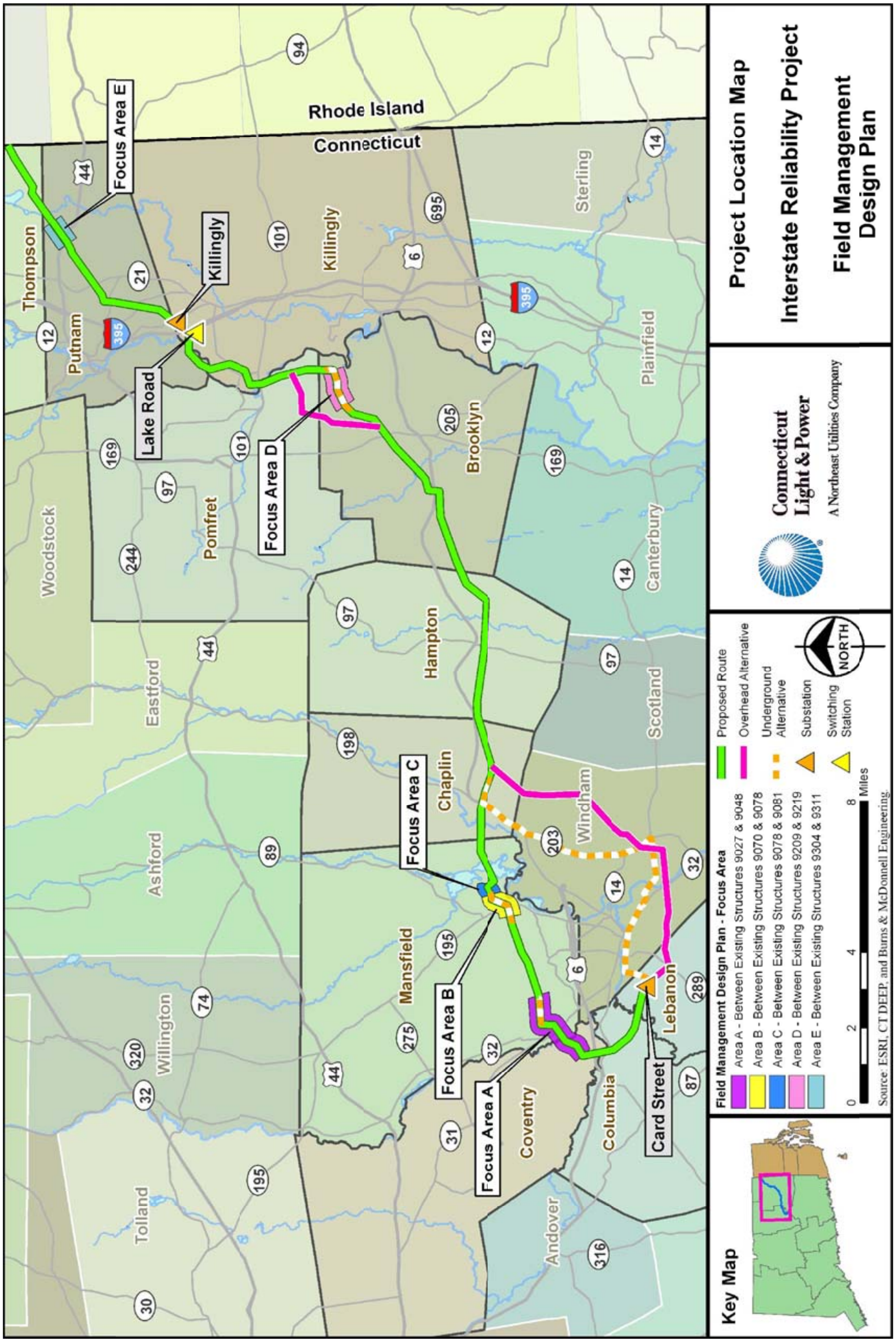
supported by steel monopoles, and a 0.2-mile segment near the Lake Road Switching Station where the existing and proposed transmission lines are supported by steel monopoles with vertically-configured conductors.

Except for one segment of ROW approximately 1 mile in length in Mansfield (Cross Section XS-3 within the federally-owned properties), a horizontal line configuration is CL&P's base line configuration for the Project because it allows for lower structure heights (less visibility) and is the most economical configuration to build. The exception is that self-supported, steel-monopole structures with delta-configured conductors are proposed as the Base Design for XS-3, in order to match the existing line design on this section of ROW and to reduce the need for additional ROW width. For the base line configurations, the phasing of the new 345-kV transmission line would be selected with respect to the phasing of existing lines to minimize the magnetic fields produced at the ROW edges. To aid in reducing magnetic fields at the ROW edges, the new 345-kV line would also be aligned along the ROW as close to the existing 345-kV transmission line as design standards allow. Selection of line phasing, as well as minimizing the distance between the existing and proposed lines, are no-cost magnetic field management measures.

II.2 FOCUS AREAS FOR MAGNETIC FIELD MANAGEMENT

Per the Council's BMP, the focus areas for applications of low-cost magnetic field management designs are those locations where public or private schools, licensed child day-care facilities, public playgrounds, licensed youth camps, or residential areas are adjacent to a proposed new transmission line. Pursuant to these provisions, CL&P has identified five focus areas for this Project. The locations of these five areas, referred to herein as Focus Areas A, B, C, D, and E, are illustrated on Figure 1.

Figure 1: Proposed Location of Project and Project Focus Areas



Focus Area A, which is located in the towns of Coventry and Mansfield, is an approximately 2.3-mile segment of 300-foot-wide ROW between existing 330 line structures 9028 and 9048. Homes have been developed near each side of the ROW along crossing streets. The Council may or may not consider this area to be an adjacent “residential area” within the meaning of Connecticut General Statutes § 16-50p(a)(3)(D). However, given comparatively sparse settlement elsewhere along the Project ROWs, some or all of this segment of the ROW in any case is a reasonable place for attention in this Plan.

Focus Area B is a 0.9-mile segment of ROW in the Town of Mansfield, between existing 330 line structures 9070 and 9078. Along this segment, the existing 300-foot-wide ROW passes near two home-based child day-care facilities and the Mount Hope Montessori School, which is both a licensed child day-care facility and a school. These facilities are situated along Bassetts Bridge Road and Storrs Road.

Focus Area C, which abuts Focus Area B, is a 0.4-mile segment of 300-foot-wide ROW in the Town of Mansfield. Specifically, the focus area is located north of Bassetts Bridge Road and northwest of Mansfield Hollow State Park, between existing 330 Line structures 9078 and 9081.

In this area, homes have been developed on Hawthorne Lane (a cul-de-sac) primarily to the north of the ROW. This area is unique in that Hawthorne Lane landowners are interested in shifting a small section of the existing ROW to the south, thus placing the new and existing 345-kV lines farther from most of the homes, without CL&P having to purchase new easements. The current landowners control the properties along both the existing and potentially relocated ROW segments. However, in addition to conveyances from each of the landowners, a release of a conservation easement by the Town of Mansfield would be required to accomplish this relocation. This ROW relocation would provide additional distance between the new line and all but one home to the north, but would decrease the distance to one house to the south.

Focus Area D, which is located in the Town of Brooklyn, is a 1-mile section of 300-foot-wide ROW between existing 330 Line structures 9210 and 9219. There are two home-based child day-care facilities situated along Church Street and Hickory Lane, and several homes near the existing ROW along Darby Road and Meadowbrook Drive.

Focus Area E, which is located in the Town of Putnam, is a 0.6-mile section of a 300-foot-wide ROW between existing 347 Line structures 9305 and 9310. To the southeast of this ROW section a number of homes have been developed along Elvira Heights, and the transmission line ROW crosses the rear portions of some of the home lots. A natural gas transmission pipeline corridor parallels the CL&P ROW to the southeast in this area, and also crosses the rear portions of these lots (and is closer to the homes). Fifteen homes are located within 400 feet of the ROW, the nearest of which is about 115 feet from the southeast ROW edge. The proposed line would be located farther from these homes than the existing 345-kV line. This area differs from the others in that the modeled power flows over the existing line will increase and control the magnetic fields to the southeast of the ROW where the homes are located.

II.3 BASE PROJECT LINE DESIGN AND ALTERNATE PROJECT LINE DESIGNS FOR MAGNETIC FIELD REDUCTIONS IN FOCUS AREAS

The proposed transmission line would be predominately built using typical H-Frame structures with horizontally configured conductors, as shown in Figure 2. With no-cost, close line placement and best circuit phasing in relation to adjacent lines, this is CL&P's base-case line design in each of the five focus areas.

As explained in more detail below, in Focus Areas A through D, the construction of the new transmission line in this base configuration would reduce magnetic fields at and near the ROW edge closest to the existing 345-kV transmission line when compared to the existing levels if no new line was built. Although the horizontal line configuration would increase magnetic field levels along the ROW edge nearest to the proposed new line, the new field levels there would remain lower than the pre-Project levels that exist along the opposite ROW edge in Focus Areas A through D. In Focus Area E, the increased Connecticut power imports assumed for the post-NEEWS modeling in 2020 produce significantly higher currents on the existing 347 Line, leading to increases in magnetic field levels along the ROW edge closest to this existing line.

By altering the conductor configurations for the proposed line in Focus Areas A through D, magnetic field levels may be further reduced at the ROW edges in some cases. Similarly, increasing structure heights, and therefore conductor heights, on the new line could reduce magnetic field levels at the ROW edges in Focus Areas A through D, but only relatively large height increases in this case can achieve the 15% reduction target.

However, in Focus Area E, different conductor configurations and increased conductor heights on the new line would have relatively little effect on magnetic field levels at the southeast ROW edge closest to the existing line. Larger magnetic field reductions on that ROW edge would require that the existing line also be modified. The base-case line configuration in each focus area, as well as several alternative configurations and height variations, are discussed and compared in detail below.

II.3.1 Horizontal Conductor Configuration Using 345-kV H-Frame Line Structures, the Base-Case Line Design[3]

A typical 345-kV H-frame line structure is shown in Figure 2. Cost estimates for a 345-kV H-frame transmission line using steel poles with direct-embedded or concrete pier foundations are summarized in Table 1 for two typical structure heights. ROW cross-sections for this configuration showing the proposed new H-frame line structures alongside the typical existing line structures are provided in Figures 13 and 14 (these figures are located at the end of this Plan, in Section III).

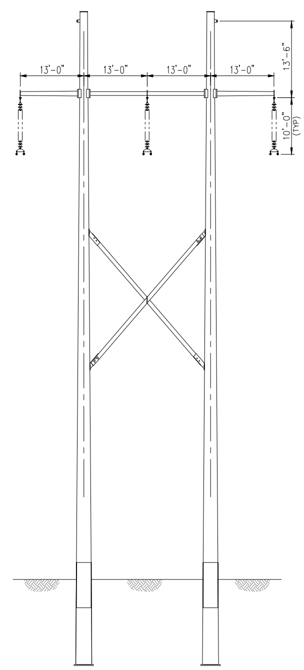
Table 1: Typical 345-kV H-Frame Line Costs Per Mile

Cost Per Mile	
Structure Description	**Total**
85' H-Frame	$4,804,000
105' H-Frame	$5,395,000

Notes:

- *Structure costs are based on (10) structures per mile [(8) tangents and (2) 3-pole structures for H-frames].*
- *Conductor costs are based on 2-conductor bundles of 1590-kcmil ACSS "Falcon" conductor.*
- *Costs are "all-in" estimated capital cost.*

Figure 2: Typical H-Frame Tangent Structure



3 In a 1-mile section of ROW within Mansfield Hollow, XS-3, the base-case line design is not H-frame, but rather a delta line design to match the existing line along that section of ROW.

II.3.2 345-kV Delta Line Configuration

A typical 345-kV delta line structure is shown in Figure 3. Such a line would be constructed using steel monopoles and concrete pier foundations. A delta configuration of the line conductors allows for a narrower line and can aid in adjacent line EMF cancellation with best circuit phasings. Compared to the use of the base-case design in the Project Focus Areas A through D, constructing the new line in a delta configuration, with the existing line left in place, would reduce magnetic field levels at the ROW edge nearest to the new line, while increasing the magnetic field levels at the opposite edge. In Focus Area E, constructing only the new line in a delta configuration would increase magnetic field levels at both ROW edges as compared to the base-case design. Table 2 presents typical 345-kV, delta line construction costs for two typical structure heights. ROW cross-sections for this configuration showing the delta line structures alongside the typical existing line structures are provided in Figures 15 and 16 (these figures are located at the end of this Plan, in Section III).

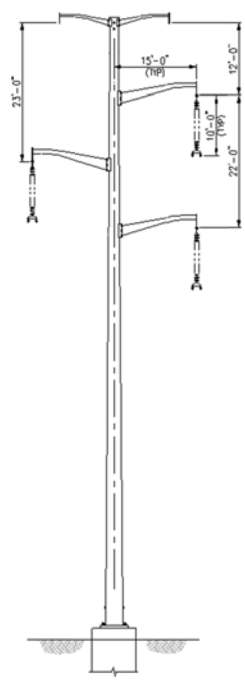
Table 2: Typical 345-kV Delta Line Costs Per Mile

Cost Per Mile	
Structure Description	**Total**
110' Delta	$6,074,000
130' Delta	$6,795,000

Note:

- *Structure costs are based on (10) structures per mile [(8) tangents, (1) angle, (1) deadend].*
- *Conductor costs are based on 2-conductor bundles of 1590-kcmil ACSS "Falcon" conductor.*
- *Costs are "all-in" estimated capital cost.*

Figure 3: Typical Delta Tangent Structure



II.3.3 345-kV Vertical Line Configuration

Figure 4 shows a typical structure used for vertically configured transmission lines. The vertical line configuration is the narrowest configuration, and it is typically constructed on narrower ROWs or where several lines are routed on the same ROW. Such a line would be constructed using steel monopoles and concrete pier foundations. For Project Focus Areas A through D, the vertical configuration of the new line, with the existing line left unaltered, would reduce the magnetic field levels at the ROW edge nearest the new line, but would increase levels at the other ROW edge when compared to the base-case line design. In Focus Area E, constructing only the new line in a vertical configuration would increase magnetic field levels on both ROW edges as compared to the base-case design. Typical 345-kV vertical line construction costs for two typical structure heights are provided in Table 3. ROW cross-sections for this configuration showing the vertical line structures alongside the typical existing line structures are provided in Figures 17 and 18 (these figures are located at the end of this Plan, in Section III).

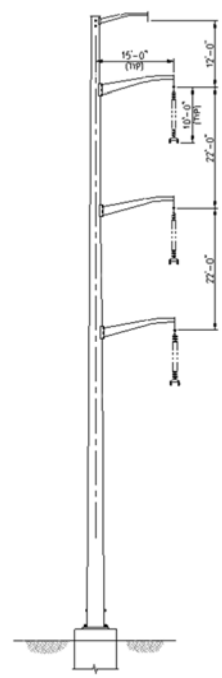
Table 3: Typical 345-kV Vertical Line Costs Per Mile

Cost Per Mile	
Structure Description	**Total**
130' Vertical	$6,128,000
150' Vertical	$6,802,000

Note:

- *Structure costs are based on (10) structures per mile [(8) tangents, (1) angle, (1) deadend].*
- *Conductor costs are based on 2-conductor bundles of 1590-kcmil ACSS "Falcon" conductor. Costs are "all-in" estimated capital cost.*
- *Costs are "all-in" estimated capital cost*

Figure 4: Typical Vertical Tangent Structure



II.3.4 345-kV Split-Phase Line Configuration

A 345-kV split-phase line configuration, using structures as shown in Figure 5, would employ twice as many line conductors, thus reducing the current in any one conductor by half. Such a line would be constructed using steel monopoles and concrete pier foundations. Typical 345-kV split-phase line costs are provided in Table 4.

The split-phase configuration of the new line, together with reverse phasing of the two sets of line conductors, would achieve larger reductions in magnetic field levels at the ROW edge closest to the proposed 345-kV line, when compared to the base-case line design. However, the field-cancelling interaction between the split-phase line and the existing line is less, so the opposite ROW edge experiences higher magnetic field levels, when compared to the base line design. In Focus Area E, constructing only the new line in a split-phase configuration would increase magnetic field levels on both ROW edges as compared to the base-case design. ROW cross-sections for this configuration showing the split-phase line structures alongside the typical existing line structures, are provided in Figure 19 (this figure is located at the end of this Plan, in Section III).

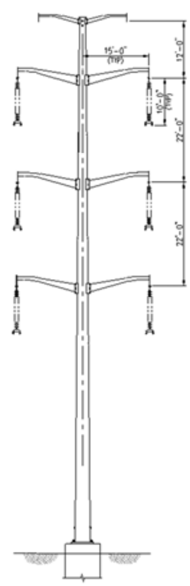
Table 4: Typical 345-kV Split-Phase Line Costs Per Mile

Cost Per Mile	
Structure Description	**Total**
130' Split-phase	$9,264,000

Note:

- *Structure costs are based on (10) structures per mile [(6) tangents, (1) angle, (3) deadends].*
- *Conductor costs are based on 2-conductor bundles of 1590-kcmil ACSS "Falcon" conductor.*
- *Costs are "all-in" estimated capital cost.*

Figure 5: Typical Split-Phase Tangent Structure



II.3.5 Conductor Heights above Ground

CL&P calculates magnetic fields using typical conductor heights above ground at the low point of the sag of cross-country line spans, assuming that all adjacent lines have a common low point location. For a 345-kV line, a typical bottom conductor height of 35 feet is used. Wherever conductor heights are higher above ground, magnetic fields would typically be lower at the ground level on and immediately adjacent to the ROWs. Because conductor heights above ground increase between the lowest points in the span and the attachment points on the transmission line structures, magnetic field levels would be lower than CL&P's calculated values at points along the ROW edge that are not located exactly at the low points of the conductor span.

At an extra cost, all of the 345-kV transmission line designs depicted in Sections II.3.1 through II.3.4 could be constructed with taller supporting structures, which would increase conductor heights above ground level. In this Plan, the magnetic field consequences of additional conductor heights above ground of 20 feet were modeled for the base-case line design, as well as for two alternative line designs (see Section II.4).

II.3.6 Conductor Separation

Reducing the separation distance between each of the three conductor bundles of a 345-kV transmission line can reduce magnetic field levels. However, reducing the conductor separations for each 345-kV transmission line design below CL&P's standard separations can reduce reliability, increase corona-caused noise levels in wet weather, and make it unsafe for line workers to perform live-line maintenance. To achieve the target 15% reduction in magnetic field levels at ROW edges, the conductor-bundle separation distance for an H-frame line must be reduced from the standard 26 feet to 22 feet. CL&P evaluated this reduced phase spacing on H-Frame structures and determined it compromises safe live-line maintenance. As such, CL&P is not considering any use of reduced conductor-bundle separations for H-frame lines in this Plan.

II.3.7 Passive Loop Shielding

Magnetic field reduction can be achieved over small areas with wire loops installed parallel with and beneath overhead lines, e.g., on poles along a ROW edge. Such loops can be designed such that the magnetic fields produced by currents induced in the loop conductors partially cancel the transmission line magnetic fields, resulting in a decreased magnetic field at the ROW edge. However, the area of reduced magnetic fields near passive loops is relatively small, the additional poles and wire loops add visual impact, and there are some public safety concerns should a passive loop wire drop on the ground. For these reasons, CL&P does not consider passive loop shielding to be a very practical magnetic field management tool in any of the Project focus areas.

II.3.8 Shifting the ROW or Alignments of Lines on a ROW

Under certain circumstances, an entire ROW segment, or the alignment of lines on a ROW segment, could be shifted to provide additional distance between the new lines and adjacent facilities, thereby reducing magnetic field levels at facilities of interest. When the existing ROW has adequate space for the construction of a new transmission line, ROW relocation seldom proves to be either a low-cost or environmentally-preferred option, because it typically would require purchasing new easements and then rebuilding the existing lines and constructing the new lines on the newly-created ROW.

Shifting the alignment of a new line on a ROW where extra unused ROW width exists is also a possible, but seldom practical, magnetic field management option. For a ROW where there are homes close to both edges of the ROW, any shift in new line alignment within a ROW usually reduces magnetic field levels at the residences on one side of the ROW, while increasing the levels at residences on the other side.

For the Project focus areas, moving the base-case new H-frame line to the north/west within the currently unused ROW area would increase magnetic field levels on both ROW edges. Furthermore, shifting the proposed 345-kV line in this manner could limit the future use of the ROW in areas where the ROW is wide enough for a future line addition.

For most of the line design alternatives considered for the focus areas in this Plan, the structures of the new line all share the same centerline location on the right-of-way, keeping the new line relatively close to the existing line. However, for Focus Area E, design alternatives which shift both the new and existing line alignments on the ROW are presented since residential development exists only on one side of the ROW.

II.4 MAGNETIC FIELD LEVELS PRODUCED BY THE BASE-CASE LINE DESIGN AND BMP ALTERNATE LINE DESIGNS IN FOCUS AREAS A, B, C, AND D

CL&P's consultant, Exponent, calculated magnetic fields for the ROW cross-sections pursuant to recognized industry practice (i.e., typical minimum mid-span clearance of conductors to ground, 1 meter above ground, and assuming flat terrain and balanced circuit currents). These calculations were made at three New England system load levels projected by CL&P to occur in the year 2020. Specifically, the calculations were performed using: a) annual average load (AAL), b) annual peak load (APL), and c) peak-daily average load (PDAL). (Please refer to Section 7 of the Application to the Council for the assumptions made in the system power-flow modeling used to determine the circuit currents on each ROW cross-section for each of the three load levels.)

ROW cross-sections XS-2 and XS-6 are identical and apply to the Focus Areas A through D. Accordingly, the calculated fields for these cross-sections with the base-case line design are also identical. For these four Focus Areas, Table 5 shows the difference in the calculated magnetic field levels at the edges of the ROW for the pre-Interstate condition in 2015 and for the comparable post-NEEWS condition in 2020 with the base-case line design. Table 5 shows that the base-case line design, when compared with the levels existing in 2015 before a new line is built, reduces magnetic field levels at the south ROW edge and increases them along the north/west edge, but this increase is to a lower field level than would exist along the south edge with or without the new line.

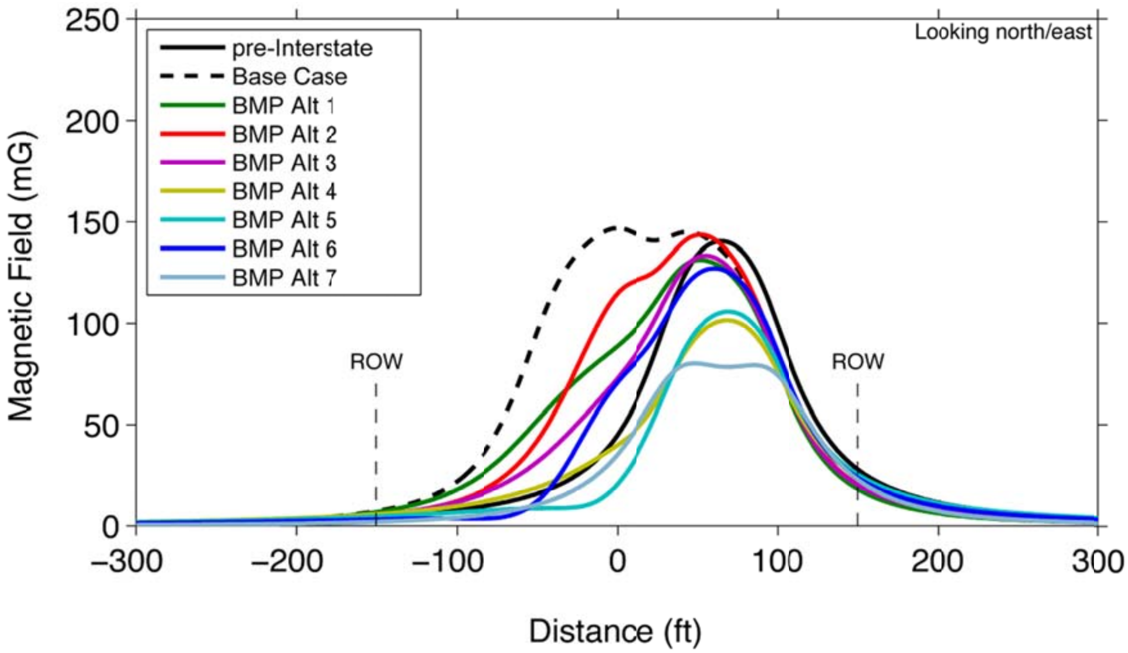
Table 5: Magnetic Field Comparison for Focus Area A, B, C, and D Sections of the Project ROW

XS-2 and XS-6 Configurations	Magnetic Fields for Annual Average Load Case		
	Maximum Level on ROW (mG)	North/West ROW Edge Level (mG)	South/East ROW Edge Level (mG)
Pre-Interstate (2015)	140.5	4.6	28.0
Post-NEEWS (2020) - Base-Line Case	146.9	7.2	18.4

Figure 6 provides a graphical representation of the calculated magnetic field levels across the ROW cross-section for Focus Areas A, B, C, and D. Calculation results are included for the existing line assuming the pre-Interstate Reliability Project AAL load case for 2015, as well as for the proposed and alternative configurations of the new 345-kV transmission line assuming the 2020 AAL load case. The alternative line configurations are as follows:

- Base Case: H-frame line with horizontally configured conductors;
- BMP Alternative 1: H-frame line with horizontally configured conductors and 20-foot conductor height increase;
- BMP Alternative 2: Steel-monopole line with delta-configured conductors;
- BMP Alternative 3: Steel-monopole line with delta-configured conductors and 20-foot conductor height increase;
- BMP Alternative 4: Steel-monopole line with vertically configured conductors;
- BMP Alternative 5: Steel-monopole line with vertically configured conductors and 20-foot conductor height increase;
- BMP Alternative 6: Steel-monopole line with split-phase conductor configuration;
- BMP Alternative 7: Steel-monopole line with vertically configured conductors for both the proposed and existing circuits on relocated ROW, Focus Area C only.

Figure 6: Magnetic Field Profiles for the Focus Area A, B, C, and D Sections of the Project ROW



Tables 6, 7, 8 and 9 compare the calculated edge-of-ROW magnetic field levels at mid-span in each of the Focus Areas A through D for the base-case line design and the various alternative designs. The results in each of these tables are based on the 2020 AAL load case. Also presented in the tables are estimated local construction costs associated with each of these line designs. The tables show the percentage by which these mid-span edge-of-ROW magnetic fields are reduced or increased with the alternate line designs relative to the edge-of-ROW magnetic field levels with the base-case line design.

Table 6: Magnetic Field Management Results for Focus Area A

Focus Area A XS-2 Cross Section Configuration	Typical Structure Height (ft)	Magnetic Field for Annual Average Load Case					Cost	
		Maximum Level on ROW (mG)	North ROW Edge		South ROW Edge			
			Level (mG)	Change (%)	Level (mG)	Change (%)	Section Amount ($)	Project Increase[a] (%)
Base Line Design H-Frame	85	146.9	7.2		18.4		$10,320,459	-
Alt 1 - H-Frame +20 feet	105	131.2	6.8	-6%	18.2	-1%	$11,616,544	0.6%
Alt 2 - Delta Configuration	110	143.6	5.2	-28%	20.6	12%	$13,040,737	1.3%
Alt 3 - Delta +20 feet	130	133.4	5.4	-25%	20.2	10%	$14,467,025	1.9%
Alt 4 - Vertical Configuration	130	101.5	5.8	-20%	24.3	32%	$13,418,505	1.4%
Alt 5 - Vertical +20 feet	150	105.8	4.6	-36%	25.5	39%	$14,680,935	2.0%
Alt 6 - Split Phase	130	127.1	3.1	-57%	23.8	29%	$19,358,355	4.2%

[a] The base project cost without implementing BMP desingns in any of the focus areas is $213.7 million dollars.

Table 7: Magnetic Field Management Results for Focus Area B

Focus Area B XS-2 Cross Section Configuration	Typical Structure Height (ft)	Magnetic Field for Annual Average Load Case					Cost	
		Maximum Level on ROW (mG)	North ROW Edge		South ROW Edge			
			Level (mG)	Change (%)	Level (mG)	Change (%)	Section Amount ($)	Project Increase[a] (%)
Base Line Design H-Frame	85	146.9	7.2		18.4		$3,879,199	-
Alt 1 - H-Frame +20 feet	105	131.2	6.8	-6%	18.2	-1%	$4,386,589	0.2%
Alt 2 - Delta Configuration	110	143.6	5.2	-28%	20.6	12%	$4,942,327	0.5%
Alt 3 - Delta +20 feet	130	133.4	5.4	-25%	20.2	10%	$5,504,342	0.8%
Alt 4 - Vertical Configuration	130	101.5	5.8	-20%	24.3	32%	$4,995,001	0.5%
Alt 5 - Vertical +20 feet	150	105.8	4.6	-36%	25.5	39%	$5,581,315	0.8%
Alt 6 - Split Phase	130	127.1	3.1	-57%	23.8	29%	$7,559,719	1.7%

[a] The base project cost without implementing BMP desingns in any of the focus areas is $213.7 million dollars.

Table 8: Magnetic Field Management Results for Focus Area C

Focus Area C XS-2 Cross Section Configuration	Typical Structure Height (ft)	Magnetic Field for Annual Average Load Case					Cost	
		Maximum Level on ROW (mG)	North ROW Edge		South ROW Edge			
			Level (mG)	Change (%)	Level (mG)	Change (%)	Section Amount ($)	Project Increase[a] (%)
Base Line Design H-Frame	85	146.9	7.2		18.4		$3,311,244	-
Alt 1 - H-Frame +20 feet	105	131.2	6.8	-6%	18.2	-1%	$3,561,195	0.1%
Alt 2 - Delta Configuration	110	143.6	5.2	-28%	20.6	12%	$3,414,870	0.0%
Alt 3 - Delta +20 feet	130	133.4	5.4	-25%	20.2	10%	$3,687,898	0.2%
Alt 4 - Vertical Configuration	130	101.5	5.8	-20%	24.3	32%	$3,471,144	0.1%
Alt 5 - Vertical +20 feet	150	105.8	4.6	-36%	25.5	39%	$3,846,612	0.3%
Alt 6 - Split Phase	130	127.1	3.1	-57%	23.8	29%	$5,941,222	1.2%
Alt 7 - Vertical Configuration of Two Lines on Relocated ROW[b]	130	80.2	2.0	-72%	22.9	25%	$5,084,530	0.8%

[a] The base project cost without implementing BMP desingns in any of the focus areas is $213.7 million dollars.

[b] For Alternative 7, the north and south ROW edges are not at the same location as the other alternatives.

Table 9: Magnetic Field Management Results for Focus Area D

Focus Area D XS-6 Cross Section Configuration	Typical Structure Height (ft)	Magnetic Field for Annual Average Load Case					Cost	
		Maximum Level on ROW (mG)	North ROW Edge		South ROW Edge			
			Level (mG)	Change (%)	Level (mG)	Change (%)	Section Amount ($)	Project Increase[a] (%)
Base Line Design H-Frame	85	146.9	7.2		18.4		$5,118,233	-
Alt 1 - H-Frame +20 feet	105	131.2	6.8	-6%	18.2	-1%	$5,764,942	0.3%
Alt 2 - Delta Configuration	110	143.6	5.2	-28%	20.6	12%	$6,529,045	0.7%
Alt 3 - Delta +20 feet	130	133.4	5.4	-25%	20.2	10%	$7,278,072	1.0%
Alt 4 - Vertical Configuration	130	101.5	5.8	-20%	24.3	32%	$6,579,640	0.7%
Alt 5 - Vertical +20 feet	150	105.8	4.6	-36%	25.5	39%	$7,244,063	1.0%
Alt 6 - Split Phase	130	127.1	3.1	-57%	23.8	29%	$9,686,516	2.1%

[a] The base project cost without implementing BMP desingns in any of the focus areas is $213.7 million dollars.

Relative to the magnetic fields with the base-case line design, Tables 6 through 9 show that a delta line design achieves a significant magnetic field reduction on the north/west ROW edge adjacent to the new line while slightly increasing the magnetic field on the south/east ROW edge. These tables also show that the line configurations for Alternatives 3 through 6 also reduce magnetic fields on the north/west ROW edge nearest to the proposed line, but each of these alternatives would also further increase the magnetic fields on the south/east ROW edge. Nonetheless, all of the new line configurations would result in lower magnetic field levels on the south/east edge of the ROW when compared to the pre-Interstate levels. With the exception of the delta configuration, increasing the heights of the new line by 20 feet would cause additional reductions in magnetic field levels at the ROW edges nearest to the new line. The results are mixed along the opposite ROW edge, as the 20-foot taller delta configuration further reduces magnetic fields by only a few tenths of a milliGauss, while the 20-foot taller vertical line configuration actually increases field levels along this ROW edge.

In addition to magnetic field levels along the ROW edges, levels beyond the ROW edges at nearby "statutory facilities," including the nearest portions of homes that might be considered by the Council to be in developed "residential areas" may be of interest. Accordingly, Tables 10, 11, 12, and 13 compare the magnetic field levels for the 2015 pre-Interstate AAL loading condition with those for the 2020 post-NEEWS AAL loading condition for the proposed base-case line design and the delta line design.

These field levels were determined at the nearest corners of the statutory facilities and homes at ground level.

Table 10: MF Levels at Nearest Corners of Homes in Focus Area A

Facility	Distance to Nearest Edge of ROW (ft)[a]	Magnetic Fields for Annual Average Load Case		
		2015 Pre-Interstate (mG)	2020 Post-NEEWS	
			Base Line Design (mG)	Delta Design (mG)
Homes North of ROW	4	4.4	6.7	4.9
Homes South of ROW	5	25.2	16.2	18.3

[a] Distance is to the home closest to the ROW edge. Homes further from ROW edges will have lower field levels.

Table 11: MF Levels at Nearest Corners of Statutory Facilities in Focus Area B

Facility	Distance to Nearest Edge of ROW (ft)	Magnetic Fields for Annual Average Load Case		
		2015 Pre-Interstate (mG)	2020 Post-NEEWS	
			Base Line Design (mG)	Delta Design (mG)
Mount Hope Montessori School	137	1.7	1.2	1.4
Green Dragon Day Care	196	2.7	0.9	1.7
Come Play with Me Day Care	76	8.2	4.0	5.4

Table 12: MF Levels at Nearest Corners of Homes in Focus Area C

Facility	Distance to Nearest Edge of ROW (ft)[a]	Magnetic Fields for Annual Average Load Case		
		2015 Pre-Interstate (mG)	2020 Post-NEEWS	
			Base Line Design (mG)	Delta Design (mG)
Homes North of ROW	70	2.6	2.5	2.3
Home South of ROW	240	2.0	0.6	1.2

[a] Distance is to the home closest to the ROW edge. Homes further from ROW edges will have lower field levels.

Table 13: MF Levels at Nearest Corners of Statutory Facilities in Focus Area D

Facility	Distance to Nearest Edge of ROW (ft)	Magnetic Fields for Annual Average Load Case		
		2015	2020 Post-NEEWS	
		Pre-Interstate (mG)	Base Line Design (mG)	Delta Design (mG)
Jacqueline Ben Day Care	11	4.2	5.9	4.5
Susan Kirkconnell Day Care	497	0.4	0.1	0.3

II.5 MAGNETIC FIELD LEVELS PRODUCED BY THE BASE-CASE LINE DESIGN AND BMP ALTERNATE LINE DESIGNS IN FOCUS AREA E

CL&P's consultant, Exponent, calculated magnetic fields for the ROW cross-section pursuant to recognized industry practice (i.e., typical minimum mid-span clearance of conductors to ground, 1 meter above ground, and assuming flat terrain and balanced circuit currents). These calculations were made at three New England system load levels projected by CL&P to occur in the year 2020. Specifically, the calculations were performed using: a) annual average load (AAL), b) annual peak load (APL), and c) peak-daily average load (PDAL). (Please refer to Section 7 of the Application to the Council for the assumptions made in the system power-flow modeling used to determine the circuit currents on each ROW cross-section for each of the three load levels.

ROW cross-section XS-12 applies to Focus Area E. For XS-12, Table 14 shows the difference in the calculated magnetic field levels at the edges of the ROW for the pre-Interstate condition in 2015 and for the comparable post-NEEWS condition in 2020 with the base-case line design. Table 14 shows that the base-case line design, when compared with the levels existing in 2015 before a new line is built, increases magnetic field levels at both ROW edges. However, owing to adjacent line interactions, the increase along the southeast edge is to a lower level than would exist there if the new line was built elsewhere to circumvent Focus Area E.

Table 14: Magnetic Field Comparison for the Focus Area E Section of the Project ROW

XS-12 Configuration	Magnetic Fields for Annual Average Load Case		
	Maximum Level on ROW (mG)	North/West ROW Edge Level (mG)	South/East ROW Edge Level (mG)
Pre-Interstate (2015)	36.1	1.2	7.2
Post-NEEWS (2020) - Base-Line Case	112.7	2.2	20.4

Figure 7 provides a graphical representation of the calculated magnetic field levels across the ROW cross-section for Focus Area E. Calculation results are included for the existing line assuming the pre-Interstate AAL load case for 2015, as well as for the proposed and alternative configurations of the new 345-kV transmission line assuming the 2020 AAL load case. The alternative line configurations considered for Focus Area E are as follows:

- Base Case: H-frame line with horizontally configured conductors;
- BMP Alternative 1: H-frame line with horizontally configured conductors and 20-foot conductor height increase;
- BMP Alternative 2: Steel-monopole line with delta-configured conductors;
- BMP Alternative 3: Steel-monopole line with delta-configured conductors and 20-foot conductor height increase;
- BMP Alternative 4: Steel-monopole line with vertically configured conductors;
- BMP Alternative 5: Steel-monopole line with vertically configured conductors and 20-foot conductor height increase;
- BMP Alternative 6: Steel-monopole line with split-phase conductor configuration;
- BMP Alternative 8: Steel-pole line with vertically configured conductors for both the proposed and existing lines, on the same conductor centerlines as the base-case design;
- BMP Alternative 9: Steel-pole line with delta-configured conductors for both the proposed and existing lines, on the same line centerlines as the base-case design;

- BMP Alternative 10: H-frame line with horizontally configured conductors for both the proposed and existing lines, each shifted westward on the ROW by 45 feet;

- BMP Alternative 11: Steel-monopole line with vertically configured conductors for both the proposed and existing circuits, structures separated by 75 feet and centered within the ROW.

Cross section drawings showing the different ROW configurations can be found in the reference material at the end of this Appendix.

Figure 7: Magnetic Field Profiles for the Focus Area E Section of the Project ROW

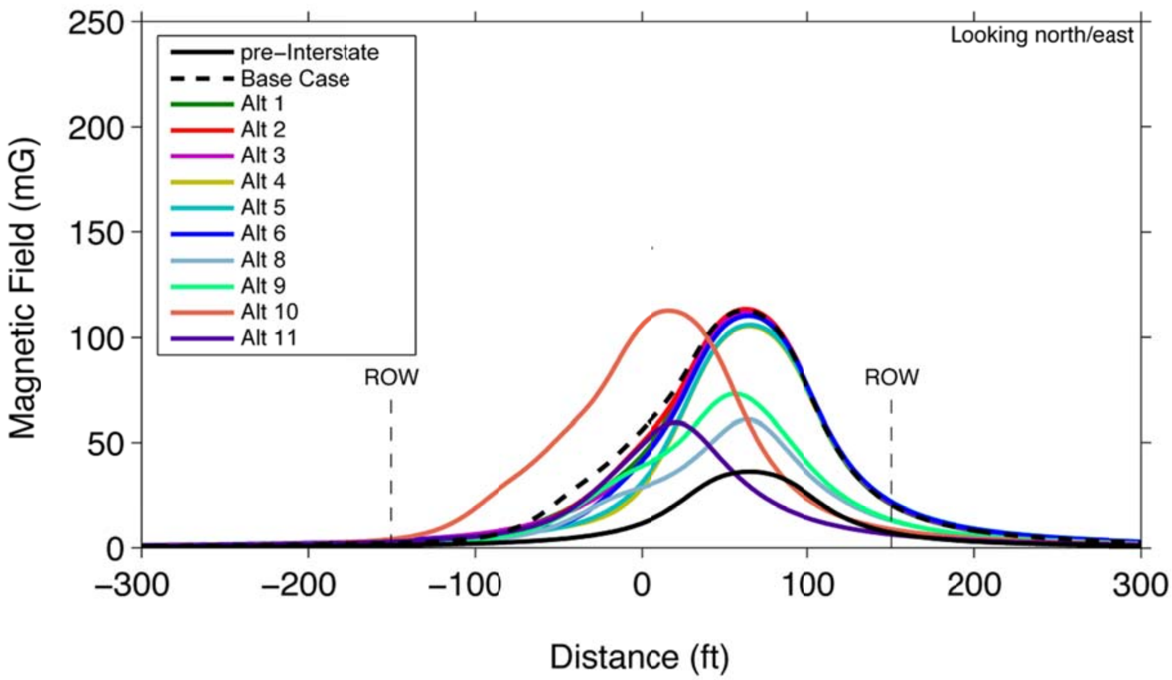


Table 15 compares the calculated edge-of-ROW magnetic field levels at mid-span in Focus Area E for the base-case line design and the applicable alternative designs. The results in this table are based on the 2020 AAL load case. Also presented in the table are estimated local construction costs associated with each of these line designs. The table shows the percentage by which these mid-span edge-of-ROW magnetic fields are reduced or increased with the alternate line designs relative to the edge-of-ROW magnetic field levels with the base-case line design.

Table 15: Magnetic Field Management Results for Focus Area E

Focus Area E XS-12 Cross Section Configuration	Typical Structure Height (ft)	Magnetic Field for Annual Average Load Case: Maximum Level on ROW (mG)	North ROW Edge: Level (mG)	North ROW Edge: Change (%)	South ROW Edge: Level (mG)	South ROW Edge: Change (%)	Cost: Section Amount ($)	Cost: Project Increase[a] (%)
Base Line Design H-Frame	85	146.9	2.2		20.4		$3,141,826	-
Alt 1 - H-Frame +20 feet	105	131.2	2.5	14%	20.4	0%	$3,411,990	0.1%
Alt 2 - Delta Configuration	110	143.6	3.3	50%	21.2	4%	$3,779,466	0.3%
Alt 3 - Delta +20 feet	130	133.4	3.5	59%	21.0	3%	$4,014,011	0.4%
Alt 4 - Vertical Configuration	130	101.5	3.3	50%	21.6	6%	$4,433,135	0.6%
Alt 5 - Vertical +20 feet	150	105.8	3.1	41%	21.9	7%	$4,861,558	0.8%
Alt 6 - Split Phase	130	127.1	3.3	50%	21.7	6%	$6,472,509	1.6%
Alt 7 - Vertical Configuration of Two Lines on Relocated ROW - Not Applicable to Focus Area E								
Alt 8 - Two Vertical Configurations with Conductors Located on H-Frame Centerlines	130	61	1.7	-23%	12.9	-37%	$9,396,201	2.9%
Alt 9 - Two Delta Configurations with Pole Located on H-Frame Centerlines	110	73.2	1.8	-18%	13.3	-35%	$7,415,909	2.0%
Alt 10 - Two H-Frame Configurations Shifted to the North Side of the ROW	85	112.7	4.1	86%	8.8	-57%	$10,202,048	3.3%
Alt 11 - Two Vertical Configurations Shifted to the Center of the ROW	130	59.5	2.9	32%	6.3	-69%	$10,305,500	3.4%

[a] The base project cost without implementing BMP desingns in any of the focus areas is $213.7 million dollars.

Relative to the magnetic fields with the base-case line design, Table 15 shows that no alternative design of the new line alone (i.e., Alternatives 1 through 6), would achieve a magnetic field reduction on either ROW edge. Alternatives 8 through 11 each involve rebuilding the existing line in this focus area in addition to building the new line. In each of these alternatives, the designs of the new and existing line would match. In Alternatives 10 and 11, each line would also be shifted northwesterly on the ROW. These four alternatives would all reduce magnetic fields on the south/east ROW edge by more than the minimum BMP requirement of 15%, and Alternatives 8 and 9 would also reduce magnetic fields on the north/west ROW edge by more than the BMP requirement. Alternative 9 would do so at the least additional cost. However, this additional cost represents approximately half of the Council's $8.5 million BMP guideline budget for the Project.

In addition to magnetic field levels along the ROW edges, levels beyond the ROW edges at the nearest portions of homes that might be considered by the Council to be in developed "residential areas" may be of interest for reviewing alternative designs. Accordingly, Table 16 compares the magnetic field levels for the 2015 pre-Interstate AAL loading condition with those for the 2020 post-NEEWS AAL loading condition for the proposed base-case line design and the Alternatives 8 through 11. These field levels were determined at the nearest corners of the homes at ground level.

Table 16: MF Levels at Nearest Corners of Homes in Focus Area E

Facility	Distance to Nearest Edge of ROW (ft)[a]	Magnetic Fields for Annual Average Load Case					
		2015	2020 Post-NEEWS				
		Pre-Interstate (mG)	Base Line Design (mG)	Alternative 8 (mG)	Alternative 9 (mG)	Alternative 10 (mG)	Alternative 11 (mG)
Homes South of ROW	113	1.4	3.7	2.9	2.8	2.4	1.9

[a] Distance is to the home closest to the ROW edges. Homes further from ROW edges will have lower field levels.

Note that Alternatives 10 and 11 would increase the distance between the existing line and the homes to the southeast of the ROW. These alternatives would provide magnetic field reductions at all homes in the area because of the increased distance, and for Alternate 11, because the vertical line configurations would have slightly better magnetic field cancellation. Because these two alternatives would involve relocating the existing line westerly, a short rebuild of the existing 345-kV line would be required, along with the construction of the new line. Rebuilding the existing line is also required for Alternatives 8 and 9, and would require outages on the existing line.

II.6 CL&P'S BMP DESIGN PREFERENCES FOR THE PROJECT FOCUS AREAS

Alternate line designs achieving magnetic field reductions of at least 15% on the north and west edges of the ROW, without causing safety or reliability concerns or interfering with the ability of the ROW to accept future lines, have been developed for the five Project focus areas. For Focus Areas A through D, all alternate new line configurations, with the existing line remaining as is, yield magnetic field reductions (compared to the levels associated with the base-case line design) on the north/west ROW edge, adjacent to the proposed line. Field levels at the opposite ROW edge increase relative to those with the base line design for all alternatives except Alternative 1, the H-frame design with a height increase of 20 feet.

For Focus Area E, the base-case line configuration increases magnetic fields on the southeast ROW edge (compared to pre-Project 2015 levels), and all alternate line configurations with the existing line remaining as is produce small increases compared to the levels with the base-case line configuration. In Focus Area E, modifications to the existing line would be necessary to yield projected post-Project magnetic field levels on the southeast ROW edge that are lower than base-case levels by 15% or more.

Focus Area A. Homes have been developed on both sides of the ROW in Focus Area A, between existing line structures 9027 and 9048. Relative to the edge-of-ROW magnetic field values of the existing configuration at the 2015 AAL, the levels at the same locations with the annual average loading in 2020 increase by approximately 2.5 mG along the north/west ROW edge with the new line built with the base-case line design. Conversely, the base-case line design decreases magnetic field levels by approximately 9.5 mG along the south/east edge. All of the alternate new line design configurations, with the existing line remaining as is, would further reduce magnetic field levels on the north/west ROW edge, and increase levels on the south/east ROW edge relative to the base-case line design. However, such increases would be to levels that are below the 2015 pre-Interstate level.

For this area, the most effective line design for reducing the magnetic field levels at the north/west ROW edge, while least increasing the levels on the south/east ROW edge, is the delta configuration. All other line designs further reduce the magnetic field levels on the north/west ROW edge, but also increase the magnetic field levels on the south/east ROW edge. Therefore, CL&P prefers a delta line design, shown in Figure 15, as the most effective low-cost field reduction choice for this focus area. However, given the modest change in magnetic field levels along the ROW edges and at the nearest homes produced by adding the new line using the base-case H-frame line design, the Council may consider that the magnetic field reduction offered by the delta design is offset by the visual impact of the taller structures required for the delta configuration, and therefore select the base-case H-frame line design for all or portions of this focus area.

Focus Area B. In Focus Area B, one licensed child day-care facility and school is located on the northern side of the ROW. There are also two home-based child day-care facilities located to the south of the ROW. As displayed in Tables 7 and 11, the magnetic field levels would be lower on the northern ROW edge closest to the school if a delta new line design is used; however, the level at the Mount Hope Montessori School building would be lower using the base-case H-frame line design. Further, as indicated in Table 11, magnetic field levels at the two child day-care facilities to the south of the ROW would be lower with the base-case line design. The field levels at all three of these facilities with the base-case line design would also be lower by comparison to the comparable 2015 pre-Interstate condition. Therefore, CL&P prefers a standard H-frame line as the BMP design for this focus area (see Figure 13).

Focus Area C. In Focus Area C, homes have been developed near the ROW, primarily on the northern side. As displayed in Tables 8 and 12, magnetic field levels are lower on the northern ROW edge using a delta line design for the new line, and the extra costs of a delta line design here is relatively small. However, the levels at the nearest homes to the north are only marginally lower with the delta line design than those with the base-case H-frame line design. For the home to the south of the ROW, only the base case line design reduces magnetic field levels. In addition, from Table 12, magnetic field levels for the base-case design are lower by comparison to the comparable 2015 pre-Interstate levels at the nearest homes, both north and south of the ROW. Therefore, CL&P prefers a standard H-frame line design, as shown in Figure13, as the BMP design for this focus area.

As noted earlier, because of landowner requests, the Focus Area C alternatives reviewed in this plan include an Alternative 7 which uses vertical conductor configurations for both the existing and the proposed lines on relocated ROW. This is illustrated in Figure 20 (refer to Section III for this figure). Alternative 7 presents a potential opportunity to further reduce already low magnetic field levels at the nearest north-side homes if the existing ROW is relocated slightly to the south passing over Hawthorne Lane (refer to Figure 25). Such a ROW shift would move both the new and existing 345-kV lines farther from the homes near the north edge of the ROW. Due to the vertical conductor configuration, best circuit phasing for both the existing and proposed line, and the additional distance to most of the homes from the relocated ROW, the magnetic field levels at the new north ROW edge and at most of the nearby homes would be reduced. Magnetic field levels for the base-case H-frame line design on existing ROW and Alternative 7 on relocated ROW are compared in Table 17 for residences located to the north and south of the ROW.

Table 17: MF Levels at Nearest Corners of Homes in Focus Area C with Alternative 7

Facility	Distance to Nearest Edge of ROW (ft)[a,b]	Magnetic Fields for Annual Average Load Case		
		2015	2020 Post-NEEWS	
		Pre-Interstate (mG)[c]	Base Line Design (mG)[c]	Alternative 7 (mG)
Homes North of ROW	125 (70)	2.6	2.5	0.5
Home South of ROW	185 (240)	2.0	0.6	1.0

[a] Distance is to the home closest to the ROW edge. Homes further from ROW edges will have lower field levels.
[b] Distances from ROW edges before ROW shift are shown in parentheses.
[c] Pre-Interstate and Base Line Design magnetic fields based on current ROW limits before relocation during the Project.

Acquisition of the requisite new easements from each landowner without purchase, and the release of a conservation easement from the Town of Mansfield, are each critical to Alternative 7. Based on discussions with the affected landowners during the preparation of this Plan, CL&P anticipates that the necessary rights could potentially be obtained from them and the Town without monetary consideration. Any order of the Council adopting this alternative should be conditioned on the acquisition of these rights without monetary consideration.

Alternative 7 requires a rebuild of the existing line in addition to the construction of the new line, making it one of the more costly BMP alternatives for this focus area. Further, relocating the existing ROW would require outages on the existing line and the erection and use of temporary structures to provide space to rebuild the existing line and construct the new line. However, due to the existing line layout on this segment of ROW, the alternate could be implemented with minor additional steps during construction, instead of a complex process requiring extended line outages. Specifically, a new 345-kV line span could be constructed on the new ROW to replace a short segment of the existing 330 Line. Outages of the 330 Line would be needed for this construction. After the existing 345-kV line segment is relocated, the new 345-kV line would be constructed adjacent to the relocated existing 330 Line. Notwithstanding CL&P's EMF BMP design preference for Focus Area C above, CL&P would be prepared to work with the Council and all affected parties to further explore Alternate 7, the shifted ROW. However, to do so while staying within the $8.5 million BMP guideline budget, another of CL&P's BMP design preferences in this plan would have to be modified.

For Alternative 7 (illustrated on Figures 20 and 25), CL&P would move the 300-foot-wide ROW a short distance to the south in the vicinity of the Hawthorne Lane cul-de-sac, between existing structure numbers 9079 and 9080. This shift would be onto property owned by the current landowners along CL&P's existing 300-foot-wide easement. CL&P owns in fee the property on which structure numbers 9079 and 9078 are located. However, a 0.32-acre portion of the property needed for the ROW shift on the privately-owned property would have to be on land that is under a Town of Mansfield conservation easement, as shown in Figure 25. This conservation easement was established in 2002 when the Hawthorne Lane subdivision was created. Based on consultations with the Town of Mansfield, CL&P determined that the ROW cannot be shifted onto this property with the Conservation Restriction in place in its present form. CL&P informed the Hawthorne Lane residents of this issue and explained that the residents must determine whether it is practically and legally feasible to secure a Conservation Restriction modification.

As illustrated on Figure 25 (also see Volume 9 Mapsheet 9 of 40 and Volume 11 Mapsheet 31 of 134), the ROW for Alternative 7 would be shifted onto property that is primarily grass or similar low-growth vegetation. The conductors would span the Hawthorne Lane cul-de-sac pavement, as well as wetland W20-63, a forested wetland located between structure numbers 9080 and 9079 that contains three vernal pools. Compared to the Proposed Route configuration, the ROW shift would result in a slightly narrower crossing of wetland W20-63 and would minimize forest vegetation clearing in wetland W20-64. Along the Focus Area C segment, both the ROW shift and the existing ROW would span stream S20-19.

In contrast to the BMP designs considered for some other areas, the impact of the Alternative 7 design for this Focus Area on nearby residential properties would be less than that of the base-case line design because of the ROW shift. In fact, it was the avoidance of tree clearing and associated visual improvement that first elicited the landowners' interest in moving the ROW.

Focus Area D. In Focus Area D, two home-based child day-care facilities are situated to the north of the ROW (only one of which is close to the ROW), and homes are located along both sides of the ROW. In this area, the northern side of the ROW is more densely populated with homes than the south. When compared to the 2015 pre-Interstate conditions, the base H-frame line design produces higher magnetic field levels on the northern edge of the ROW, while it reduces the levels on the southern edge. A delta line configuration, as shown in Figure 15, reduces ROW edge levels on the northern edge by over 15%. This line configuration increases magnetic field levels on the southern ROW edge by a few milligauss relative to the base-case H-frame line design yet still yields a large reduction from the 2015 pre-Interstate levels. The vertical and split-phase line designs produce higher edge-of-ROW magnetic field values on the southern edge, while substantially increasing costs. Therefore, in this focus area, CL&P considers that a delta line design is the most effective low-cost choice for reducing magnetic field levels along the ROW edges. However, given the modest changes in magnetic field levels resulting from the use of the base-case line design, the Council may consider that the benefit of the delta design in reducing magnetic field levels on one side of the ROW is offset by the additional visual impact of the taller structures[4], and therefore select the base-case H-frame line design for this focus area.

Focus Area E: In Focus Area E, a number of homes are located a short distance southeast of the ROW. The new line in this area would be constructed farther away from these homes than the existing line. The base-case H-frame line design produces higher magnetic field levels on both edges of the ROW when compared to the 2015 pre-Interstate conditions. However, the post-Project levels on the southeast edge with this design are comparable to those in the other four focus areas. At the additional distance to the nearest home, the post-Project magnetic field level at AAL in 2020 is 3.7 mG.

As shown in Table 15, no alternate configuration of only the new line in Focus Area E would reduce the magnetic field level on the southeast edge by over 15%, with respect to the base-case deign level. In fact, all such alternatives would slightly increase magnetic field levels on both ROW edges. Magnetic field reductions on the southeast ROW edge would be achieved only if the existing 345-kV line was also modified.

Therefore, four alternatives with existing line modifications were also considered in this plan for Focus Area E. These alternatives included:

- New and existing line in delta configurations;
- New and existing line in vertical configurations;
- New and existing lines in horizontal configurations but shifted westerly on the ROW; and
- New and existing lines in vertical configurations but shifted so as to be centered on the ROW. (Refer to Figures 21 – 24 in the reference figures at the end of this Appendix)

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[4] Because this segment of the ROW in the Town of Brooklyn is approximately 2,800 feet west of the Danielson Airport, the Federal Aviation Administration has issued Notices of Presumed Hazard (NPHs) to seven H-frame structures along the existing 345-kV line. The taller delta line design structures also could result in NHPs. Coordination with the FAA would be required to resolve issues related to the NHPs.

Resulting 2020 AAL magnetic fields on the northwest ROW edge, where there is no existing land development, are more than 15% lower than the base-case design level except for the horizontal and vertical line-shift alternatives.

CL&P prefers not to shift line alignments on a ROW for reasons discussed in Section II.3.8. Because of the increased costs and need for outages associated with rebuilding a segment of the 347 Line, CL&P also prefers not to rebuild that line in this location in a delta or vertical configuration. However, this appears to be the only practical BMP alternative available. Therefore, CL&P prefers delta designs for the existing and new line, with no line alignment shifts, as the BMP configuration in this focus area (see Figure 22). However, in considering BMP criteria for the overall project (including the 4% cost benchmark) CL&P expresses strong reservations with respect to this design option. At the distance to the nearest home to the southeast of the ROW, this alternative would reduce the post-Project AAL magnetic field level in 2020 by 23% from 3.6 mG to 2.8 mG. And the additional cost to achieve this relatively small absolute reduction from an already low MF level is $4.3 million, or approximately half of the 4% guideline budget for magnetic field mitigation. In addition, the use of this alternative would affect environmental resources. Specifically, the use of delta configurations for the new 345-kV line and the rebuilt 347 Line would:

- Decrease the amount of upland and wetland forest vegetation removal required along the north edge of the ROW by 10 feet, resulting in a 0.8-acre reduction in total forest removal (of this 0.8 acre, approximately 0.2 acre is forested wetland).

- Increase the amount of vegetation disturbed along the ROW, due to the construction activities within the ROW near both the existing 347 Line and new 345-kV line. Assuming that the entire 140-foot-wide presently managed portion of the ROW along the 347 Line would be affected, along with the 80-foot-wide area of additional vegetation removal along the north side of the ROW (refer to XS-12 BMP), 19.2 acres of scrub-shrub and forest vegetation would be affected. In comparison, the use of the base-case H-frame design for the new 345-kV line (with the 347 Line left in place) would affect approximately 11.3 acres of primarily forest vegetation including a minimal amount of scrub-shrub (managed) vegetation.

- Increase temporary and permanent effects to wetlands and watercourses as a consequence of rebuilding the 347 Line segment. This existing 345-kV line extends for approximately 0.2 mile through a wetland (W20-197); two of the existing transmission line structures (Nos. 9306 and 9307) are located in this wetland. Removing the existing H-frame structures and installing the new delta line design structures would require temporary access and crane pads that would have to be located in wetland W20-197. The new delta line structures also would have to be located in this wetland, and would represent a permanent loss of approximately 252 cubic yards of wetland habitat for three structures. In comparison, approximately 141 cubic yards of wetland habitat would be permanently lost for two H-frame structures installed in the same wetland. There would be an increase of approximately 0.3 acres of temporary impacts to wetland for the additional crane pads and no additional impacts for access roads.

BMP Summary

Based on the analysis presented in this Plan, CL&P has identified preferred magnetic field management designs in Focus Areas A, D, and E. The total cost of implementing these designs is estimated at $8.4 million, including $4.3 million for the Focus Area E recommendation. .CL&P expects that the additional costs of these for magnetic field management measures would be borne solely by Connecticut consumers.

In its efforts to balance environmental effects and magnetic field management, should the Council conclude that the base-case H-frame line design or any of the other overhead 345-kV transmission line design alternatives examined for each of the five Focus Areas in the Plan best fulfills the requirements of the BMP and other objectives of the Council, CL&P is prepared to proceed with any of these alternatives.

II.7 ALTERNATE PROJECT LINE DESIGNS FOR MAGNETIC FIELD REDUCTION – CONSIDERED BUT ELIMINATED

During the preparation of this Plan, a line design configuration was considered that involved building two vertically-configured lines centered on the 300-foot-wide ROW at locations between Babcock Hill Junction and Day Street Junction where statutory facilities or residential development exists to both sides of the ROW, i.e., Focus Areas A through D. This alternative requires re-building the existing line in addition to the construction of the new line, at almost double the cost of constructing only the new line. This combination of line configuration matched with no-cost best phasing of these vertical lines would result in a reduction of magnetic fields at both edges of the ROW. These values are presented in Table 18.

Table 18: MF Levels at ROW Edges for Two Vertically Configured Lines Centered in the ROW, Babcock Hill Junction to Day Street Junction

XS-2 and XS-6 Cross Section Configuration	Typical Structure Height (ft)	Magnetic Fields for Annual Average Load Case				
		Maximum Level on ROW (mG)	North ROW Edge		South ROW Edge	
			Level (mG)	Change (%)	Level (mG)	Change (%)
Base Line Design H-Frame	90	146.9	7.2		18.4	
2 Vertical Configuration Centered on ROW	130	80.3	3.8	-45%	3.5	-81%

In Focus Area C, where there is an opportunity to shift the ROW, so already requiring that the existing line be rebuilt, this alternate configuration with two vertical lines was considered in Section II.4. However, in the focus areas where the construction of two vertical lines would have to occur entirely in the existing ROW, the construction becomes more difficult. Due to this difficulty and substantially higher cost, this option was considered but eliminated from this Plan. Nonetheless, CL&P would be prepared to work with the Council and all affected parties if the Council preferred this configuration for a limited use within a focus area, consistent with the 4% BMP spending guideline.

III. REFERENCE FIGURES

The following drawings and figures are included for reference. Included are Project Location Maps showing the relative location of homes and statutory facilities in and near the focus areas along the Proposed Route. Because the five focus areas overlap with sections of the Proposed Route where overhead and underground variations are considered (refer to Volume 1A, Section 15), the locations of these variations are also shown on the maps. Cross-section drawings illustrating the alternate line configurations examined by the Plan are also included.

Figure 8: Project Location Map for Focus Area A

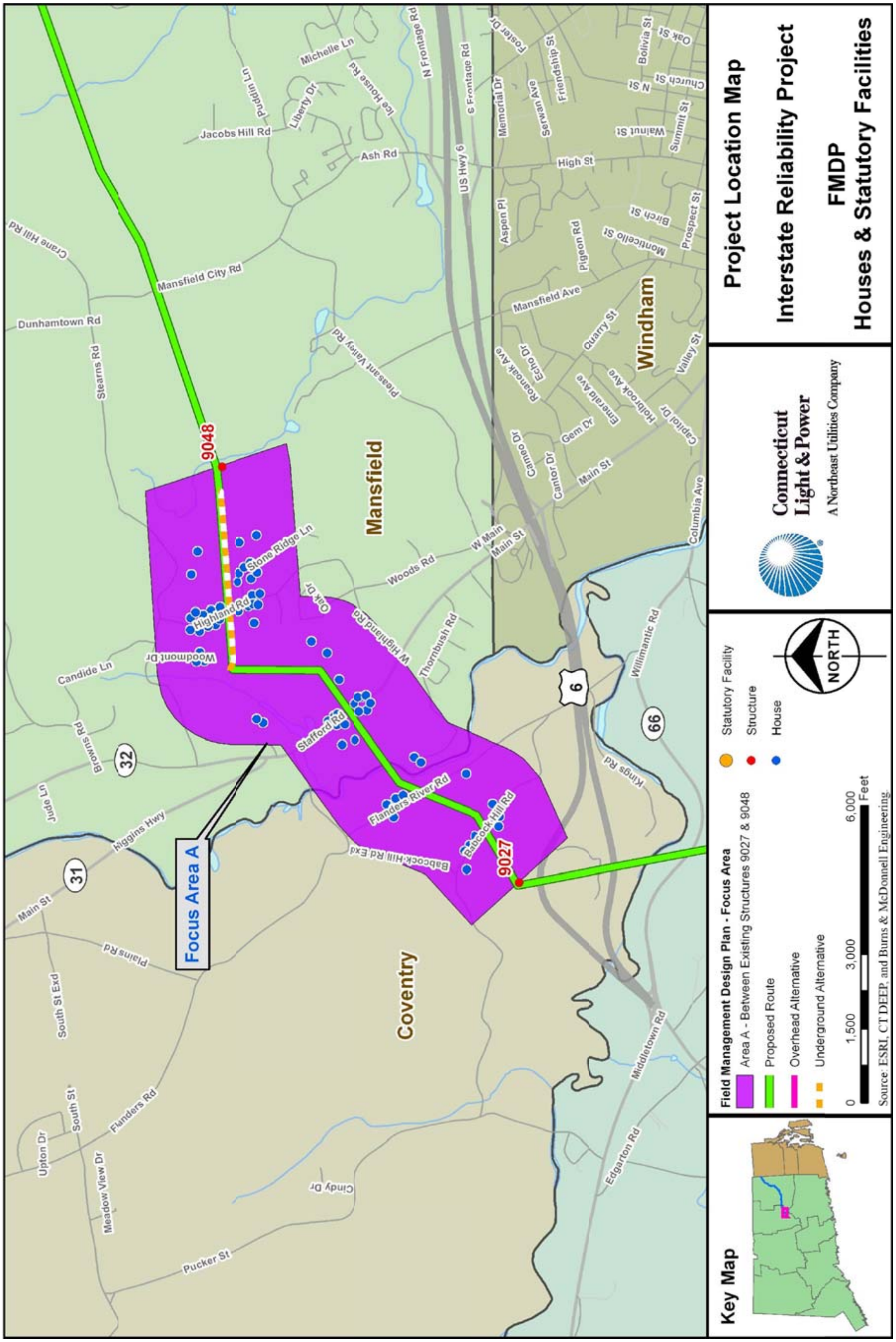


Figure 9: Project Location Map for Focus Area B

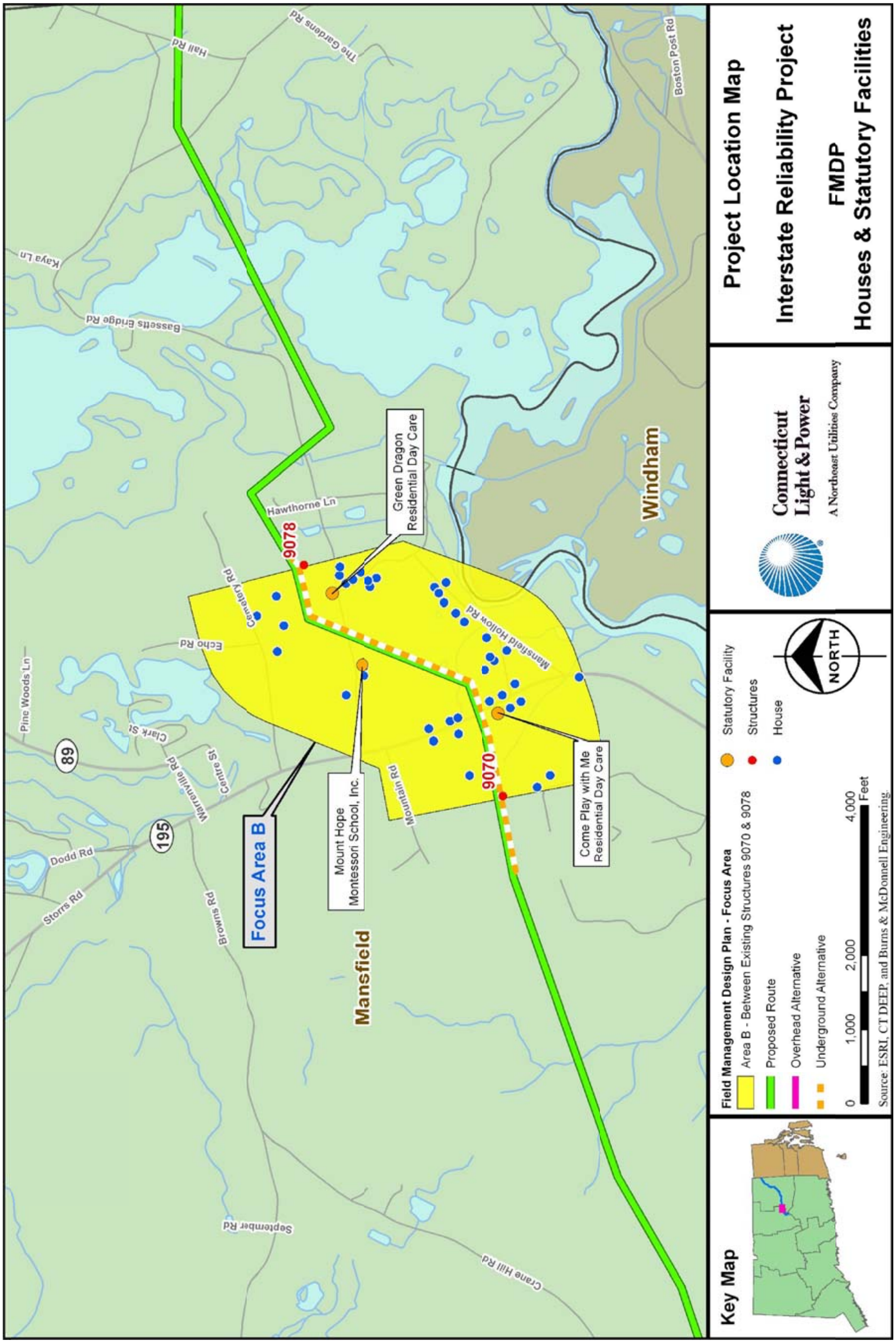


Figure 10: Project Location Map for Focus Area C

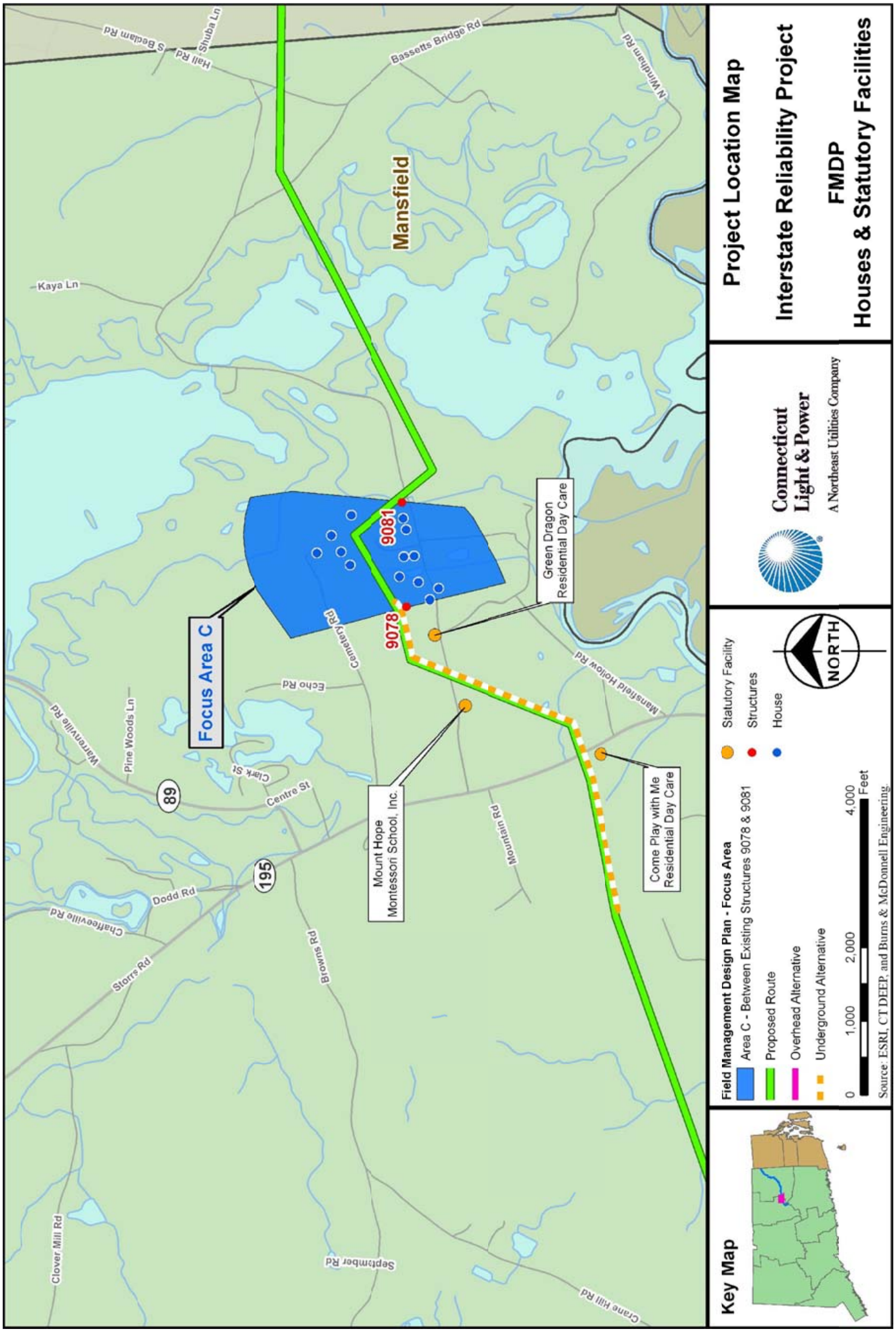
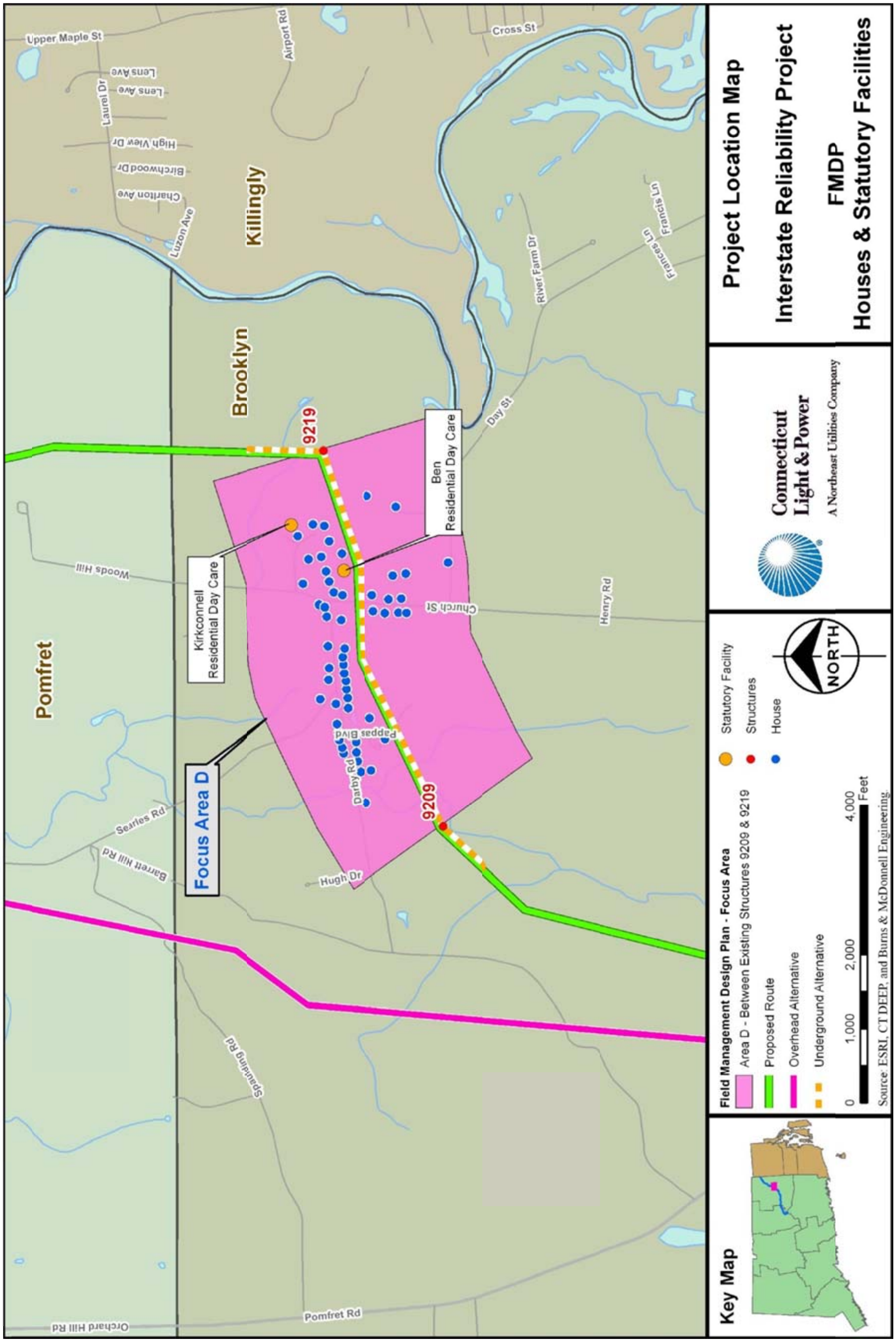


Figure 11: Project Location Map for Focus Area D



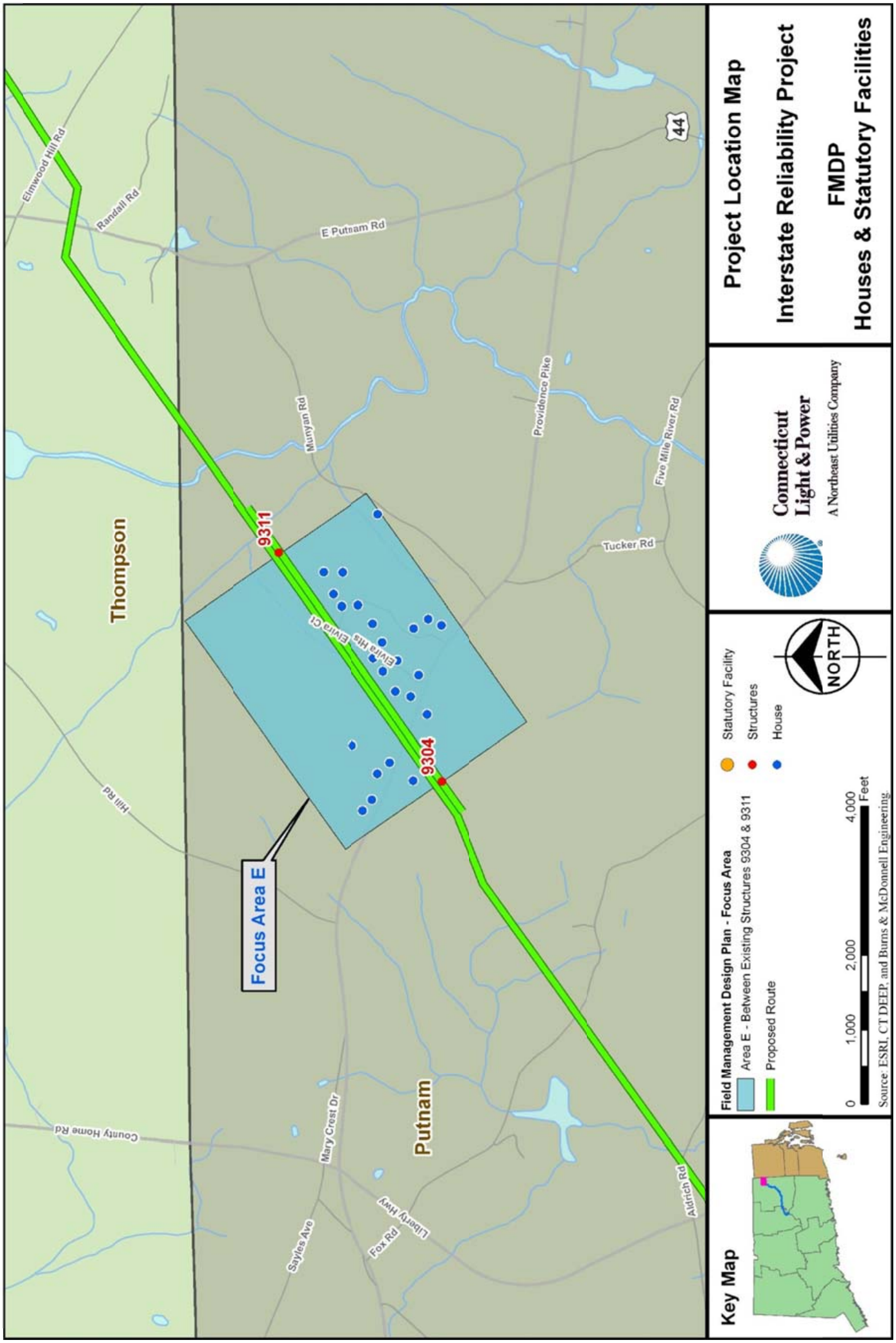


Figure 12: Project Location Map for Focus Area E

Figure 13: EMF BMP Cross Section, Proposed Configuration Base

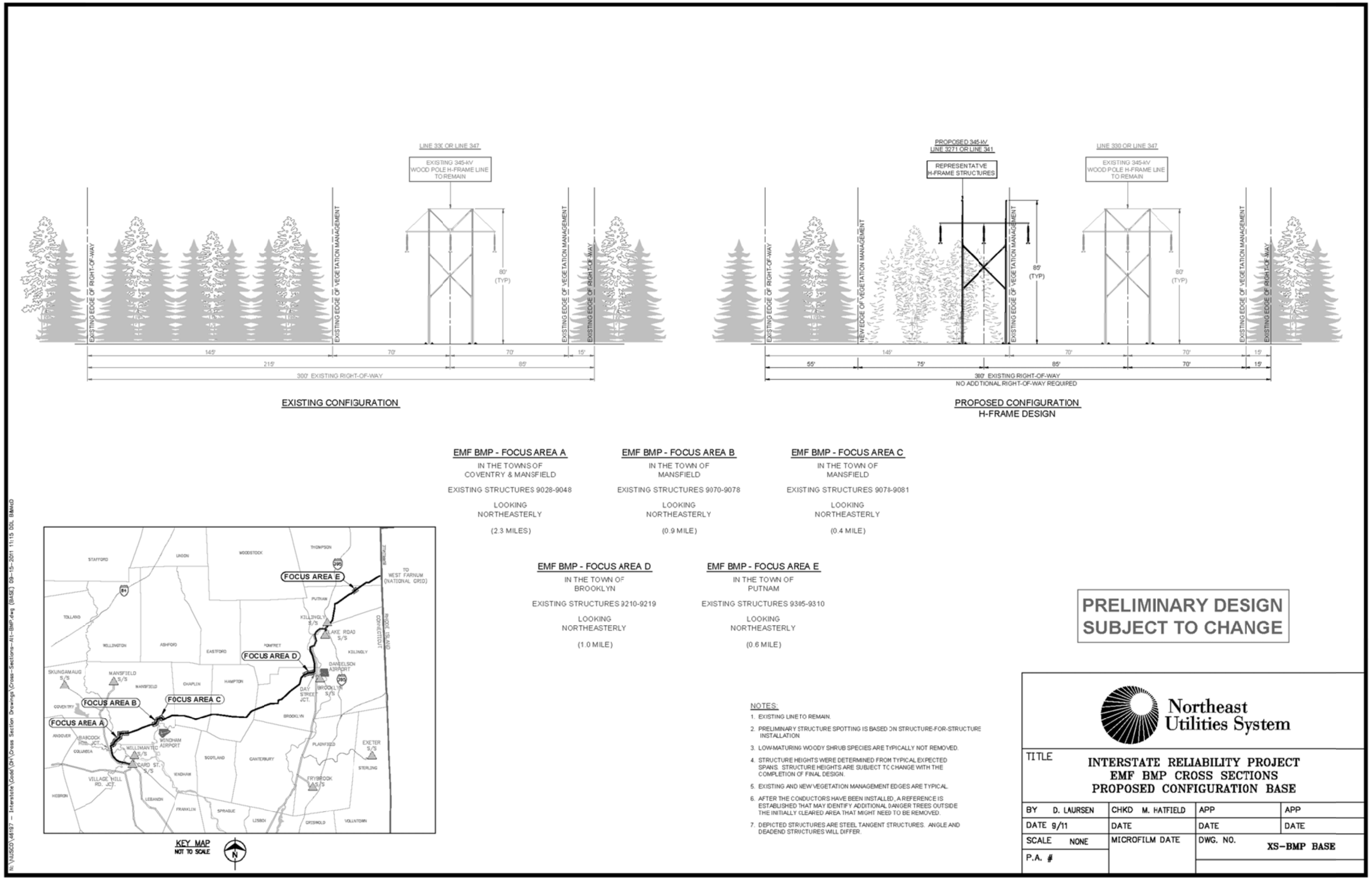


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Figure 14: EMF BMP Cross Section, Alternate Configuration 1

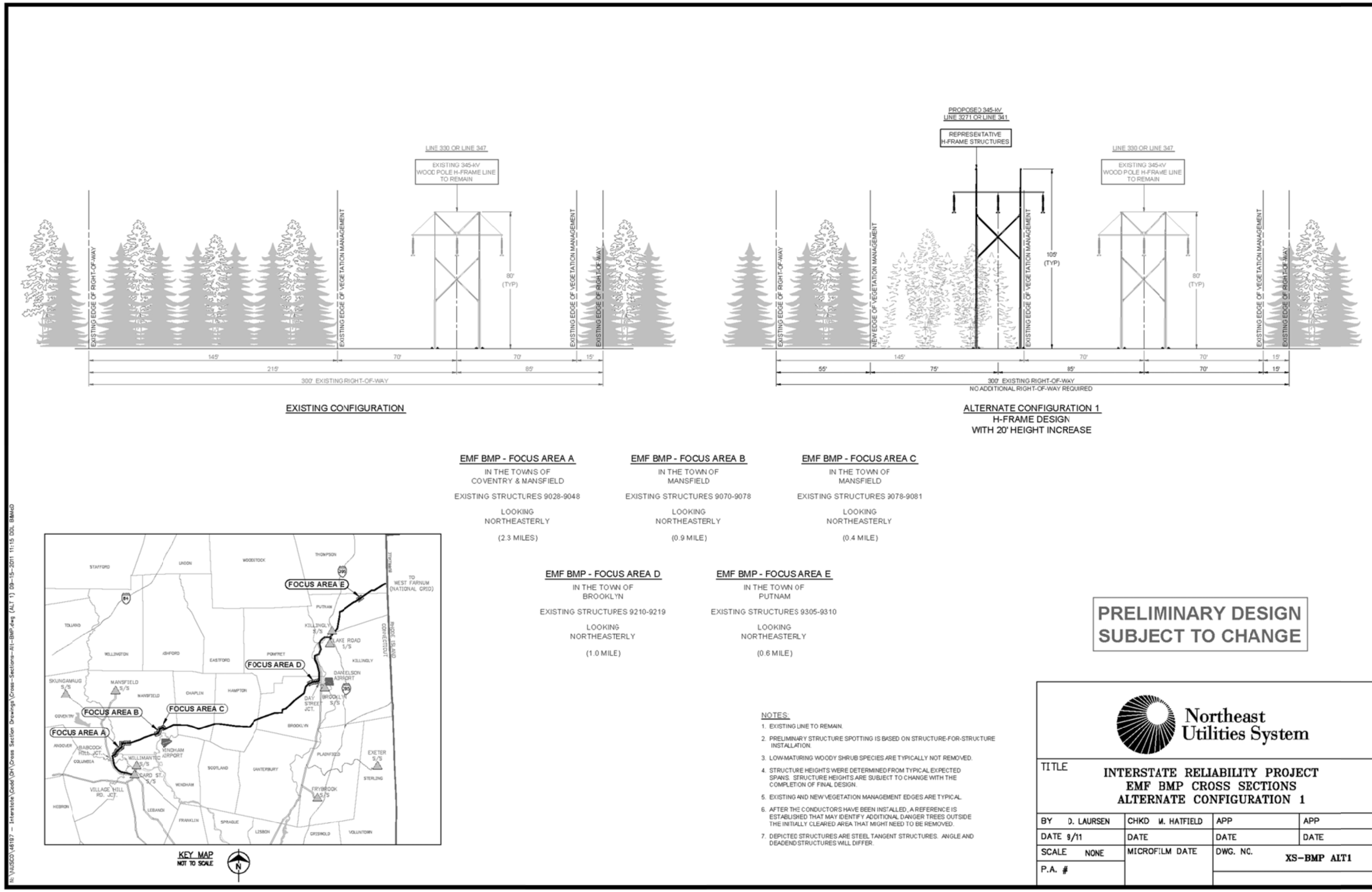

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Figure 15: EMF BMP Cross Section, Alternate Configuration 2

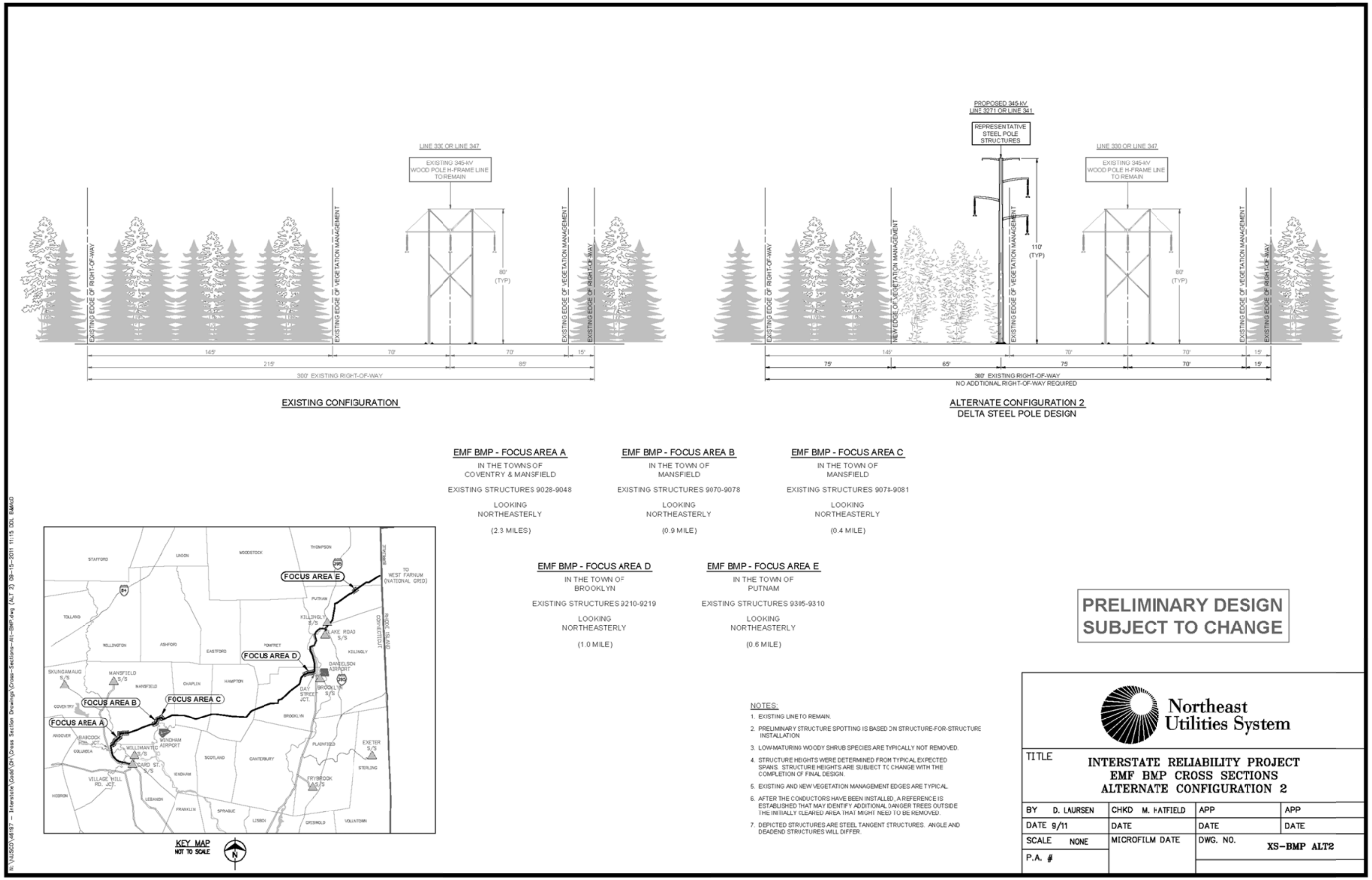

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Figure 16: EMF BMP Cross Section, Alternate Configuration 3

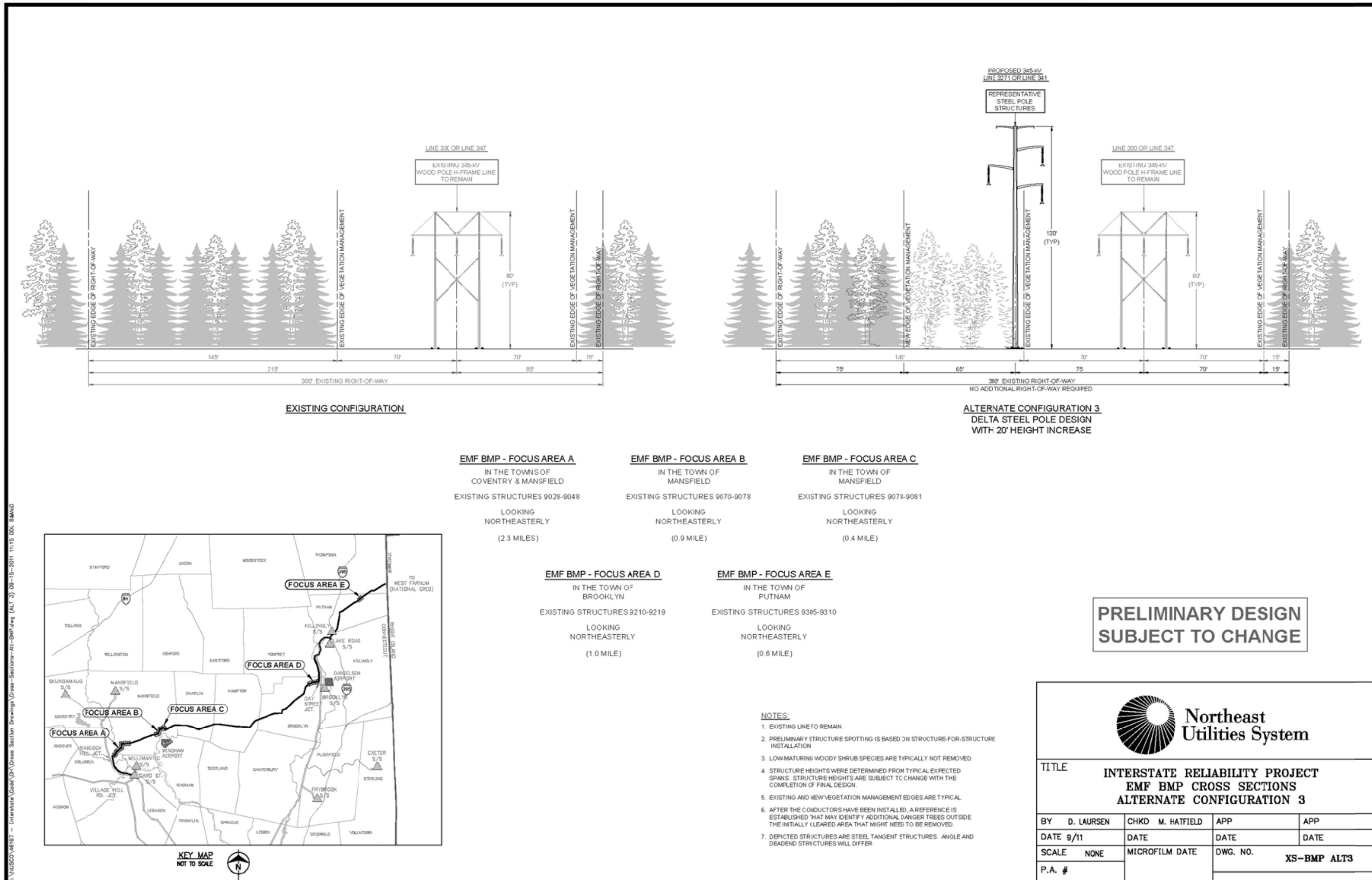

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Figure 17: EMF BMP Cross Section, Alternate Configuration 4

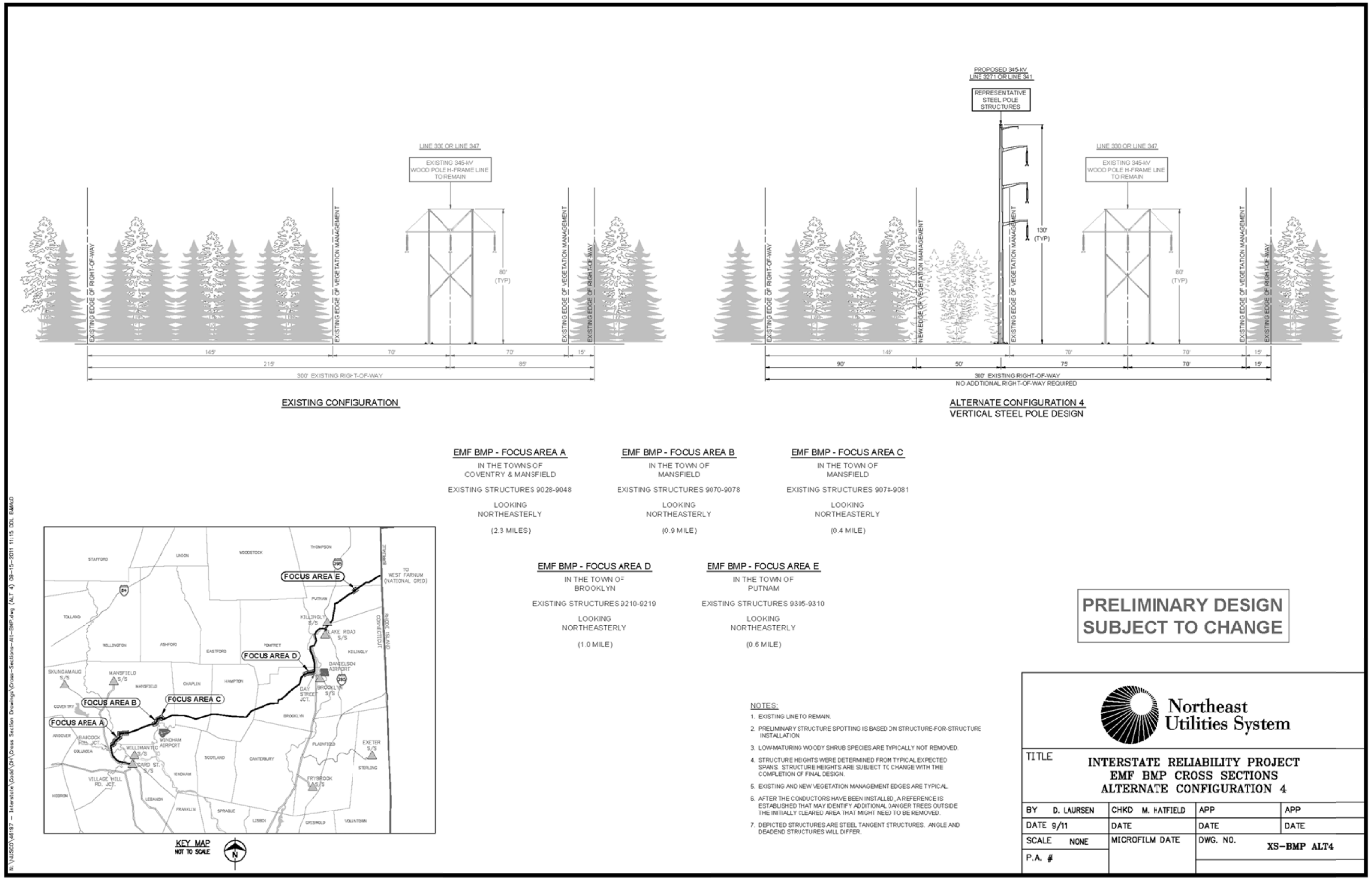

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Figure 18: EMF BMP Cross Section, Alternate Configuration 5

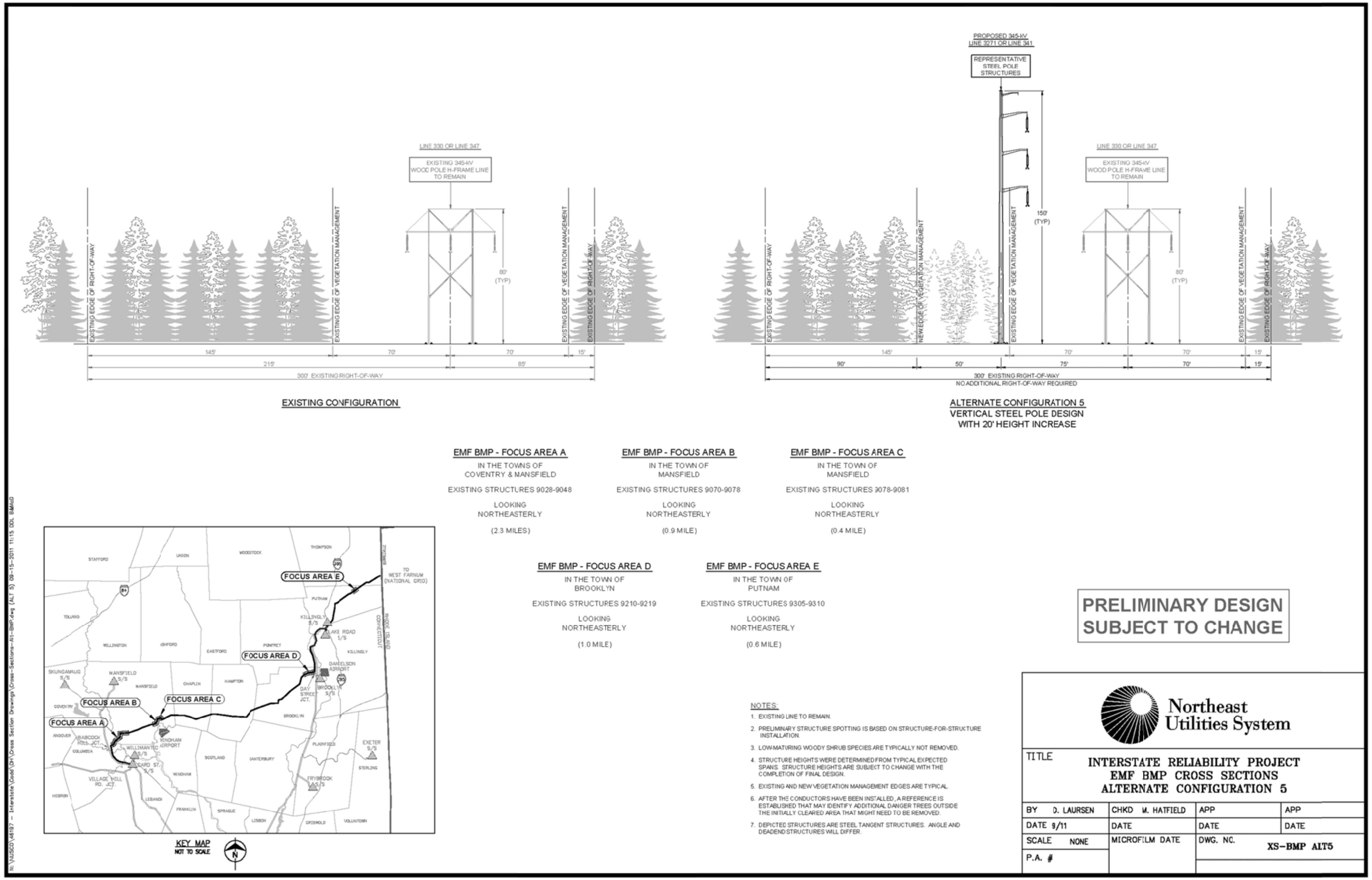

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Figure 19: EMF BMP Cross Section, Alternate Configuration 6

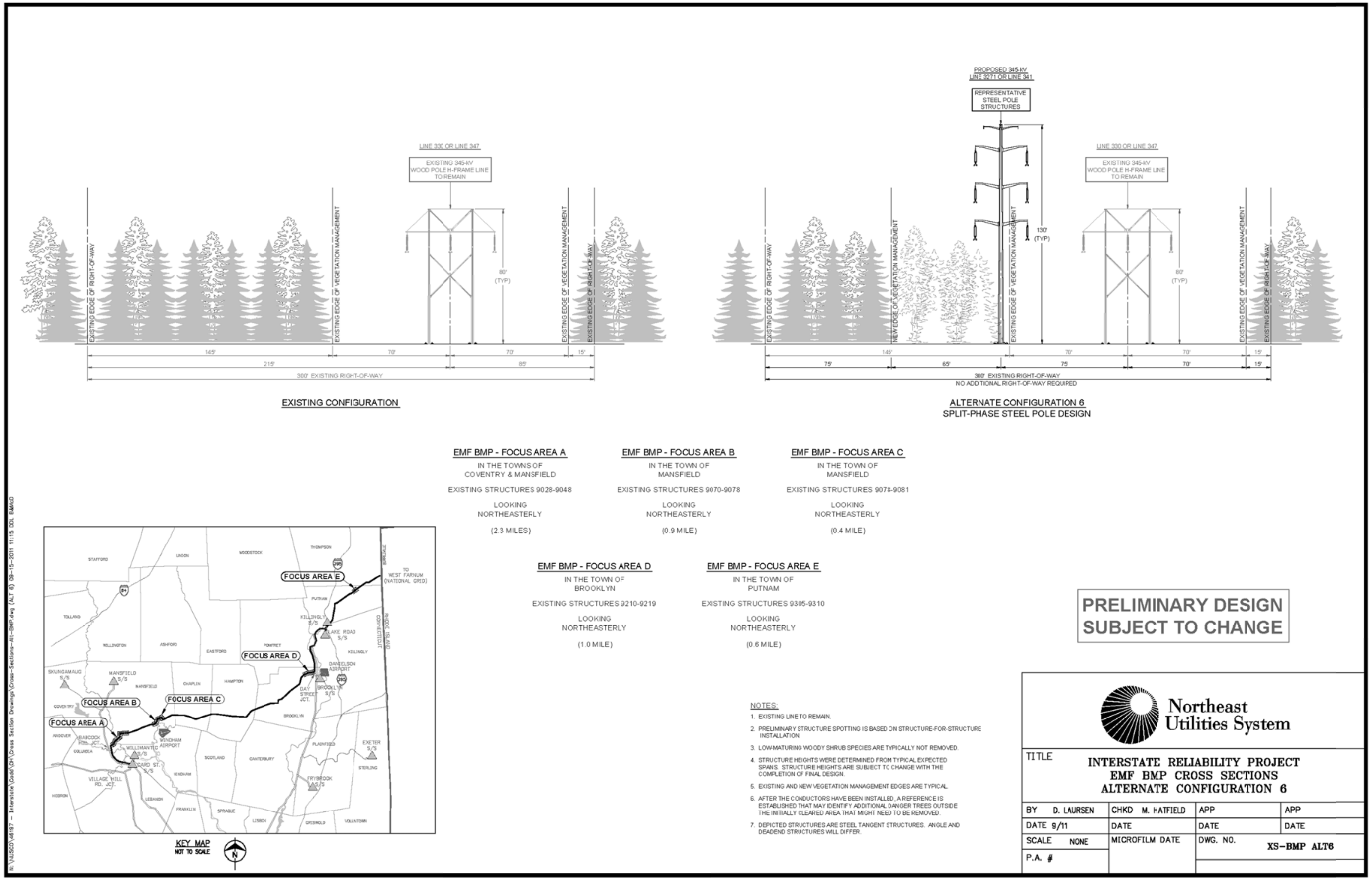

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Figure 20: EMF BMP Cross Section, Alternate Configuration 7

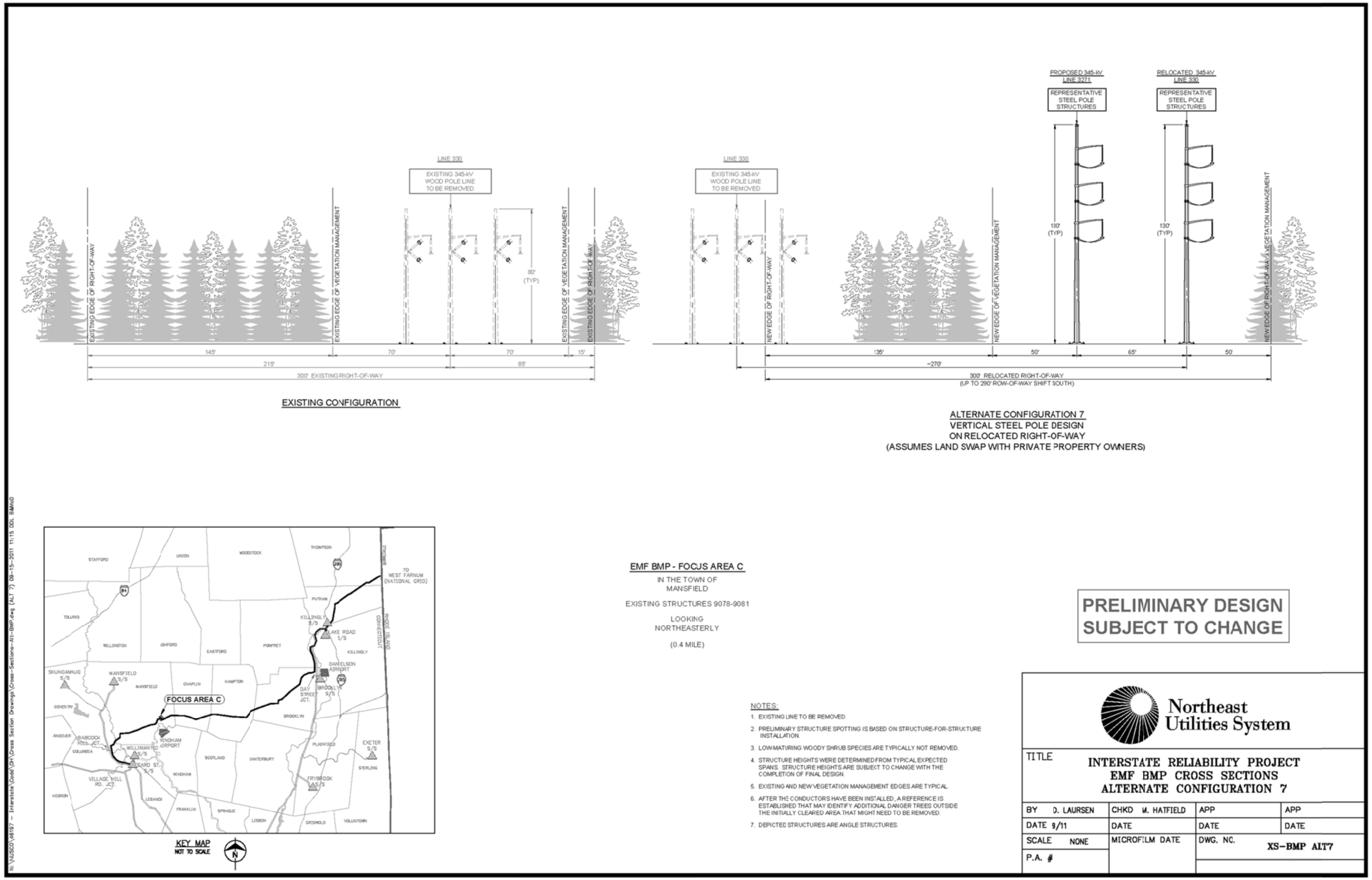

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Figure 21: EMF BMP Cross Section, Alternate Configuration 8

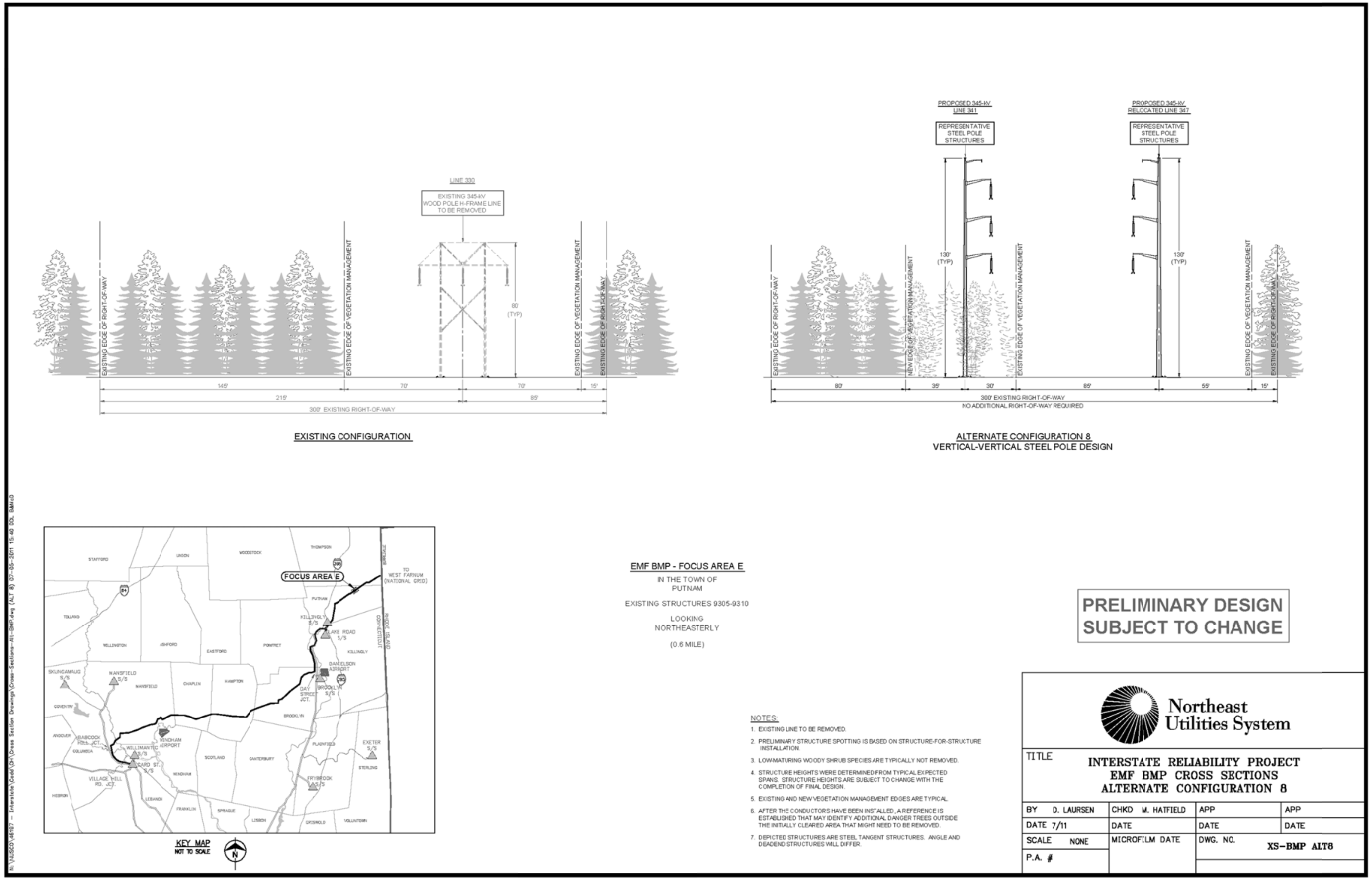

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Figure 22: EMF BMP Cross Section, Alternate Configuration 9

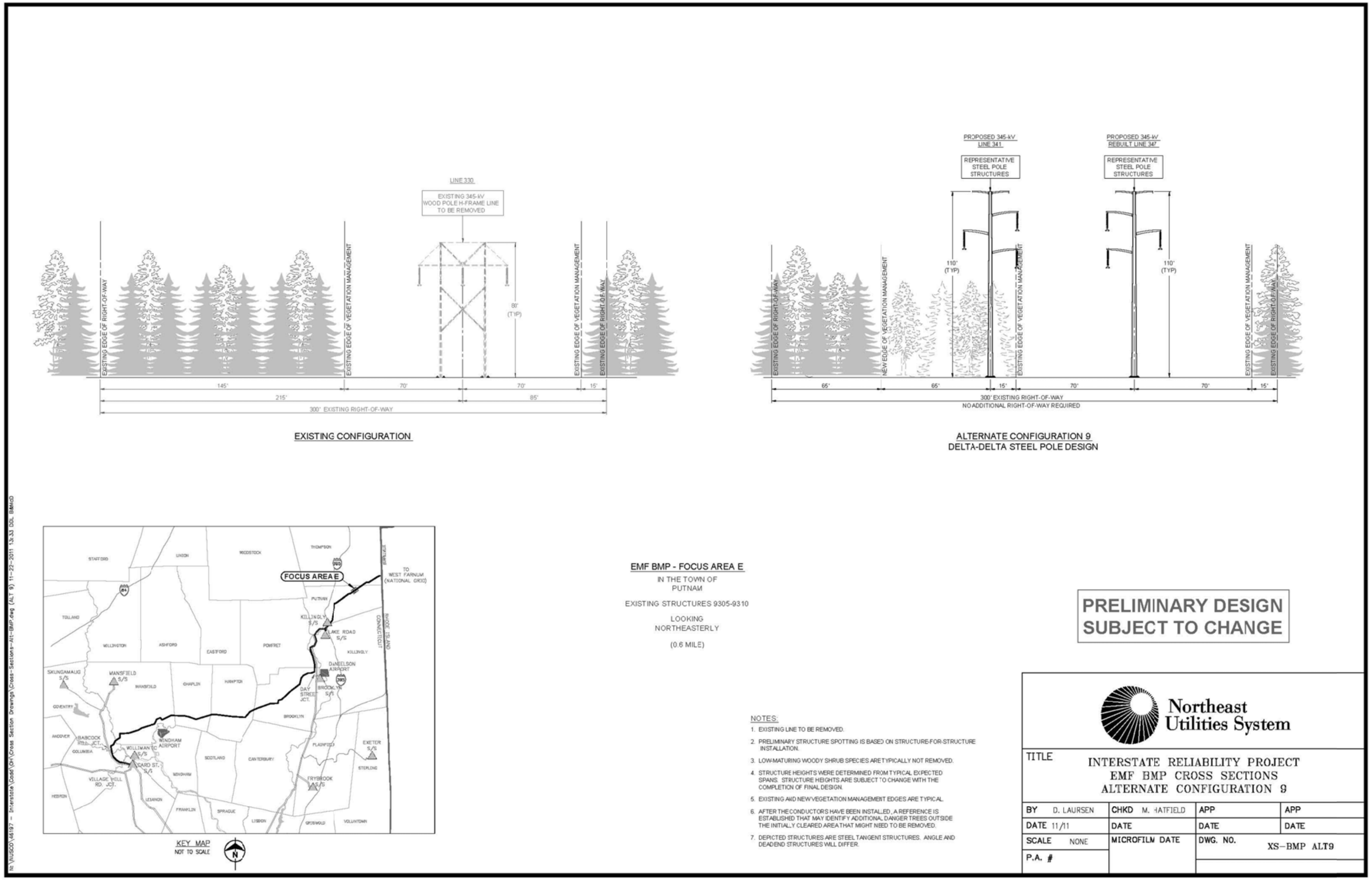

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Figure 23: EMF BMP Cross Section, Alternate Configuration 10

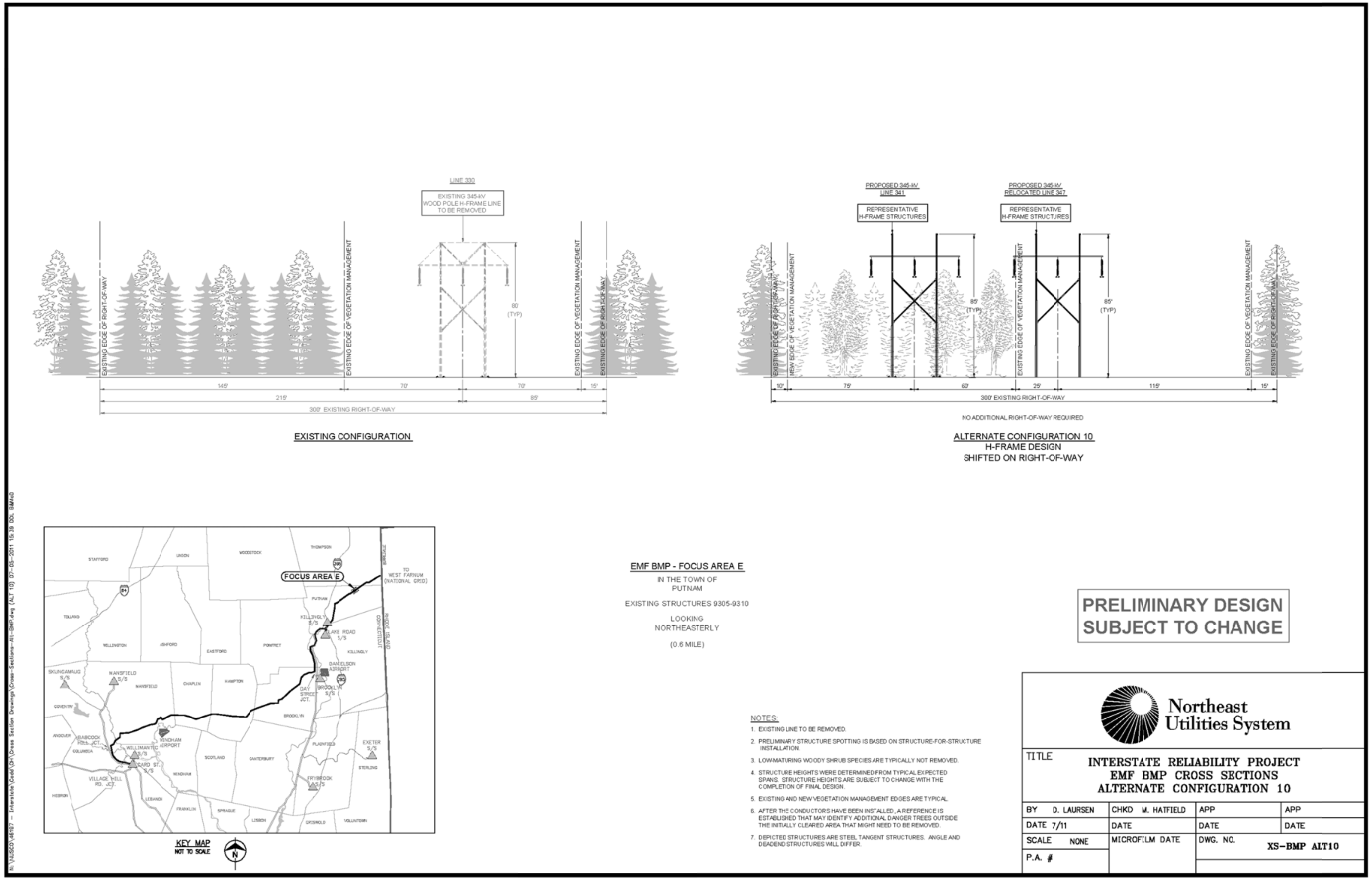

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Figure 24: EMF BMP Cross Section, Alternate Configuration 11

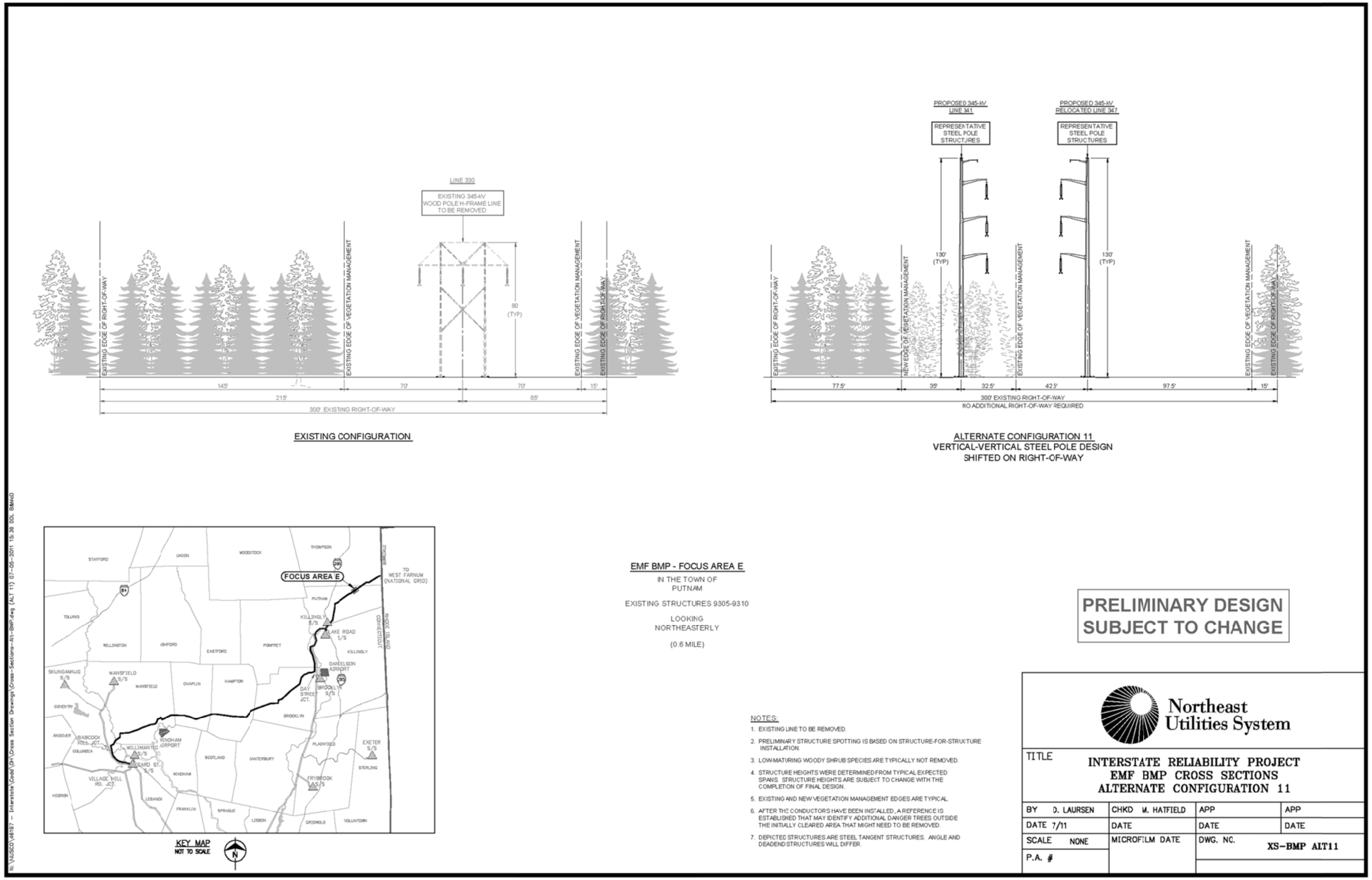

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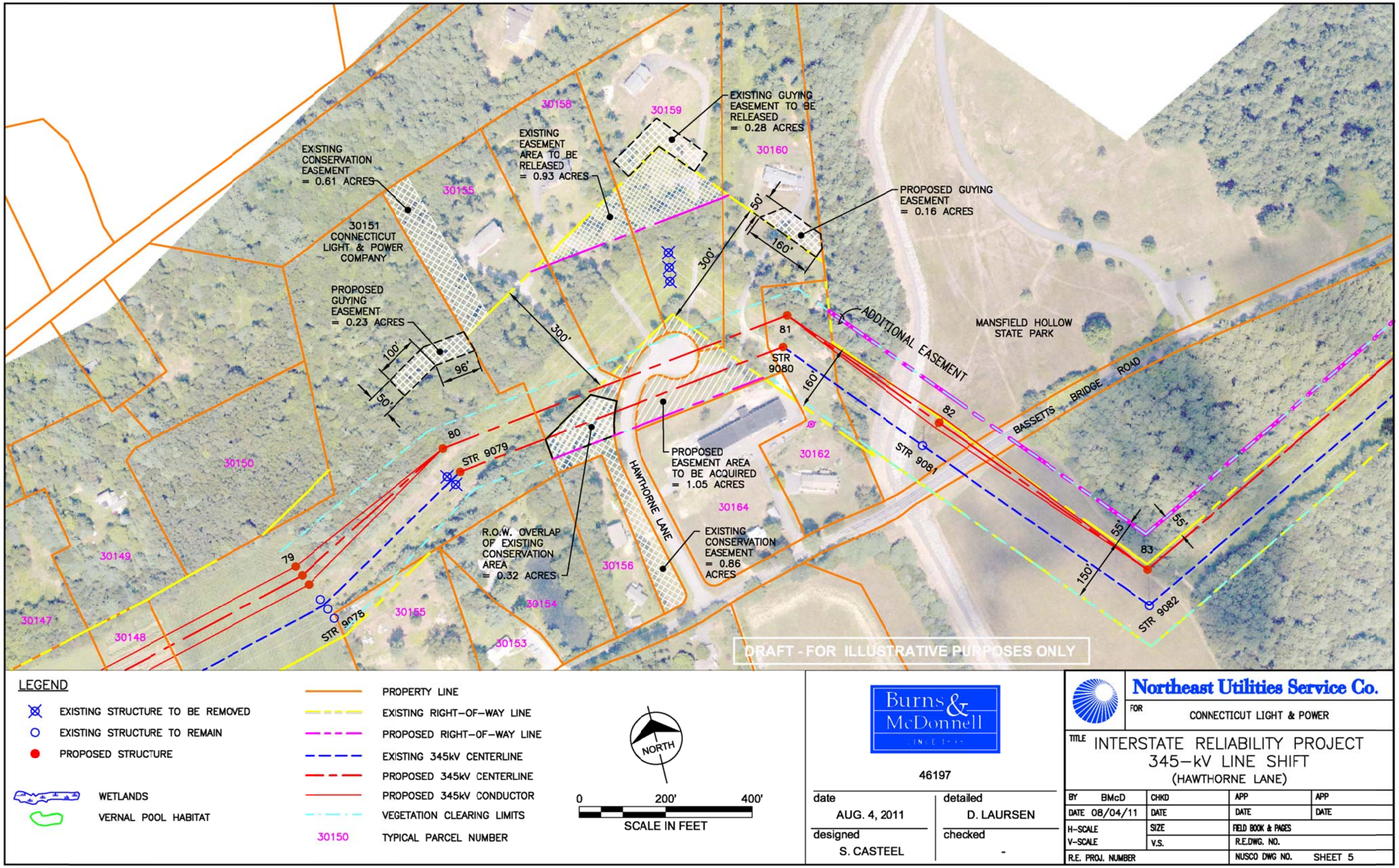
Figure 25: Focus Area C Potential ROW Shift



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Appendix 7C – Tabular Data EMF levels for Cross-Sections

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Table 1: Magnetic Field (mG) at Distances Relative to the ROW Centerline (ft) - Annual Average Load Condition (AAL)

Line Section	Configuration	-300	-275	-250	-225	-200	-175	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150	175	200	225	250	275	300	- ROW Edge	+ ROW Edge
XS-1: Card St. S/S to Babcock Hill Junction	pre-Interstate	2.0	2.4	3.0	3.9	5.2	7.6	12.0	20.8	35.4	37.3	21.2	10.5	19.6	41.2	85.7	133.9	138.6	99.6	51.7	28.2	17.3	11.6	8.3	6.2	4.9	7.6	28.2
	post-NEEWS	1.4	1.7	2.2	2.9	4.0	5.8	9.0	15.6	28.7	37.9	50.9	95.2	132.2	143.2	138.8	144.4	127.7	82.2	38.1	18.7	10.4	6.3	4.2	2.9	2.1	5.8	18.7
XS-2 BMP: Focus Area A -Babcock Hill Junction to Vicinity of Highland Rd.	pre-Interstate	1.6	1.8	2.1	2.5	3.0	3.7	4.6	5.9	7.8	10.7	15.8	25.2	45.0	87.7	133.5	137.5	98.9	51.3	28.0	17.2	11.5	8.3	6.2	4.8	3.9	4.6	28.0
	post-NEEWS	1.2	1.5	1.8	2.2	2.8	3.8	5.2	7.7	12.2	21.5	41.6	78.4	114.9	126.4	143.5	128.9	83.2	39.9	20.6	12.1	7.8	5.4	4.0	3.1	2.4	5.2	20.6
XS-2: Vicinity of Highland Rd. to Mansfield Hollow State Park	pre-Interstate	1.6	1.8	2.1	2.5	3.0	3.7	4.6	5.9	7.8	10.7	15.8	25.2	45.0	87.7	133.5	137.5	98.9	51.3	28.0	17.2	11.5	8.3	6.2	4.8	3.9	4.6	28.0
	post-NEEWS	1.0	1.3	1.7	2.3	3.2	4.7	7.2	11.9	21.9	45.6	94.9	134.2	146.9	140.9	144.2	126.7	81.5	37.7	18.4	10.2	6.2	4.1	2.8	2.0	1.5	7.2	18.4
XS-3: Mansfield Hollow State Park to Bassetts Bridge Rd.	pre-Interstate	1.5	1.8	2.1	2.5	3.1	3.9	4.9	6.6	9.1	13.3	20.8	35.3	60.9	86.8	79.3	46.4	26.1	16.0	10.6	7.5	5.6	4.3	3.4	2.7	2.3	8.8	24.7
	post-NEEWS	1.9	2.3	2.9	3.6	4.8	6.6	9.6	15.0	25.5	46.8	80.4	105.5	100.4	100.5	81.2	44.4	23.6	13.9	9.0	6.2	4.5	3.5	2.7	2.2	1.8	24.1	22.3
XS-4: Bassetts Bridge Rd. to Shuba Ln.	pre-Interstate	1.6	1.8	2.1	2.5	3.0	3.7	4.6	5.9	7.8	10.7	15.8	25.2	45.0	87.7	133.5	137.5	98.9	51.3	28.0	17.2	11.5	8.3	6.2	4.8	3.9	4.6	28.0
	post-NEEWS	1.0	1.3	1.7	2.3	3.2	4.7	7.2	11.9	21.9	45.6	94.9	134.2	146.9	140.9	144.2	126.7	81.5	37.7	18.4	10.2	6.2	4.1	2.8	2.0	1.5	7.2	18.4
XS-5: Vicinity of Shuba Ln. through Mansfield Hollow WMA to Vicinity of Willimantic Rd.	pre-Interstate	1.8	2.1	2.5	3.0	3.6	4.5	5.7	7.5	10.4	15.1	23.9	42.2	82.2	130.8	138.8	104.4	54.9	29.6	18.0	12.0	8.5	6.4	4.9	3.9	3.2	8.3	35.2
	post-NEEWS	1.3	1.7	2.3	3.1	4.5	6.9	11.3	20.5	42.2	89.3	131.8	146.7	140.8	144.8	129.4	87.1	40.8	19.6	10.7	6.5	4.2	2.9	2.1	1.5	1.2	25.1	24.1
XS-6: Willimantic Rd. to Day St. Junction	pre-Interstate	1.6	1.8	2.1	2.5	3.0	3.7	4.6	5.9	7.8	10.7	15.8	25.2	45.0	87.7	133.5	137.5	98.9	51.3	28.0	17.2	11.5	8.3	6.2	4.8	3.9	4.6	28.0
	post-NEEWS	1.0	1.3	1.7	2.3	3.2	4.7	7.2	11.9	21.9	45.6	94.9	134.2	146.9	140.9	144.2	126.7	81.5	37.7	18.4	10.2	6.2	4.1	2.8	2.0	1.5	7.2	18.4
XS-6 BMP: Focus Area D - Vicinity of Day Street Junction	pre-Interstate	1.6	1.8	2.1	2.5	3.0	3.7	4.6	5.9	7.8	10.7	15.8	25.2	45.0	87.7	133.5	137.5	98.9	51.3	28.0	17.2	11.5	8.3	6.2	4.8	3.9	4.6	28.0
	post-NEEWS	1.2	1.5	1.8	2.2	2.8	3.8	5.2	7.7	12.2	21.5	41.6	78.4	114.9	126.4	143.5	128.9	83.2	39.9	20.6	12.1	7.8	5.4	4.0	3.1	2.4	5.2	20.6
XS-7: Day St. Junction to Hartford Turnpike	pre-Interstate	2.1	2.5	3.1	3.9	5.1	6.8	9.6	14.4	23.6	43.3	86.6	135.3	144.4	112.2	78.2	58.1	22.3	50.1	47.7	20.2	7.9	3.5	1.7	0.9	0.5	6.4	16.6
	post-NEEWS	2.8	3.8	5.3	7.9	12.7	22.7	46.2	94.4	132.4	145.0	140.0	145.9	133.6	95.6	65.8	47.7	17.6	46.7	46.6	22.2	10.2	5.6	3.5	2.3	1.7	20.0	18.7
XS-8: Hartford Turnpike to Lake Rd. Junction	pre-Interstate	1.0	1.5	2.5	4.3	8.2	17.8	35.0	29.9	21.3	52.9	43.1	22.3	22.6	39.3	77.9	129.6	141.5	110.1	58.0	30.4	18.0	11.7	8.2	6.0	4.6	15.1	27.1
	post-NEEWS	3.0	3.9	5.3	7.7	12.3	21.8	34.3	20.4	27.2	38.1	8.9	66.6	121.0	144.5	142.3	147.2	133.8	93.2	43.6	20.2	10.6	6.1	3.8	2.4	1.6	19.3	17.6
XS-9: Lake Rd. Junction to Lake Rd. S/S	pre-Interstate	1.8	2.1	2.5	3.1	4.0	5.2	7.1	9.7	10.8	6.0	7.1	12.3	20.0	33.2	56.6	76.8	57.3	34.3	21.3	14.1	9.9	7.2	5.5	4.3	3.5	9.7	34.3
	post-NEEWS	1.7	2.1	2.8	3.8	5.3	7.9	12.4	20.8	32.3	29.9	16.5	15.4	33.4	65.5	81.1	72.4	41.1	19.9	10.2	5.6	3.3	2.0	1.3	0.9	0.6	20.8	19.9
XS-10: Lake Rd. S/S to Killingly S/S	pre-Interstate	2.8	3.9	5.7	9.2	17.0	31.9	29.4	15.5	44.2	40.8	20.5	11.0	7.4	6.5	8.4	14.6	21.5	21.7	16.1	8.9	5.1	3.3	2.3	1.7	1.4	17.0	5.1
	post-NEEWS	2.5	3.5	5.3	8.8	16.7	31.9	30.1	16.4	45.2	41.7	19.7	10.8	16.8	28.1	41.4	54.5	69.7	67.6	45.5	22.0	11.2	6.4	4.0	2.7	1.9	16.7	11.2
XS-11: Killingly S/S to Heritage Rd.	pre-Interstate	0.5	0.6	0.8	1.0	1.4	2.2	4.7	16.7	21.7	6.5	4.4	5.1	7.6	13.4	25.5	35.2	34.2	22.6	11.6	6.5	4.1	2.8	2.0	1.5	1.2	2.5	7.2
	post-NEEWS	0.8	1.0	1.1	1.3	1.6	2.3	4.2	15.8	25.7	10.1	12.5	25.6	40.7	60.4	87.9	111.6	104.8	66.8	33.4	18.3	11.3	7.6	5.4	4.1	3.1	2.5	20.4
XS-12: Heritage Rd. to Connecticut/Rhode Island State Border, Excluding Elvira Heights	pre-Interstate	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.5	2.0	2.8	4.1	6.5	11.6	22.6	34.3	35.4	25.4	13.2	7.2	4.4	3.0	2.1	1.6	1.2	1.0	1.2	7.2
	post-NEEWS	0.8	0.9	1.1	1.3	1.5	1.8	2.2	2.9	4.5	9.4	21.8	37.0	56.0	80.9	109.4	108.8	75.9	38.3	20.4	12.3	8.1	5.8	4.3	3.3	2.6	2.2	20.4
XS-12 BMP: Focus Area E - Vicinity of Elvira Heights	pre-Interstate	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.5	2.0	2.8	4.1	6.5	11.6	22.6	34.3	35.4	25.4	13.2	7.2	4.4	3.0	2.1	1.6	1.2	1.0	1.2	7.2
	post-NEEWS	0.7	0.8	0.9	1.0	1.2	1.4	1.8	2.4	3.7	6.7	14.2	27.0	38.7	51.8	71.9	64.1	40.2	22.5	13.3	8.5	5.8	4.2	3.2	2.5	2.0	1.8	13.3

Table 2: Magnetic Field (mG) at Distances Relative to the ROW Centerline (ft) - Annual Peak Load Condition (APL)

Line Section	Configuration	-300	-275	-250	-225	-200	-175	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150	175	200	225	250	275	300	- ROW Edge	+ ROW Edge
XS-1: Card St. S/S to Babcock Hill Junction	pre-Interstate	3.7	4.5	5.5	7.0	9.3	13.2	20.4	34.9	58.5	62.0	35.5	22.5	43.1	87.3	178.6	277.5	286.8	206.1	107.0	58.4	35.8	24.0	17.2	12.9	10.0	13.2	58.4
	post-NEEWS	2.4	3.0	3.9	5.1	7.0	10.1	15.6	27.1	50.1	66.8	92.0	174.2	242.2	262.4	254.1	264.1	233.4	150.2	69.6	34.1	18.9	11.6	7.6	5.3	3.8	10.1	34.1
XS-2 BMP: Focus Area A -Babcock Hill Junction to Vicinity of Highland Rd.	pre-Interstate	3.3	3.8	4.5	5.3	6.3	7.7	9.5	12.2	16.1	22.3	32.7	52.2	93.4	181.8	276.8	285.0	205.0	106.4	58.0	35.6	23.9	17.1	12.8	10.0	8.0	9.5	58.0
	post-NEEWS	2.3	2.7	3.3	4.1	5.2	6.9	9.5	14.0	22.4	39.3	76.0	143.4	210.2	231.1	262.4	235.8	152.1	73.0	37.6	22.1	14.3	10.0	7.3	5.6	4.4	9.5	37.6
XS-2: Vicinity of Highland Rd. to Mansfield Hollow State Park	pre-Interstate	3.3	3.8	4.5	5.3	6.3	7.7	9.5	12.2	16.1	22.3	32.7	52.2	93.4	181.8	276.8	285.0	205.0	106.4	58.0	35.6	23.9	17.1	12.8	10.0	8.0	9.5	58.0
	post-NEEWS	1.9	2.4	3.2	4.3	5.9	8.6	13.2	21.8	40.1	83.4	173.5	245.4	268.5	257.6	263.7	231.7	149.1	69.0	33.6	18.6	11.3	7.4	5.1	3.7	2.7	13.2	33.6
XS-3: Mansfield Hollow State Park to Bassetts Bridge Rd.	pre-Interstate	3.2	3.7	4.4	5.2	6.4	8.0	10.3	13.6	18.8	27.5	43.2	73.2	126.3	179.9	164.5	96.1	54.1	33.1	22.0	15.5	11.5	8.9	7.0	5.7	4.7	18.2	51.3
	post-NEEWS	3.5	4.2	5.2	6.7	8.8	12.1	17.5	27.3	46.6	85.5	147.0	192.8	183.6	183.8	148.5	81.1	43.2	25.4	16.4	11.3	8.3	6.3	5.0	4.0	3.3	44.0	40.8
XS-4: Bassetts Bridge Rd. to Shuba Ln.	pre-Interstate	3.3	3.8	4.5	5.3	6.3	7.7	9.5	12.2	16.1	22.3	32.7	52.2	93.4	181.8	276.8	285.0	205.0	106.4	58.0	35.6	23.9	17.1	12.8	10.0	8.0	9.5	58.0
	post-NEEWS	1.9	2.4	3.2	4.3	5.9	8.6	13.2	21.8	40.1	83.4	173.5	245.4	268.5	257.6	263.7	231.7	149.1	69.0	33.6	18.6	11.3	7.4	5.1	3.7	2.7	13.2	33.6
XS-5: Vicinity of Shuba Ln. through Mansfield Hollow WMA to Vicinity of Willimantic Rd.	pre-Interstate	3.8	4.4	5.2	6.2	7.5	9.3	11.9	15.6	21.5	31.4	49.6	87.6	170.5	271.1	287.8	216.5	113.8	61.3	37.2	24.8	17.7	13.2	10.2	8.2	6.7	17.1	72.9
	post-NEEWS	2.4	3.1	4.1	5.7	8.3	12.6	20.7	37.5	77.2	163.3	240.9	268.3	257.5	264.8	236.7	159.2	74.6	35.9	19.6	11.9	7.7	5.3	3.8	2.8	2.1	45.9	44.1
XS-6: Willimantic Rd. to Day St. Junction	pre-Interstate	3.3	3.8	4.5	5.3	6.3	7.7	9.5	12.2	16.1	22.3	32.7	52.2	93.4	181.8	276.8	285.0	205.0	106.4	58.0	35.6	23.9	17.1	12.8	10.0	8.0	9.5	58.0
	post-NEEWS	1.9	2.4	3.2	4.3	5.9	8.6	13.2	21.8	40.1	83.4	173.5	245.4	268.5	257.6	263.7	231.7	149.1	69.0	33.6	18.6	11.3	7.4	5.1	3.7	2.7	13.2	33.6
XS-6 BMP: Focus Area D - Vicinity of Day Street Junction	pre-Interstate	3.3	3.8	4.5	5.3	6.3	7.7	9.5	12.2	16.1	22.3	32.7	52.2	93.4	181.8	276.8	285.0	205.0	106.4	58.0	35.6	23.9	17.1	12.8	10.0	8.0	9.5	58.0
	post-NEEWS	2.3	2.7	3.3	4.1	5.2	6.9	9.5	14.0	22.4	39.3	76.0	143.4	210.2	231.1	262.4	235.8	152.1	73.0	37.6	22.1	14.3	10.0	7.3	5.6	4.4	9.5	37.6
XS-7: Day St. Junction to Hartford Turnpike	pre-Interstate	4.5	5.5	6.7	8.4	10.9	14.6	20.5	30.6	49.7	90.6	180.1	279.8	295.8	225.1	146.8	101.8	42.9	86.4	77.7	30.7	10.7	3.9	1.5	1.0	1.1	13.7	24.7
	post-NEEWS	5.0	6.7	9.5	14.2	22.9	41.2	84.2	172.8	242.8	265.6	256.2	266.5	241.9	169.4	109.1	73.8	29.5	74.5	71.8	33.3	14.9	8.0	4.9	3.2	2.3	36.3	28.0
XS-8: Hartford Turnpike to Lake Rd. Junction	pre-Interstate	1.0	1.6	2.9	5.6	11.4	26.1	53.3	46.1	35.0	88.3	72.1	40.0	46.2	81.5	161.1	267.9	292.5	228.0	120.6	63.5	37.7	24.6	17.2	12.7	9.7	22.0	56.7
	post-NEEWS	4.7	6.1	8.3	11.9	18.6	32.6	49.1	26.9	45.0	56.4	23.8	127.7	223.7	264.4	259.9	268.7	244.1	170.1	79.9	37.2	19.6	11.4	7.1	4.7	3.2	28.9	32.4
XS-9: Lake Rd. Junction to Lake Rd. S/S	pre-Interstate	1.1	1.2	1.3	1.6	2.4	4.5	9.2	19.5	37.5	43.1	35.6	36.1	47.8	74.1	122.0	162.2	119.1	70.1	42.7	27.8	19.2	13.9	10.5	8.1	6.5	19.5	70.1
	post-NEEWS	4.3	5.5	7.1	9.4	13.1	19.1	29.6	48.0	70.9	58.3	23.6	10.0	51.4	117.7	151.8	135.7	76.3	36.4	18.2	9.7	5.5	3.2	2.0	1.2	0.8	48.0	36.4
XS-10: Lake Rd. S/S to Killingly S/S	pre-Interstate	3.7	5.2	7.9	13.2	25.0	48.1	45.1	24.3	72.5	67.4	32.2	15.5	9.2	10.0	18.4	37.5	57.8	59.2	41.4	20.6	10.7	6.2	4.0	2.7	1.9	25.0	10.7
	post-NEEWS	3.0	4.4	6.8	11.8	23.2	45.7	44.0	24.7	73.4	68.5	31.9	15.8	14.2	22.9	43.3	86.4	132.3	136.0	96.7	49.3	26.4	15.9	10.4	7.3	5.4	23.2	26.4
XS-11: Killingly S/S to Heritage Rd.	pre-Interstate	1.4	1.7	2.0	2.4	3.1	4.3	7.7	25.4	38.5	15.2	12.9	16.5	25.4	45.7	87.2	120.7	117.0	76.9	39.5	22.1	13.9	9.4	6.8	5.2	4.1	4.7	24.6
	post-NEEWS	2.2	2.5	3.0	3.5	4.4	5.7	8.9	25.3	42.7	20.1	19.3	25.9	40.7	73.7	141.1	195.6	189.7	124.6	64.0	35.8	22.4	15.3	11.1	8.4	6.6	6.1	39.8
XS-12: Heritage Rd. to Connecticut/Rhode Island State Border, Excluding Elvira Heights	pre-Interstate	1.4	1.6	1.9	2.2	2.7	3.2	4.0	5.2	6.8	9.4	13.8	22.1	39.5	77.0	117.2	120.7	86.8	45.1	24.6	15.1	10.1	7.3	5.4	4.2	3.4	4.0	24.6
	post-NEEWS	2.3	2.6	3.1	3.6	4.3	5.3	6.5	8.4	11.1	15.3	22.4	35.8	64.1	124.8	190.0	195.7	140.7	73.0	39.8	24.5	16.4	11.7	8.8	6.9	5.5	6.5	39.8
XS-12 BMP: Focus Area E - Vicinity of Elvira Heights	pre-Interstate	1.4	1.6	1.9	2.2	2.7	3.2	4.0	5.2	6.8	9.4	13.8	22.1	39.5	77.0	117.2	120.7	86.8	45.1	24.6	15.1	10.1	7.3	5.4	4.2	3.4	4.0	24.6
	post-NEEWS	0.7	0.8	0.8	0.9	1.0	1.1	1.4	2.4	5.2	12.2	29.0	57.1	81.9	102.7	133.6	116.0	71.5	39.5	23.0	14.5	9.9	7.1	5.3	4.1	3.3	1.4	23.0

Table 3: Magnetic Field (mG) at Distances Relative to the ROW Centerline (ft) - Peak Daily Average Load Condition (PDAL)

Line Section	Configuration	-300	-275	-250	-225	-200	-175	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150	175	200	225	250	275	300	- ROW Edge	+ ROW Edge
XS-1: Card St. S/S to Babcock Hill Junction	pre-Interstate	2.9	3.4	4.2	5.4	7.3	10.4	16.2	27.8	46.9	49.8	28.4	16.5	31.6	64.8	133.2	207.4	214.4	154.1	80.0	43.7	26.8	18.0	12.9	9.7	7.5	10.4	43.7
	post-NEEWS	1.9	2.4	3.0	4.0	5.5	7.9	12.4	21.7	40.0	52.0	67.3	124.4	172.3	186.5	180.8	188.3	166.5	107.2	49.7	24.3	13.5	8.3	5.4	3.8	2.7	7.9	24.3
XS-2 BMP: Focus Area A -Babcock Hill Junction to Vicinity of Highland Rd.	pre-Interstate	2.5	2.9	3.3	3.9	4.7	5.7	7.1	9.1	12.0	16.6	24.4	39.0	69.8	135.8	206.8	213.0	153.1	79.5	43.4	26.6	17.9	12.8	9.6	7.5	6.0	7.1	43.4
	post-NEEWS	1.6	1.9	2.3	2.9	3.7	4.9	6.8	10.0	15.9	28.0	54.2	102.2	149.9	164.8	187.1	168.1	108.4	52.1	26.8	15.7	10.2	7.1	5.2	4.0	3.1	6.8	26.8
XS-2: Vicinity of Highland Rd. to Mansfield Hollow State Park	pre-Interstate	2.5	2.9	3.3	3.9	4.7	5.7	7.1	9.1	12.0	16.6	24.4	39.0	69.8	135.8	206.8	213.0	153.1	79.5	43.4	26.6	17.9	12.8	9.6	7.5	6.0	7.1	43.4
	post-NEEWS	1.4	1.7	2.3	3.0	4.2	6.1	9.4	15.6	28.6	59.5	123.8	175.0	191.5	183.7	188.0	165.2	106.3	49.2	24.0	13.3	8.1	5.3	3.6	2.6	1.9	9.4	24.0
XS-3: Mansfield Hollow State Park to Bassetts Bridge Rd.	pre-Interstate	2.4	2.8	3.3	3.9	4.8	6.0	7.7	10.2	14.1	20.6	32.3	54.7	94.3	134.4	122.9	71.8	40.4	24.7	16.4	11.6	8.6	6.6	5.2	4.3	3.5	13.6	38.3
	post-NEEWS	2.5	3.0	3.7	4.8	6.3	8.6	12.5	19.5	33.3	61.0	104.8	137.5	130.9	131.0	105.8	57.9	30.8	18.1	11.7	8.1	5.9	4.5	3.6	2.9	2.4	31.4	29.1
XS-4: Bassetts Bridge Rd. to Shuba Ln.	pre-Interstate	2.5	2.9	3.3	3.9	4.7	5.7	7.1	9.1	12.0	16.6	24.4	39.0	69.8	135.8	206.8	213.0	153.1	79.5	43.4	26.6	17.9	12.8	9.6	7.5	6.0	7.1	43.4
	post-NEEWS	1.4	1.7	2.3	3.0	4.2	6.1	9.4	15.6	28.6	59.5	123.8	175.0	191.5	183.7	188.0	165.2	106.3	49.2	24.0	13.3	8.1	5.3	3.6	2.6	1.9	9.4	24.0
XS-5: Vicinity of Shuba Ln. through Mansfield Hollow WMA to Vicinity of Willimantic Rd.	pre-Interstate	2.8	3.3	3.9	4.6	5.6	7.0	8.9	11.7	16.1	23.4	37.0	65.4	127.4	202.6	215.0	161.7	85.0	45.8	27.8	18.5	13.2	9.9	7.6	6.1	5.0	12.8	54.5
	post-NEEWS	1.7	2.2	2.9	4.1	5.9	9.0	14.7	26.7	55.0	116.5	171.8	191.3	183.6	188.8	168.7	113.5	53.2	25.6	14.0	8.5	5.5	3.8	2.7	2.0	1.5	32.8	31.5
XS-6: Willimantic Rd. to Day St. Junction	pre-Interstate	2.5	2.9	3.3	3.9	4.7	5.7	7.1	9.1	12.0	16.6	24.4	39.0	69.8	135.8	206.8	213.0	153.1	79.5	43.4	26.6	17.9	12.8	9.6	7.5	6.0	7.1	43.4
	post-NEEWS	1.4	1.7	2.3	3.0	4.2	6.1	9.4	15.6	28.6	59.5	123.8	175.0	191.5	183.7	188.0	165.2	106.3	49.2	24.0	13.3	8.1	5.3	3.6	2.6	1.9	9.4	24.0
XS-6 BMP: Focus Area D - Vicinity of Day Street Junction	pre-Interstate	2.5	2.9	3.3	3.9	4.7	5.7	7.1	9.1	12.0	16.6	24.4	39.0	69.8	135.8	206.8	213.0	153.1	79.5	43.4	26.6	17.9	12.8	9.6	7.5	6.0	7.1	43.4
	post-NEEWS	1.6	1.9	2.3	2.9	3.7	4.9	6.8	10.0	15.9	28.0	54.2	102.2	149.9	164.8	187.1	168.1	108.4	52.1	26.8	15.7	10.2	7.1	5.2	4.0	3.1	6.8	26.8
XS-7: Day St. Junction to Hartford Turnpike	pre-Interstate	3.3	4.0	4.9	6.2	8.0	10.8	15.1	22.6	36.8	67.4	134.4	209.2	222.3	170.9	115.0	82.7	32.8	70.8	65.8	27.0	10.0	4.1	1.8	0.9	0.7	10.1	22.0
	post-NEEWS	3.6	4.9	6.9	10.3	16.5	29.5	60.2	123.1	172.8	189.1	182.5	190.2	173.7	123.4	83.0	58.8	22.4	60.3	59.5	28.1	12.8	6.9	4.3	2.9	2.1	26.0	23.7
XS-8: Hartford Turnpike to Lake Rd. Junction	pre-Interstate	1.1	1.8	3.0	5.4	10.5	23.3	46.5	39.8	29.1	73.7	60.1	32.1	34.8	60.9	120.5	200.4	218.9	170.5	90.0	47.3	28.0	18.3	12.8	9.4	7.2	19.7	42.2
	post-NEEWS	3.7	4.9	6.6	9.6	15.2	26.8	41.4	23.3	35.4	48.6	12.6	87.6	158.1	188.4	185.5	191.9	174.4	121.4	56.9	26.4	13.8	8.0	4.9	3.2	2.2	23.7	23.0
XS-9: Lake Rd. Junction to Lake Rd. S/S	pre-Interstate	0.5	0.6	0.9	1.5	2.8	5.2	10.2	20.4	37.3	40.9	31.8	29.7	37.2	56.5	92.2	121.9	89.0	52.1	31.6	20.5	14.1	10.2	7.6	5.9	4.7	20.4	52.1
	post-NEEWS	3.4	4.3	5.6	7.5	10.4	15.2	23.6	38.4	57.0	47.7	20.6	5.6	35.6	83.8	108.8	97.4	54.5	25.8	12.8	6.7	3.7	2.2	1.3	0.8	0.5	38.4	25.8
XS-10: Lake Rd. S/S to Killingly S/S	pre-Interstate	3.1	4.4	6.8	11.4	21.8	42.3	40.2	20.4	62.2	58.1	27.6	13.2	8.2	10.3	19.5	39.7	61.0	62.4	43.8	22.0	11.5	6.8	4.3	3.0	2.1	21.8	11.5
	post-NEEWS	2.5	3.7	5.8	9.9	19.5	38.5	37.1	20.2	60.9	56.8	26.5	13.0	11.4	18.2	34.6	69.3	106.0	108.9	77.3	39.4	21.1	12.6	8.3	5.8	4.3	19.5	21.1
XS-11: Killingly S/S to Heritage Rd.	pre-Interstate	1.3	1.6	1.8	2.2	2.8	3.8	6.5	20.0	31.0	13.2	11.9	15.6	24.3	43.8	83.8	116.1	112.6	74.0	38.0	21.3	13.3	9.1	6.6	5.0	3.9	4.2	23.7
	post-NEEWS	1.8	2.1	2.4	2.9	3.6	4.7	7.2	20.2	33.9	16.2	15.7	21.1	33.3	60.2	115.3	159.8	155.1	101.9	52.3	29.3	18.3	12.5	9.0	6.8	5.4	5.0	32.6
XS-12: Heritage Rd. to Connecticut/Rhode Island State Border, Excluding Elvira Heights	pre-Interstate	1.4	1.6	1.8	2.1	2.6	3.1	3.9	5.0	6.6	9.1	13.3	21.3	38.1	74.1	112.8	116.2	83.5	43.4	23.7	14.5	9.7	7.0	5.2	4.1	3.3	3.9	23.7
	post-NEEWS	1.9	2.1	2.5	2.9	3.5	4.3	5.3	6.8	9.0	12.5	18.3	29.3	52.4	102.0	155.3	159.9	115.0	59.7	32.6	20.0	13.4	9.6	7.2	5.6	4.5	5.3	32.6
XS-12 BMP: Focus Area E - Vicinity of Elvira Heights	pre-Interstate	1.4	1.6	1.8	2.1	2.6	3.1	3.9	5.0	6.6	9.1	13.3	21.3	38.1	74.1	112.8	116.2	83.5	43.4	23.7	14.5	9.7	7.0	5.2	4.1	3.3	3.9	23.7
	post-NEEWS	0.7	0.8	0.9	1.0	1.1	1.3	1.6	2.3	4.2	9.4	22.1	43.7	63.4	81.6	108.7	95.3	59.1	32.8	19.2	12.2	8.3	6.0	4.5	3.5	2.8	1.6	19.2

Table 4: Electric Field (kV/m) at Distances Relative to the ROW Centerline (ft)

Line Section	Configuration	-300	-275	-250	-225	-200	-175	-150	-125	-100	-75	-50	-25	0	25	50	75	100	125	150	175	200	225	250	275	300	- ROW Edge	+ ROW Edge
XS-1: Card St. S/S to Babcock Hill Junction	pre-Interstate	0.03	0.03	0.04	0.05	0.06	0.06	0.05	0.11	0.75	1.16	0.33	0.43	1.02	2.25	4.55	3.60	3.14	4.85	2.65	1.20	0.60	0.34	0.21	0.14	0.10	0.06	1.20
	post-NEEWS	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.17	0.78	1.31	2.73	4.81	2.84	5.38	7.52	4.36	2.95	4.79	2.62	1.18	0.59	0.33	0.20	0.13	0.09	0.06	1.18
XS-2 BMP: Focus Area A -Babcock Hill Junction to Vicinity of Highland Rd.	pre-Interstate	0.02	0.02	0.03	0.04	0.05	0.06	0.09	0.13	0.19	0.30	0.53	1.03	2.25	4.55	3.60	3.15	4.85	2.65	1.20	0.60	0.34	0.21	0.14	0.09	0.07	0.09	1.20
	post-NEEWS	0.05	0.06	0.08	0.10	0.14	0.19	0.28	0.45	0.78	1.42	2.46	2.56	5.21	6.81	4.18	3.16	4.82	2.64	1.21	0.62	0.36	0.23	0.16	0.12	0.09	0.28	1.21
XS-2: Vicinity of Highland Rd. to Mansfield Hollow State Park	pre-Interstate	0.02	0.02	0.03	0.04	0.05	0.06	0.09	0.13	0.19	0.30	0.53	1.03	2.25	4.55	3.60	3.15	4.85	2.65	1.20	0.60	0.34	0.21	0.14	0.09	0.07	0.09	1.20
	post-NEEWS	0.05	0.06	0.08	0.11	0.16	0.24	0.39	0.70	1.42	3.16	4.98	2.85	5.35	7.51	4.35	2.96	4.80	2.63	1.19	0.60	0.34	0.21	0.14	0.10	0.08	0.39	1.19
XS-3: Mansfield Hollow State Park to Bassetts Bridge Rd.	pre-Interstate	0.03	0.04	0.05	0.06	0.08	0.11	0.15	0.22	0.34	0.57	1.03	1.90	2.73	2.53	4.15	2.02	0.92	0.52	0.33	0.22	0.15	0.11	0.09	0.07	0.05	0.33	0.87
	post-NEEWS	0.07	0.09	0.12	0.16	0.22	0.32	0.50	0.86	1.56	2.61	2.60	5.17	4.94	3.08	4.27	2.11	0.99	0.57	0.36	0.25	0.18	0.13	0.10	0.08	0.07	1.47	0.93
XS-4: Bassetts Bridge Rd. to Shuba Ln.	pre-Interstate	0.02	0.02	0.03	0.04	0.05	0.06	0.09	0.13	0.19	0.30	0.53	1.03	2.25	4.55	3.60	3.15	4.85	2.65	1.20	0.60	0.34	0.21	0.14	0.09	0.07	0.09	1.20
	post-NEEWS	0.05	0.06	0.08	0.11	0.16	0.24	0.39	0.70	1.42	3.16	4.98	2.85	5.35	7.51	4.35	2.96	4.80	2.63	1.19	0.60	0.34	0.21	0.14	0.10	0.08	0.39	1.19
XS-5: Vicinity of Shuba Ln. through Mansfield Hollow WMA to Vicinity of Willimantic Rd.	pre-Interstate	0.02	0.03	0.04	0.05	0.06	0.09	0.12	0.18	0.29	0.50	0.96	2.07	4.33	3.89	3.01	4.92	2.86	1.29	0.64	0.36	0.22	0.14	0.10	0.07	0.05	0.21	1.63
	post-NEEWS	0.06	0.08	0.11	0.15	0.23	0.37	0.66	1.32	2.92	4.99	2.91	4.87	7.54	4.81	2.82	4.86	2.84	1.28	0.64	0.36	0.22	0.15	0.11	0.08	0.06	1.66	1.62
XS-6: Willimantic Rd. to Day St. Junction	pre-Interstate	0.02	0.02	0.03	0.04	0.05	0.06	0.09	0.13	0.19	0.30	0.53	1.03	2.25	4.55	3.60	3.15	4.85	2.65	1.20	0.60	0.34	0.21	0.14	0.09	0.07	0.09	1.20
	post-NEEWS	0.05	0.06	0.08	0.11	0.16	0.24	0.39	0.70	1.42	3.16	4.98	2.85	5.35	7.51	4.35	2.96	4.80	2.63	1.19	0.60	0.34	0.21	0.14	0.10	0.08	0.39	1.19
XS-6 BMP: Focus Area D - Vicinity of Day Street Junction	pre-Interstate	0.02	0.02	0.03	0.04	0.05	0.06	0.09	0.13	0.19	0.30	0.53	1.03	2.25	4.55	3.60	3.15	4.85	2.65	1.20	0.60	0.34	0.21	0.14	0.09	0.07	0.09	1.20
	post-NEEWS	0.05	0.06	0.08	0.10	0.14	0.19	0.28	0.45	0.78	1.42	2.46	2.56	5.21	6.81	4.18	3.16	4.82	2.64	1.21	0.62	0.36	0.23	0.16	0.12	0.09	0.28	1.21
XS-7: Day St. Junction to Hartford Turnpike	pre-Interstate	0.04	0.05	0.07	0.09	0.13	0.20	0.31	0.54	1.04	2.26	4.55	3.60	3.18	5.08	3.26	0.78	0.53	0.56	1.17	0.82	0.32	0.14	0.07	0.04	0.03	0.18	0.68
	post-NEEWS	0.11	0.15	0.23	0.38	0.70	1.42	3.16	4.98	2.85	5.35	7.51	4.34	2.99	5.03	3.24	0.77	0.53	0.56	1.16	0.81	0.31	0.14	0.07	0.04	0.02	1.22	0.67
XS-8: Hartford Turnpike to Lake Rd. Junction	pre-Interstate	0.03	0.04	0.07	0.14	0.32	0.82	1.18	0.53	0.55	0.52	1.42	0.99	1.10	2.00	4.14	4.20	2.93	4.91	3.10	1.39	0.68	0.37	0.23	0.15	0.10	0.68	1.19
	post-NEEWS	0.05	0.07	0.11	0.18	0.37	0.87	1.22	0.46	0.68	0.40	1.33	4.33	2.92	4.45	7.54	5.30	2.76	4.84	3.07	1.38	0.67	0.37	0.23	0.15	0.10	0.73	1.18
XS-9: Lake Rd. Junction to Lake Rd. S/S	pre-Interstate	0.15	0.18	0.21	0.25	0.27	0.22	0.13	1.36	4.24	3.64	0.95	0.09	0.16	0.41	2.37	4.80	2.39	0.44	0.15	0.26	0.26	0.23	0.19	0.16	0.14	1.36	0.44
	post-NEEWS	0.07	0.08	0.09	0.11	0.11	0.05	0.28	1.43	3.96	2.36	4.10	3.56	2.87	4.60	1.83	4.20	2.37	0.58	0.05	0.10	0.11	0.10	0.08	0.07	0.06	1.43	0.58
XS-10: Lake Rd. S/S to Killingly S/S	pre-Interstate	0.04	0.07	0.13	0.27	0.69	1.27	0.42	0.51	0.41	1.34	0.85	0.56	0.65	1.09	2.28	4.56	3.61	3.14	4.85	2.64	1.19	0.60	0.34	0.21	0.14	0.69	1.19
	post-NEEWS	0.07	0.10	0.16	0.31	0.72	1.30	0.40	0.53	0.45	0.91	0.88	2.91	4.88	2.83	5.36	7.51	4.35	2.95	4.80	2.62	1.19	0.60	0.34	0.21	0.14	0.72	1.19
XS-11: Killingly S/S to Heritage Rd.	pre-Interstate	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.19	0.35	0.18	0.32	0.59	1.19	2.64	4.85	3.15	3.60	4.55	2.25	1.03	0.53	0.30	0.19	0.13	0.09	0.03	1.20
	post-NEEWS	0.04	0.05	0.06	0.08	0.11	0.16	0.23	0.27	0.30	1.55	3.63	4.70	2.89	6.24	7.30	3.55	3.44	4.51	2.23	1.03	0.53	0.31	0.20	0.13	0.10	0.17	1.19
XS-12: Heritage Rd. to Connecticut/Rhode Island State Border, Exluding Elvira Heights	pre-Interstate	0.02	0.02	0.03	0.04	0.05	0.06	0.09	0.13	0.19	0.30	0.53	1.03	2.25	4.55	3.60	3.15	4.85	2.65	1.20	0.60	0.34	0.21	0.14	0.09	0.07	0.09	1.20
	post-NEEWS	0.05	0.06	0.08	0.11	0.16	0.24	0.39	0.70	1.42	3.16	4.98	2.85	5.35	7.51	4.35	2.96	4.80	2.63	1.19	0.60	0.34	0.21	0.14	0.10	0.08	0.39	1.19
XS-12 BMP: Focus Area E - Vicinity of Elvira Heights	pre-Interstate	0.02	0.02	0.03	0.04	0.05	0.06	0.09	0.13	0.19	0.30	0.53	1.03	2.25	4.55	3.60	3.15	4.85	2.65	1.20	0.60	0.34	0.21	0.14	0.09	0.07	0.09	1.20
	post-NEEWS	0.04	0.06	0.08	0.10	0.14	0.21	0.33	0.54	0.98	1.81	2.73	2.42	4.55	3.57	4.32	2.25	2.55	1.56	0.84	0.47	0.29	0.19	0.13	0.09	0.07	0.33	0.84

Appendix 7D – EMF Health Report

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Health Sciences Practice

Exponent®

Current Status of Research on Extremely Low Frequency Electric and Magnetic Fields and Health: Interstate Reliability Project

Current Status of Research on Extremely Low Frequency Electric and Magnetic Fields and Health: Interstate Reliability Project

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June 10, 2011

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Acronyms and Abbreviations

AC	Alternating current
AD	Alzheimer’s disease
ALL	Acute lymphoblastic leukemia
ALS	Amyotrophic lateral sclerosis
AMI	Acute myocardial infarction
AML	Acute myeloid leukemia
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
BMP	Best Management Practices
BNU	Butylnitrosourea
CI	Confidence interval
CSC	Connecticut Siting Council
CVD	Cardiovascular disease
DMBA	7,12-dimethylbenz[a]anthracene
ELF	Extremely low frequency
EHC	Environmental Health Criteria
EMF	Electric and magnetic fields (or electromagnetic fields)
ENU	Ethylnitrosourea
EPA	Environmental Protection Agency
G	Gauss
GHz	GigaHertz
HCN	Health Council of the Netherlands
HR	Hazard ratio
HRV	Heart rate variability
Hz	Hertz
IARC	International Agency for Research on Cancer
ICNIRP	International Committee on Non-Ionizing Radiation Protection
IRP	Interstate Reliability Project
JEM	Job exposure matrix
kV	Kilovolt

kV/m	Kilovolts per meter
m	Meter
mG	Milligauss
MPD	Myeloproliferative disorder
MPE	Maximum permissible exposure
NHL	Non-Hodgkin's lymphoma
NIEHS	National Institute for Environmental and Health Sciences
NK	Natural killer
NLMS	National Longitudinal Mortality Study
NRPB	National Radiation Protection Board of Great Britain
OR	Odds ratio
ROW	Right of way
RR	Relative Risk
SCENIHR	Scientific Committee on Emerging and Newly Identified Health Risks
SES	Socioeconomic status
SSI	Swiss Radiation Protection Authority
TWA	Time weighted average
V/m	Volts per meter
WHO	World Health Organization

1 Executive Summary

This report was prepared to address the topic of health and extremely low frequency (ELF) electric and magnetic fields (EMF) for the Connecticut Siting Council at the request of Northeast Utilities as part of its Application for the Interstate Reliability Project (IRP). The proposed IRP entails the construction of a 345-kilovolt (kV) transmission lines that strengthens the interstate transfer of electricity between Connecticut, Rhode Island, and Massachusetts. The proposed lines will begin in Massachusetts, travel into Rhode Island, and then travel west into Connecticut, where it will connect with an existing Northeast Utilities line.

ELF EMF are invisible fields surrounding all objects that generate, use or transmit electricity. There are also natural sources of ELF EMF, including the electric fields associated with the normal functioning of our circulatory and nervous systems. People living in developed countries are constantly exposed to ELF EMF in their environments, since electricity is fundamental part of technologically-advanced societies. Sources of man-made ELF EMF include appliances, wiring, and motors, as well as distribution and transmission lines. Section 3 of this report provides information on the nature and sources of ELF EMF, as well as typical exposure levels. The calculated ELF EMF levels associated with the proposed IRP are described in Section 7 of the application.

Research on EMF and health began with the goal of finding therapeutic application and understanding biological electricity, i.e., the role of electrical potentials across cell membranes and current flows between cells in our bodies. Over the past 30 years, researchers have examined whether EMF from man-made sources can cause short- or long-term health effects in humans using a variety of study designs and techniques. Research on EMF and long-term human health effects was prompted by an epidemiology study conducted in 1979 of children in Denver, Colorado, which studied the relationship of their cancers with the potential for ELF EMF exposure from nearby distribution and transmission lines. The results of that study prompted further research on childhood leukemia and other cancers. Childhood leukemia has remained the focus of EMF and health research, although many other diseases have been studied, including other cancers in children and adults, neurodegenerative diseases, reproductive effects, cardiovascular diseases, and suicide and depression.

Guidance on the possible health risks of all types of exposures comes from health risk assessments, or systematic weight-of-evidence evaluations of the cumulative literature, on a particular topic conducted by expert panels organized by scientific organizations. The public and policy makers should look to the conclusions of these reviews, since the reviews are conducted using set scientific standards by scientists representing the various disciplines required to understand the topic at hand. In a health risk assessment of any exposure, it is essential to consider the type and strength of research studies available for evaluation. Human health studies vary in methodological rigor and, therefore, in their capacity to extrapolate findings to the population at large. Furthermore, all studies in three areas of research (epidemiologic, *in vivo*, and *in vitro* research) must be evaluated to understand possible health risks. Section 4 of this report provides a summary of the methods used to conduct a health risk assessment.

The World Health Organization (WHO) published a health risk assessment of ELF EMF in 2007 that critically reviewed the cumulative epidemiologic and laboratory research to date, taking into account the strength and quality of the individual research studies. Section 5 provides a summary of the WHO's conclusions with regard to each disease. The WHO report provided the following overall conclusions:

> New human, animal, and in vitro studies published since the 2002 IARC Monograph, 2002 [*sic*] do not change the overall classification of ELF as a possible human carcinogen (p. 347).
>
> Acute biological effects [i.e., short-term, transient health effects such as a small shock] have been established for exposure to ELF electric and magnetic fields in the frequency range up to 100 kHz that may have adverse consequences on health. Therefore, exposure limits are needed. International guidelines exist that have addressed this issue. Compliance with these guidelines provides adequate protection. Consistent epidemiological evidence suggests that chronic low-intensity ELF magnetic field exposure is associated with an increased risk of childhood leukaemia. However, the evidence for a causal relationship is limited, therefore exposure limits based upon epidemiological evidence are not recommended, but some precautionary measures are warranted (p. 355).

This report contains a systematic literature review and a critical evaluation of all epidemiology and *in vivo* studies published after the WHO report (Section 6). These recent studies did not provide sufficient evidence to alter the basic conclusion of the WHO: the research does not suggest that electric fields or magnetic fields are a cause of cancer or any other disease at the levels we encounter in our everyday environment.

There are no national recommendations, guidelines, or standards in the U.S. to regulate ELF EMF or to reduce public exposures, although the WHO recommends adherence to the International Commission on Non-Ionizing Radiation Protection's (ICNIRP) standards for the prevention of acute health effects at high exposure levels. In light of the epidemiologic data on childhood leukemia, scientific organizations are still in agreement that only low-cost interventions to reduce ELF EMF exposure are appropriate; this is consistent with the Connecticut Siting Council's recommendation for the use of effective no-cost and low-cost technologies to reduce magnetic-field exposure to the public. While the large body of existing research does not indicate any harm associated with ELF EMF, research on this topic will continue to reduce remaining uncertainty.

2 Introduction

In response to public concerns regarding electric and magnetic fields (EMF) and health, the Connecticut Siting Council (CSC) adopted revised "EMF Best Management Practices (BMP)" on December 14, 2007 for the construction of electric transmission lines in Connecticut. The BMP policy is founded on the recognition of consistent conclusions by "a wide range of public health consensus groups," as well as their own commissioned weight-of-evidence review (p. 4). The CSC summarized the current scientific consensus by noting the conclusions of these public health consensus groups, including the most recent review by the World Health Organization (WHO) and previously published reviews by the National Institute for Environmental and Health Sciences (NIEHS) in 1999, the International Agency for Research on Cancer (IARC) in 2002, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) in 2003, the National Radiological Protection Board of Great Britain (NRPB) in 2004), and the Health Council of Netherlands (HCN) in 2005.

The CSC summarized the current scientific consensus as follows: there is limited evidence from epidemiology studies of a statistical association between estimated, average exposures greater than 3-4 milligauss (mG) and childhood leukemia; the cumulative research, however, does not indicate that magnetic fields are a cause of childhood leukemia, as animal and other experimental studies do not suggest that magnetic field are carcinogenic and the epidemiology studies are of limited quality. The CSC also noted the WHO's recent conclusion with respect to other diseases: "the scientific evidence supporting an association between ELF magnetic field exposure and all of these health effects is much weaker than for childhood leukemia" (p. 2).

Based on this scientific consensus, the CSC concluded that proportional precautionary measures for the siting of new transmission lines in the state of Connecticut include "the use of effective no-cost and low-cost technologies and management techniques on a project-specific basis to reduce MF [magnetic field] exposure to the public while allowing for the development of efficient and cost-effective electrical transmission projects" (p. 11).

The BMP also stated that the CSC will "consider and review evidence of any new developments in scientific research addressing MF and public health effects or changes in scientific consensus group positions regarding MF" (p. 5). The CSC BMP document described the scientific consensus as of 2007. Exponent has submitted a previous report to the CSC to evaluate any new developments that may have altered the current scientific consensus as articulated in the CSC's 2007 BMP;[1] this report described research published December 14, 2007-June 16, 2008 and was filed under Docket No. 370, the Connecticut Valley Electric Transmission Reliability Projects (CVETRP). In its March 16, 2010 (Docket 370) and July 20, 2010 (Docket 370A-MRdecisions approving these project, the CSC evaluated extensive evidence concerning recent developments

[1] As noted by ICNIRP, IARC and WHO, there has been no consistent or strong evidence to explain how ELF EMF exposure could affect biological processes in cells and tissues. In addition, as described in Section 4 below, such data are supplementary to epidemiology and *in vivo* studies, and are not directly used by health agencies to assess risk to human health. For these reasons, this review only systematically addresses epidemiology studies and *in vivo* studies and references reviews and the conclusions of scientific panels with regard to studies of mechanism (i.e., *in vitro* studies).

in research related to EMF and health, including the aforementioned Exponent report and commentary from the Connecticut DEP, Radiation Division, and concluded: "There is no new evidence that might alter the scientific consensus articulated in the Council's 2007 EMF BMP document" (Docket 370, Opinion at 12; Docket 370A-MR Opinion at 4; *and see* Docket 370 Findings of Fact par, 284-286).

Since the CSC BMP policies were based largely on the conclusions of the WHO report in 2007, the intent of this report is to provide the CSC with an easily-referenced document that brings the WHO report's conclusions up to date. Thus, the current report systematically evaluates peer-reviewed research and reviews by scientific panels published after the cut-off for review in the WHO report (i.e., January 1, 2006-May 1, 2011) and describes if and how these recent results affect the scientific consensus as articulated in the BMP policy from December 2007.

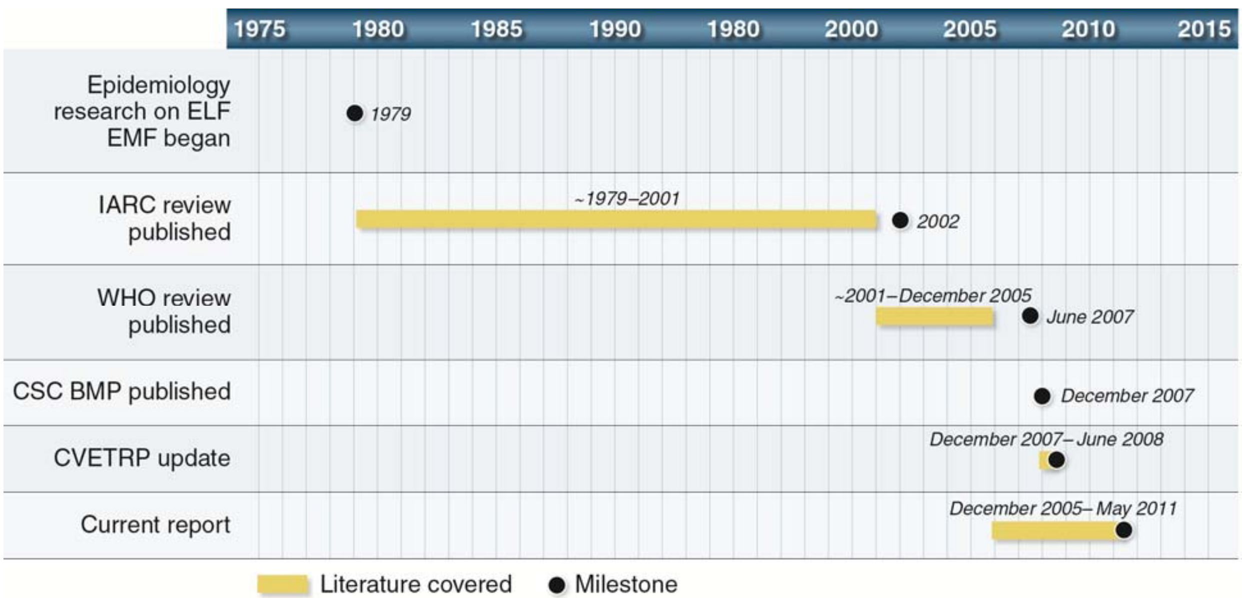


Figure 1. Timeline of research milestones and literature reviewed

3 Extremely Low Frequency Electric and Magnetic Fields: Nature, Sources, Exposure, and Known Effects

Nature of ELF EMF

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

Everything that is connected to our electrical system (i.e., power lines, appliances, and wiring) produces ELF EMF (Figure 2). Electric fields and magnetic fields are properties of the space near these electrical sources. Forces are experienced by objects capable of interacting with these fields; electric charges are subject to a force in an electric field, and moving charges experience a force in a magnetic field.

- **Electric fields** are the result of voltages applied to electrical conductors and equipment. The electric field is expressed in measurement units of volts per meter (V/m) or kilovolts per meter (kV/m); one kV/m is equal to 1,000 V/m. Conducting objects including fences, buildings, and our own skin and muscle easily block electric fields. Therefore, certain appliances within homes and workplaces are the major source of electric fields indoors, while power lines are the major source of electric fields outdoors.

- **Magnetic fields** are produced by the flow of electric currents; however, unlike electric fields, most materials do not readily block magnetic fields. The strength of a magnetic field is expressed as magnetic flux density in units called gauss (G), or in mG, where 1 G = 1,000 mG.[2] The strength of the magnetic field at any point depends on characteristics of the source, including (in the case of power lines) the arrangement of conductors, the amount of current flow, and distance from the conductors.

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

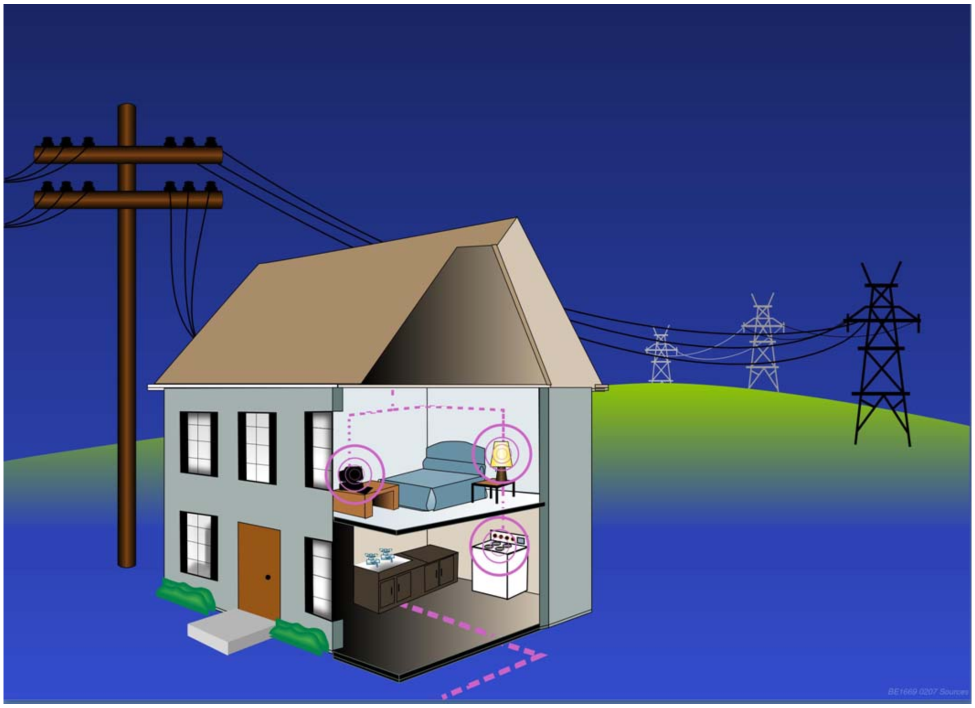


Figure 2. Numerous sources of ELF EMF in our homes (appliances, wiring, currents running on water pipes, and nearby distribution and transmission lines)

Sources and exposure

The intensity of both electric fields and magnetic fields diminishes with increasing distance from the source; for example, higher EMF levels are measured close to the conductors of distribution and transmission lines and decrease rapidly with increasing distance from the conductors. Electric and magnetic fields from transmission lines generally decrease with distance from the conductors in proportion to the square of the distance, creating a bell-shaped curve of field strength (as illustrated by the calculated field levels from the proposed transmission line in Section 7 of the application).

Since electricity is such an integral part of our infrastructure (e.g., transportation systems, homes, and businesses), people living in modern communities literally are surrounded by these fields. Figure 3 describes typical EMF levels measured in residential and occupational environments, compared to levels measured on or at the edge of transmission-line rights-of-way (ROW). While EMF levels decrease with distance from the source, any home, school, or office tends to have a "background" EMF level as a result of the combined effect of the numerous EMF sources. In general, the background magnetic-field level as estimated from the average of measurements throughout a house away from appliances is typically between 1-2 mG, while levels can be hundreds of mG in close proximity to appliances. Background levels of electric fields range from 0.01-0.02 kV/m, while appliances produce levels up to several tens of kV/m (WHO, 2007).

Experiments have yet to show which aspect of ELF EMF exposure, if any, may be relevant to biological systems. The current standard of EMF exposure for health research is long-term, average personal exposure, which is the average of all exposures to the varied electrical sources encountered in the many places we live, work, eat, shop, etc. As expected, this exposure is difficult to approximate, and exposure assessment is a major source of uncertainty in studies of ELF EMF and health (WHO, 2007).

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

- *Personal magnetic-field exposure:*
    - The vast majority of persons in the United States have a time-weighted average (TWA) exposure to magnetic fields less than 2 mG (Zaffanella and Kalton, 1998).[3]
    - In general, personal magnetic-field exposure is greatest at work and during travel (Zaffanella and Kalton, 1998).
- *Residential magnetic-field exposure:*
    - The highest magnetic-field levels are typically found directly next to appliances (Zaffanella, 1993). For example, Gauger (1985) reported the maximum AC magnetic field at 3 centimeters from a sampling of appliances as 3,000 mG (can opener), 2,000 mG (hair dryer), 5 mG (oven), and 0.7 mG (refrigerator).
    - The following parameters affect the distribution of personal magnetic-field exposures at home: residence type, residence size, type of water line, and proximity to overhead power lines. Persons living in small homes, apartments, homes with metallic piping, and homes close to three-phase electric power distribution and transmission lines tended to have higher at-home magnetic-field levels (Zaffanella and Kalton, 1998).
    - Residential magnetic-field levels are caused by currents from nearby transmission and distribution systems, pipes or other conductive paths, and electrical appliances (Zaffanella, 1993).
- *Workplace magnetic-field exposure*
    - Some occupations (e.g., electric utility workers, sewing machine operators, telecommunication workers, etc.) have higher exposures due to work near equipment with high EMF levels.[4]

[3] TWA is the average exposure over a given specified time period (i.e., an 8-hour workday or a 24-hour day) of a person's exposure to a chemical or physical agent. The average is determined by sampling the exposure of interest throughout the time period.

[4] http://www.niehs.nih.gov/health/assets/docs_p_z/emf-02.pdf

- *Power-line magnetic-field exposure*
    - The EMF levels associated with power lines vary substantially depending on their configuration, current load, etc. However, at a distance of 300 feet and during average electricity demand, the magnetic fields from many lines are often similar to the background levels found in most homes (see also Figure 3).[4] Section 7 of the application describes the calculated field levels for the proposed project.

Known effects

There is a greater opportunity for long-term exposure to magnetic fields. For this reason, among others, research on long-term health effects has focused on magnetic fields rather than electric fields. In addition, magnetic fields can induce electric currents in other materials, while electric fields cannot. Like virtually any exposure, adverse effects can be expected from exposure to very high levels of ELF EMF. If the current density or electric field induced by a very, very strong magnetic field exceeds a certain threshold, excitation of muscles and nerves is possible. Also, strong electric fields can induce charges on the surface of the body that can lead to small shocks, i.e., micro shocks. The effects caused by strong magnetic and electric fields are acute, shock-like effects that cause no long-term damage or health consequences. Limits for the general public and workplace have been set to prevent these effects, but there are no real-life situations where these levels are exceeded on a regular basis.

Two international scientific organizations, ICNIRP and the ICES, have published guidelines for limiting public exposure to ELF EMF to protect against these acute effects (ICES, 2002; ICNIRP, 2010). These guidelines were developed following a weight-of-evidence review of the literature, including epidemiologic and experimental evidence related to both short-term and long-term exposure. Valberg et al. (2011) provides a full listing of guidelines provided by health and safety organizations. Both reviews concluded that the stimulation of nerves and the central nervous system could occur at very high exposure levels immediately upon exposure, but that the research did not suggest any long-term health effects. Sections 5-7 below describe the research on long-term health effects in depth.

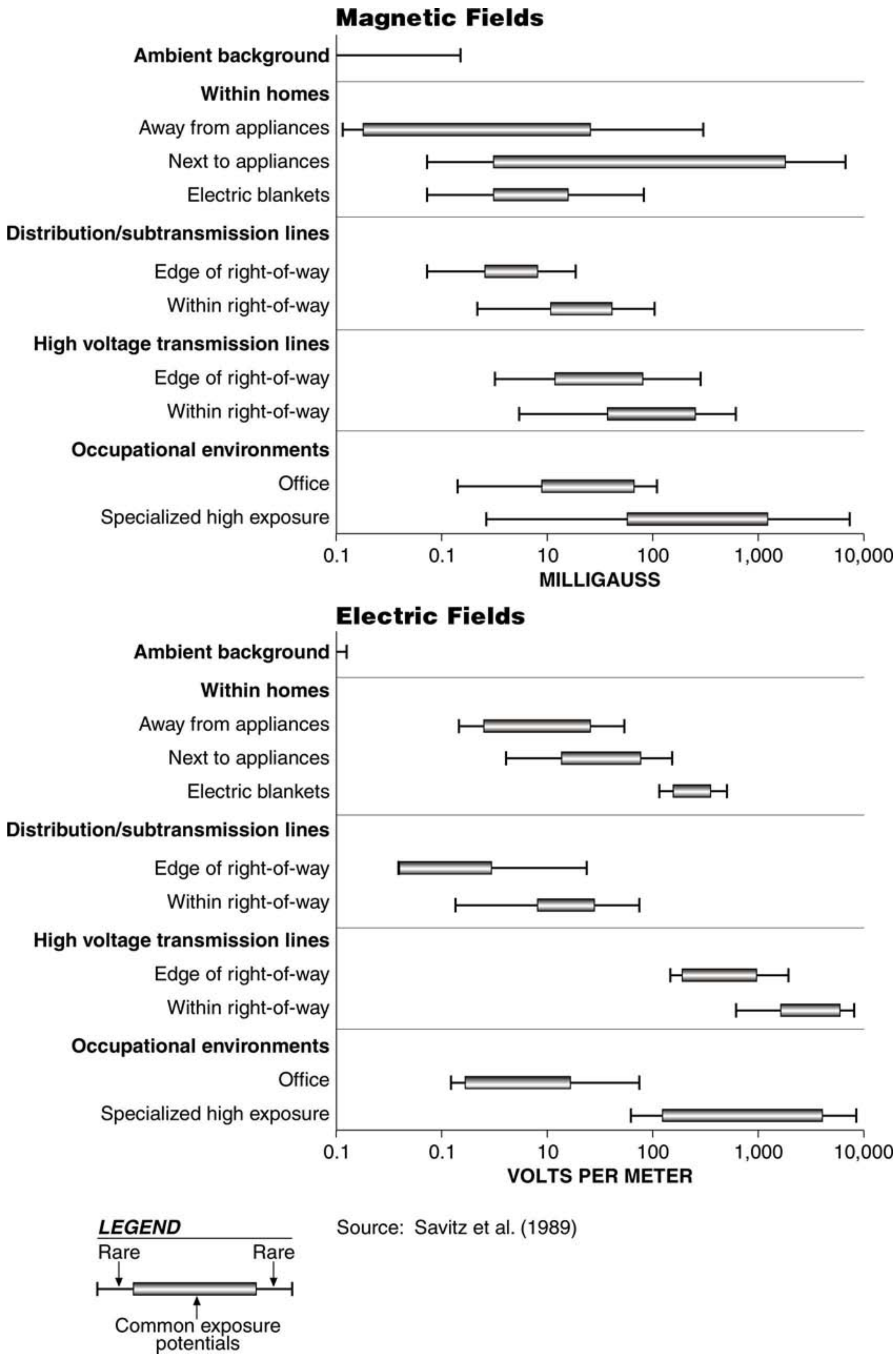
To prevent such acute, shock-like effects, the ICNIRP recommends screening values for magnetic fields of 2,000 mG for the general public and 4,200 mG for workers (ICNIRP, 2010). The ICES recommends a maximum permissible magnetic-field exposure of 9,040 mG for the general public (ICES, 2002). For reference, in a survey by Zaffanella and Kalton (1998), only about 1.6% of the general public experienced exposure to magnetic fields of at least 1,000 mG during a 24-hour period. The ICNIRP's screening value for exposure to 60-Hz electric fields for the general public is 4.2 kV/m and the ICES screening value is 5 kV/m. Both organizations allow higher exposures if it can be demonstrated that exposures do not produce electric fields within tissues that exceed basic restrictions on internal electric fields.

The recent literature includes numerous studies of workers with the potential for high-field exposures. The intent of these publications is to characterize occupational exposure and evaluate compliance with standards. These recent studies include a study of spot measurements of EMF during work tasks at 110-kV switching and transforming stations in Finland to evaluate compliance with ICNIRP reference levels (Korpinen et al., 2011a); three-hour TWA magnetic-field measurements of dentists and spot measurements near dental equipment in Taiwan (Huang et al., 2011); spot measurements and personal monitoring of magnetic fields in hospital personnel in Spain (Ubeda et al., 2011); spot measurements and personal monitoring of magnetic fields in railway workers in Italy (Contessa et al., 2010); and a study of electric fields, current densities, and contact currents at a 400-kV substation in Finland (Korpinen et al., 2011b). In general, the measured magnetic fields were below the reference values of ICNIRP in these studies; some electric field levels exceeded reference levels in the substations (Korpinen et al., 2011a, 2011b), but the induced current density in the central nervous system area did not exceed the basic restriction value.

Table 1. Reference levels for whole body exposure to 60-Hz fields: general public

Organization recommending limit	Magnetic fields	Electric fields
ICNIRP restriction level	2000 mG	4.2 kV/m
ICES maximum permissible exposure (MPE)	9,040 mG	5 kV/m 10 kV/m[a]

[a] This is an exception within transmission line ROWs because people do not spend a substantial amount of time in ROWs and very specific conditions are needed before a response is likely to occur (i.e., a person must be well insulated from ground and must contact a grounded conductor) (ICES, 2002, p. 27).



Source: Savitz et al. (1989)

Figure 3. Electric and magnetic field strengths in the environment

4 Methods for Evaluating Scientific Research

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

Weight-of-evidence reviews

The scientific process entails looking at *all* the evidence on a particular issue in a systematic and thorough manner to evaluate if the overall data presents a logically coherent and consistent picture. This is often referred to as a weight-of-evidence review, in which all studies are considered together, giving more weight to studies of higher quality and using an established analytic framework to arrive at a conclusion about a possible causal relationship. Weight-of-evidence reviews are typically conducted within the larger framework of health risk assessments or evaluations of particular exposures or exposure circumstances that qualitatively and quantitatively define health risks. Weight-of-evidence and health risk assessment methods have been described by several agencies, including the IARC, which routinely evaluates substances such as drugs, chemicals, and physical agents for their ability to cause cancer; the WHO International Programme for Chemical Safety; and the US Environmental Protection Agency (EPA), which set guidance for public exposures (WHO, 1994; USEPA, 1993; USEPA, 1996). Two steps precede a weight-of-evidence evaluation: a systematic review to identify the relevant literature and an evaluation of each study to determine its strengths and weaknesses.

The following sections discuss important considerations in the evaluation of human health studies of EMF in a weight-of-evidence review, including exposure considerations, study design, methods for estimating risk, bias, and the process of causal inference. The purpose of discussing these considerations here is to provide context for the later weight-of-evidence evaluations.

EMF exposure considerations

Exposure methods range widely in studies of EMF, including: the classification of residences based on the relative capacity of nearby power lines to produce magnetic fields (i.e., wire code categories); occupational titles; calculated magnetic-field levels based on job histories (a job-exposure matrix [JEM]); residential distance from nearby power lines; spot measurements of magnetic-field levels inside or outside residences; 24-hour and 48-hour measurements of magnetic fields in a particular location in the house, e.g., a child's bedroom; calculated magnetic-field levels based on the characteristics of nearby power installations; and, finally, personal 24-hour and 48-hour magnetic-field measurements.

Each of these methods has strengths and limitations (Kheifets and Oksuzyan, 2008). Since magnetic-field exposures are ubiquitous and vary over a lifetime as the places we frequent and the sources of EMF in those places change, making valid estimates of personal magnetic-field exposures is challenging. Furthermore, without a biological basis to define a relevant exposure metric (average, peak, etc.) and a defined critical period for exposure (*in utero,* shortly before diagnosis, etc.), relevant and valid assessments of exposure are problematic. Exposure misclassification is one of the most significant concerns in studies of ELF EMF.

In general, long-term personal measurements are the metrics selected by epidemiologists. Other methods are generally weaker because they may not be strong predictors of long-term exposure and do not take into account all magnetic-field sources. EMF can be estimated indirectly, for example, by assigning an estimated amount of EMF exposure to an individual based on calculations considering nearby power installations or a person's job title. For instance, a relative estimate of exposure could be assigned to all machine operators based on historical information on the magnitude of the magnetic field produced by the machine. Indirect measurements are not as accurate as direct measurements because they do not contain information specific to that person or the exposure situation. In the example of machine operators, the indirect measurement may not account for how much time any one individual spends working at that machine or any potential variability in magnetic fields produced by the machines over time, and occupational measurements do not take into account the worker's residential magnetic-field exposures.

While an advance over earlier methods, JEMs still have some important limitations, as highlighted recently in a review by Kheifets et al. (2009) summarizing an expert panel's findings.[5] A person's occupation provides some relative indication of the overall magnitude of their occupational magnetic-field exposure, but it does not take into account the possible variation in exposure due to different job tasks within occupational titles, the frequency and intensity of contact to relevant exposure sources, or variation by calendar time. This was highlighted by a recent study of 48-hour magnetic-field measurements of 543 workers in Italy in a variety of occupational settings, including: ceramics, mechanical engineering, textiles, graphics, retail, food, wood and biomedical industries (Gobba et al., 2011). There was significant variation in this study between the measured TWA magnetic-field levels for workers in many of the ISCO job categories, which the authors attributed to variation in industry within the task-defined ISCO categories.

Types of health research studies

Research studies can be broadly classified into two groups: 1) epidemiologic observations of people and 2) experimental studies on animals, humans, cells, and tissues in laboratory settings. Epidemiologic studies investigate how disease is distributed in populations and what factors

[5] Kheifets et al. (2009) reports on the conclusions of an independent panel organized by the Energy Networks Association in the United Kingdom in 2006 to review the current status of the science on occupational EMF exposure and identify the highest priority research needs.

influence or determine this disease distribution (Gordis, 2000). Epidemiologic studies attempt to establish causes for human disease while observing people as they go about their normal, daily lives. Such studies are designed to quantify and evaluate the associations between disease and reported exposures to environmental factors.

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

Experimental studies are designed to test specific hypotheses under controlled conditions and are vital to assessing cause-and-effect relationships. An example of a human experimental study relevant to this area of research would be studies that measure the impact of magnetic-field exposure on acute biological responses in humans, such as hormone levels. These studies are conducted in laboratories under controlled conditions. *In vivo* and *in vitro* experimental studies are also conducted under controlled conditions in laboratories. *In vivo* studies expose laboratory animals to very high levels of a chemical or physical agent to determine whether exposed animals develop cancer or other effects at higher rates than unexposed animals, while attempting to control other factors that could possibly affect disease rates (e.g., diet, genetics, etc.). *In vitro* studies of isolated cells and tissues are also important because they can help scientists understand biological mechanisms as they relate to the same exposure in intact humans and animals. The results of experimental studies of animals, and particularly those of isolated tissues or cells, however, may not always be directly extrapolated to human populations. In the case of *in vitro* studies, the responses of cells and tissues outside the body may not reflect the response of those same cells if maintained in a living system, so their relevance cannot be assumed. Therefore, it is both necessary and desirable that agents that could present a potential health threat be explored by both epidemiologic and experimental studies.

Both of these approaches—epidemiologic and experimental laboratory studies—have been used to evaluate whether exposure to EMF has any adverse effects on human health. Epidemiologic studies are valuable because they are conducted in human populations, but they are limited by their non-experimental design and typical retrospective nature. In epidemiologic studies of EMF, for example, researchers cannot control the amount of individual exposure to EMF, how exposure occurs over time, the contribution of different field sources, or individual behaviors that could affect disease risk, such as diet. In valid risk assessments of EMF, epidemiologic studies are considered alongside experimental studies of laboratory animals, while studies of isolated tissues and cells are generally acknowledged as being supplementary.

Estimating risk

Epidemiologists measure the statistical association between exposures and disease in order to estimate "risk." This brief summary of risk is included to provide a foundation for understanding and interpreting statistical associations in epidemiologic studies as risk estimates.

Two common types of risk estimates are absolute risk and relative risk (RR). Absolute risk, also known as incidence, is the amount of new disease that occurs in a given period of time. For example, the absolute risk of invasive childhood cancer in children ages 0-19 years for 2004 was 14.8 per 100,000 children (Ries et al., 2007). RRs are calculated to evaluate whether a particular exposure or inherent quality (EMF, diet, genetics, race, etc.) is associated with a disease outcome. This is calculated by looking at the absolute risk in one group relative to a comparison group. For example, white children in the 0-19 year age range had an estimated absolute risk of childhood cancer of 15.4 per 100,000 in 2004, and African American children had an estimated absolute risk of 13.3 per 100,000 in the same year. By dividing the absolute risk of white children by the absolute risk of African American children, we obtain a RR of 1.16. This RR estimate can be interpreted to mean that white children have a risk of childhood cancer that is 16% greater than the risk of African American children. Additional statistical analysis is needed to evaluate whether this association is statistically significant, as defined in the following sub-section.

It is important to understand that risk is estimated differently in cohort and case-control studies because of the way the studies are designed. Traditional cohort studies can provide a direct estimate of RR, while case-control studies can only provide indirect estimates of RR, called odds ratios (OR). For this reason, among others, cohort studies usually provide more reliable estimates of the risk associated with particular exposures. Case-control studies are more common than cohort studies, however, because of they are less costly and more time efficient.

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

Statistical significance

Statistical significance testing provides an idea of whether or not a statistical association is caused by chance alone, i.e., whether the association is likely to be observed this way upon repeated testing or whether it is simply a chance occurrence. The terms "statistically significant" or "statistically significant association" are used in epidemiologic studies to describe the tendency of the level of exposure and the occurrence of disease to be linked, with chance as an unlikely explanation. Statistically significant associations, however, are not automatically an indication of cause-and-effect, because the interpretation of statistically significant associations depends on many other factors associated with the design and conduct of the study, including, for example, how the data were collected and the size of the study.

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

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

Meta-analysis and pooled analysis

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

The disadvantage of meta- and pooled analyses is that they can convey a false sense of consistency across studies if *only* the combined estimate of effect is considered (Rothman and Greenland, 1998). These analyses typically combine data from studies with different study populations, methods for measuring and defining exposure, and disease definitions. This is particularly true for analyses that combine data from case-control studies, which often use very different methods for the selection of cases and controls and exposure assessment. Therefore, in addition to the synthesis or combining of data, meta- and pooled analyses should be used to understand what factors cause the results of the studies to vary (publication date, study design, possibility of selection bias, etc.), and how these factors affect the associations calculated from the data of all the studies combined (Rothman and Greenland, 1998).

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

Bias in epidemiologic studies

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

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

Cause vs. association and evaluating evidence regarding causal associations

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

In 1964, the Surgeon General of the United States published a landmark report on smoking-related diseases (HEW, 1964). As part of this report, nine criteria for evaluating epidemiology studies (along with experimental data) for causality were outlined. In a more recent version of this report, these criteria have been reorganized into seven criteria. In the earlier version, coherence, plausibility, and analogy were considered as distinct items, but are now summarized together because they have been treated in practice as essentially reflecting one concept (HHS, 2004). Table 2 provides a listing and brief description of each of the criterion.

Table 2. Criteria for evaluating whether an association is causal

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

Source: Department of Health and Human Services, 2004

The criteria were meant to be applied to statistically significant associations that have been observed in the cumulative epidemiologic literature, i.e., if no statistically significant association has been observed for an exposure then the criteria are not relevant. It is important to note that these criteria were not intended to serve as a checklist; rather, they were intended to serve as a guide in evaluating associations for causal inference. Theoretically, it is possible for an exposure to meet all seven criteria, but still not be deemed a causal factor. Also, no one criterion can provide indisputable evidence for causation, nor can any single criterion, aside from temporality, rule out causation.

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

Biological response vs. disease in human health

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

5 The WHO 2007 Report: Methods and Conclusions

The WHO is a scientific organization within the United Nations system whose mandate includes providing leadership on global health matters, shaping health research agendas, and setting norms and standards. The WHO established the International EMF Project in 1996, in response to public concerns about exposures to EMF and possible adverse health outcomes. The project's membership includes 8 international organizations, 8 collaborating institutions and over 54 national authorities. The overall purpose of the Project is to assess health and environmental effects of exposure to static and time varying fields in the frequency range 0-300 GigaHertz (GHz). A key objective of the Project was to evaluate the scientific literature and make a status report on health effects to be used as the basis for a coherent international response, including the identification of important research gaps and the development of internationally acceptable standards for EMF exposure.

The WHO published a Monograph in June 2007 as part of the WHO's Environmental Health Criteria (EHC) Programme summarizing health research in the ELF range. The Monograph used standard scientific procedures, as outlined in its Preamble and described above in Section 4, to conduct the review. The Task Group responsible for the report's overall conclusions consisted of 21 scientists from around the world with expertise in a wide range of disciplines. The Task Group relied on the conclusions of previous weight-of-evidence reviews,[6] where possible, and mainly focused on evaluating studies published after an IARC review of ELF EMF (with regard to cancer) in 2002 .

The WHO Task Group and IARC use specific terms to describe the strength of the evidence in support of causality between specific agents and cancer. These categories are described here because, while they are meaningful to scientists familiar with the IARC process, they can create an undue level of concern with the general public. *Sufficient evidence of carcinogenicity* is assigned to a body of epidemiologic research if a positive association has been observed in studies in which chance, bias, and confounding can be ruled out with reasonable confidence. *Limited evidence of carcinogenicity* describes a body of epidemiologic research where the findings are inconsistent or there are outstanding questions about study design or other methodological issues that preclude making a conclusion. *Inadequate evidence of carcinogenicity* describes a body of epidemiologic research where it is unclear whether the data is supportive or unsupportive of causation because there is a lack of data or there are major quantitative or qualitative issues. A similar classification system is used for evaluating *in vivo* studies and mechanistic data for carcinogenicity.

Summary categories are assigned by considering the conclusions of each body of evidence (epidemiologic, *in vivo* and *in vitro*) together (see Figure 4). *In vitro* research is not described in Figure 4 because it provides ancillary information and, therefore, is used to a lesser degree in

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[6] The term "weight-of-evidence review" is used in this report to denote a systematic review process by a multidisciplinary, scientific panel involving experimental and epidemiologic research to arrive at conclusions about possible health risks. The WHO Monograph on EMF does not specifically describe their report as a weight-of-evidence review. Rather, they describe conducting a health risk assessment. A health risk assessment differs from a weight-of-evidence review in that it also incorporates an exposure and exposure-response assessment.

evaluating carcinogenicity and is classified simply as strong, moderate, or weak. Categories include (from highest to lowest risk): carcinogenic to humans, probably carcinogenic to humans, possibly carcinogenic to humans, unclassifiable, and probably not carcinogenic to humans. These categories are intentionally meant to err on the side of caution, giving more weight to the possibility that the exposure is truly carcinogenic and less weight to the possibility that the exposure is not carcinogenic. The category "possibly carcinogenic to humans" denotes exposures for which there is limited evidence of carcinogenicity in epidemiology studies and less than sufficient evidence of carcinogenicity in studies of experimental animals.

	Epidemiology Studies				Animal Studies			
	Sufficient evidence	Limited evidence	Inadequate evidence	Evidence suggesting lack of carcinogenicity	Sufficient evidence	Limited evidence	Inadequate evidence	Evidence suggesting lack of carcinogenicity
Known Carcinogen	✓							
Probable Carcinogen		✓			✓			
Possible Carcinogen		✓				✓	✓	
Not Classifiable			✓			✓	✓	
Probably not a Carcinogen				✓				✓

Sufficient evidence in epidemiology studies—A positive association is observed between the exposure and cancer in studies, in which chance, bias and confounding were ruled out with "reasonable confidence."

Limited evidence in epidemiology studies—A positive association has been observed between the exposure and cancer for which a causal interpretation is considered to be credible, but chance, bias or confounding could not be ruled out with "reasonable confidence."

Inadequate evidence in epidemiology studies—The available studies are of insufficient quality, consistency or statistical power to permit a conclusion regarding the presence or absence of a causal association between exposure and cancer, or no data on cancer in humans are available.

Evidence suggesting a lack of carcinogenicity in epidemiology studies—There are several adequate studies covering the full range of levels of exposure that humans are known to encounter, which are mutually consistent in not showing a positive association between exposure to the agent and any studied cancer at any observed level of exposure. The results from these studies alone or combined should have narrow confidence intervals with an upper limit close to the null value (e.g. a relative risk of 1.0). Bias and confounding should be ruled out with reasonable confidence, and the studies should have an adequate length of follow-up.

Sufficient evidence in animal studies—An increased incidence of malignant neoplasms is observed in (a) two or more species of animals or (b) two or more independent studies in one species carried out at different times or indifferent laboratories or under different protocols. An increased incidence of tumors in both sexes of a single species in a well-conducted study, ideally conducted under Good Laboratory Practices, can also provide sufficient evidence.

Limited evidence in animal studies—The data suggest a carcinogenic effect but are limited for making a definitive evaluation, e.g. (a) the evidence of carcinogenicity is restricted to a single experiment; (b) there are unresolved questions regarding the adequacy of the design, conduct or interpretation of the studies; etc.

Inadequate evidence in animal studies—The studies cannot be interpreted as showing either the presence or absence of a carcinogenic effect because of major qualitative or quantitative limitations, or no data on cancer in experimental animals are available

Evidence suggesting a lack of carcinogenicity in animal studies—Adequate studies involving at least two species are available which show that, within the limits of the tests used, the agent is not carcinogenic.

Figure 4. Basic IARC method for classifying exposures based on potential carcinogenicity

The IARC has reviewed over 900 substances and exposure circumstances to evaluate their potential carcinogenicity. Over 80% of exposures fall in the categories possible carcinogen (27%) or non-classifiable (55%). This occurs because, as described above, it is nearly impossible to prove that something is completely safe and few exposures show a clear-cut or probable risk, so most agents will end up in either of these two categories. Throughout the history of the IARC, only one agent has been classified as probably not a carcinogen, which illustrates the conservatism of the evaluations and the difficulty in proving the absence of an effect beyond all doubt.

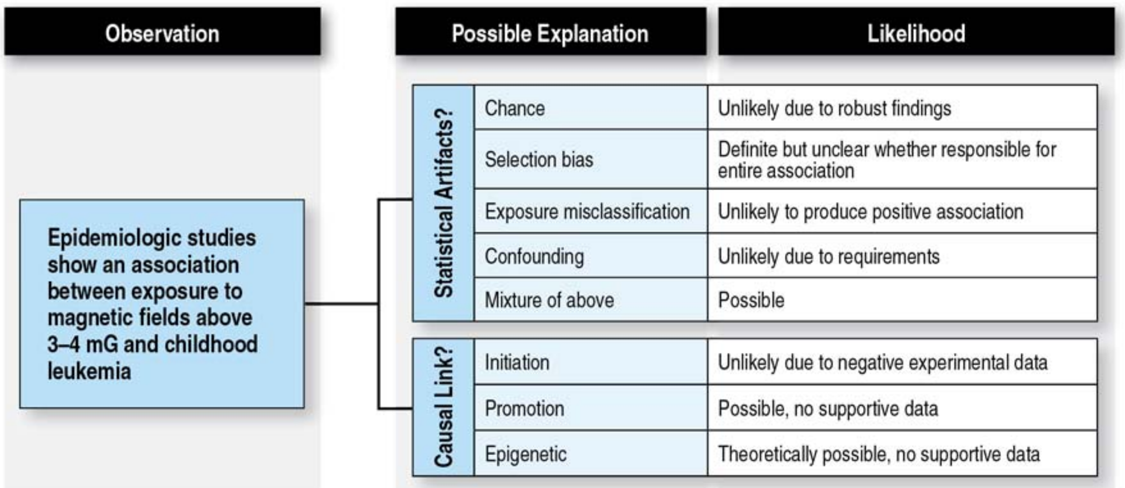
The WHO report provided the following overall conclusions with regard to ELF EMF:

> New human, animal, and in vitro studies published since the 2002 IARC Monograph, 2002 [*sic*] do not change the overall classification of ELF as a possible human carcinogen (p. 347).
>
> Acute biological effects [i.e., short-term, transient health effects such as a small shock] have been established for exposure to ELF electric and magnetic fields in the frequency range up to 100 kHz that may have adverse consequences on health. Therefore, exposure limits are needed. International guidelines exist that have addressed this issue. Compliance with these guidelines provides adequate protection. Consistent epidemiological evidence suggests that chronic low-intensity ELF magnetic field exposure is associated with an increased risk of childhood leukaemia. However, the evidence for a causal relationship is limited, therefore exposure limits based upon epidemiological evidence are not recommended, but some precautionary measures are warranted (p. 355, WHO, 2007).

With regard to specific diseases, the WHO concluded the following:

Childhood cancers. The WHO report paid particular attention to childhood leukemia because the most consistent epidemiologic association in the area of EMF and health research has been reported between this disease and TWA exposure to high, magnetic-field levels. Two pooled analyses reported an association between childhood leukemia and TWA magnetic-field exposure >3-4 mG (Ahlbom et al., 2000; Greenland et al., 2000); it is this data, categorized as limited epidemiologic evidence, that resulted in the classification of magnetic fields as possibly carcinogenic by the IARC in 2002.

The WHO report systematically evaluated several factors that might be partially, or fully, responsible for the consistent association, including: chance, misclassification of magnetic-field exposure, confounding from hypothesized or unknown risk factors, and selection bias. The authors concluded that chance is an unlikely explanation since the pooled analyses had a larger sample size and decreased variability; control selection bias is probably occurring to some extent in these studies and would result in an overestimate of the true association, but would not explain the entire observed association; it is less likely that confounding is occurring, although the possibility that some yet-to-be identified confounder is responsible for the association cannot be fully excluded; and, finally, exposure misclassification would likely result in an underestimate of the true association, although it is not entirely clear (see Figure 5 below). The WHO concluded that reconciling the epidemiologic data on childhood leukemia and the negative (i.e., no hazard or risk observed) experimental findings through innovative research is currently the highest priority in the field of ELF EMF research. Given that few children are expected to have average magnetic-field exposures greater than 3-4 mG, however, the WHO stated that the public health impact of magnetic fields on childhood leukemia would likely be minimal, if the association was determined to be causal.



Source: Adapted from Schüz and Ahlbom (2008)

Figure 5. Possible explanations for the observed association between magnetic fields and childhood leukemia

Fewer studies have been published on magnetic fields and childhood brain cancer compared to studies of childhood leukemia. The WHO Task Group described the results of these studies as inconsistent and limited by small sample sizes and recommended a meta-analysis to clarify the research findings.

Breast cancer. The WHO concluded that recently published studies on breast cancer and EMF exposure were higher in quality compared with previous studies, and for that reason, they provide strong support to previous consensus statements that magnetic-field exposure does not influence the risk of breast cancer. In summary, the WHO stated "[w]ith these [recent] studies, the evidence for an association between ELF magnetic-field exposure and the risk of female breast cancer is weakened considerably and does not support an association of this kind" (p. 9, WHO, 2007). The WHO recommended no further research with respect to breast cancer and magnetic-field exposure.

Adult leukemia and brain cancer. The WHO concluded, "In the case of adult brain cancer and leukaemia, the new studies published after the IARC monograph do not change the conclusion that the overall evidence for an association between ELF [EMF] and the risk of these disease remains inadequate" (p. 307, WHO, 2007). The WHO panel recommended updating the existing cohorts of occupationally-exposed individuals in Europe and pooling the epidemiologic data on brain cancer and adult leukemia to confirm the absence of an association.

In vivo research on carcinogenesis. The WHO concluded the following with respect to *in vivo* research, "[t]here is no evidence that ELF exposure alone causes tumours. The evidence that ELF field exposure can enhance tumour development in combination with carcinogens is inadequate" (p. 10, WHO, 2007). Recommendations for future research included the development of a rodent model for childhood acute lymphoblastic leukemia (ALL) and the continued investigation of whether magnetic fields can act as a co-carcinogen.

In vitro research on carcinogenesis. The WHO concluded that magnetic-field exposure below 50,000 mG was not associated with genotoxicity *in vitro*. There was some evidence, however, to suggest that magnetic fields above these levels might interact with other genotoxic agents to induce damage. Evidence for an association between magnetic fields and altered apoptosis or expression of genes controlling cell cycle progression was considered inadequate.

Reproductive and developmental effects. The WHO concluded that, overall, the body of research does not suggest that maternal or paternal exposures to ELF EMF cause adverse reproductive or developmental outcomes. The evidence from epidemiologic studies on miscarriage was described as inadequate, and further research on this possible association was recommended, although low priority was given to this recommendation.

In vivo research on reproductive and developmental effects. The WHO Task Group concluded that the available *in vivo* studies were inadequate for drawing conclusions regarding the potential effects of magnetic fields on the reproductive system. Furthermore, the Task Group concluded that studies conducted in mammalian models showed no adverse developmental effects associated with magnetic-field exposure.

Neurodegenerative diseases. The WHO reported that the majority of epidemiologic studies have reported associations between occupational magnetic-field exposure and mortality from Alzheimer's disease (AD) and amyotrophic lateral sclerosis (ALS), although the design and methods of these studies were relatively weak (e.g., disease status was based on death certificate data, exposure was based on incomplete occupational information from census data, and there was no control for confounding factors). The WHO concluded that there is inadequate data in support of an association between magnetic fields and AD or ALS. The panel highly recommended that further studies be conducted in this area, particularly studies where the association between magnetic fields and ALS is estimated while controlling for the possible confounding effect of electric shocks.

In vivo research on neurological effects. The WHO stated that various animal models were used to investigate possible field-induced effects on brain function and behavior. Few brief, transient responses had been identified.

Cardiovascular diseases. It has been hypothesized that magnetic-field exposure reduces heart rate variability (HRV), which in turn increases the risk for acute myocardial infarction (AMI). With one exception (Savitz et al., 1999), however, none of the studies of cardiovascular disease morbidity and mortality has shown an association with exposure. Whether a specific association exists between exposure and altered autonomic control of the heart remains speculative and the overall the evidence does not support an association. Experimental studies of both short- and long-term exposure indicate that, while electric shock is an obvious health hazard, other hazardous cardiovascular effects associated with ELF fields are unlikely to occur at exposure levels commonly encountered environmentally or occupationally.

6 Current Scientific Consensus

The following sections identify and describe epidemiologic and *in vivo* studies related to ELF EMF and health published from January 1, 2006 through May 1, 2011. The purpose of this section is to evaluate whether the findings of these recent studies alter the conclusions published by the WHO in their 2007 report, as described in Section 5.

A structured literature search was conducted using PubMed, a search engine provided by the National Library of Medicine and the National Institutes of Health that includes over 15 million up-to-date citations from MEDLINE and other life science journals for biomedical articles (http://www.pubmed.gov). A well-defined search strategy was used to identify literature indexed January 1, 2006 through May 1, 2011.[7] All fields (title, abstract, etc.) were searched with various search strings that referenced the exposure[8] and diseases of interest,[9] as well as authors that regularly publish in this field. A scientist with experience in this area reviewed the titles and abstracts of these publications for inclusion in this evaluation. Only peer-reviewed, epidemiologic studies, meta-analyses, human experimental studies, and whole animal *in vivo* studies of 50/60-Hz AC ELF EMF and recognized disease entities were included. The following specific inclusion criteria were applied:

1. **Outcome**. Included studies evaluated one of the following diseases: cancer; reproductive effects; neurodegenerative diseases; or cardiovascular disease. Research on other outcomes was not included (psychological and behavioral effects, hypersensitivity, etc.).[10] Few studies are available in these research areas and, as such, research evolves more slowly.

2. **Exposure**. The study must have evaluated 50/60-Hz AC ELF-EMF.

3. **Exposure assessment methods**. To be included in the study, exposure must have been evaluated beyond self-report of an activity or occupation. Included studies estimated exposure through various methods including: calculated EMF levels using distance from power lines; time-weighted average EMF exposures; average exposures estimated from JEMs, etc.

4. **Study design**. Epidemiology, human experimental, and *in vivo* studies were included. *In*

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[7] While extensive efforts were made to identify relevant studies, it is possible that some studies reporting on the association between a disease and some measure of EMF exposure were missed. Many occupational and environmental case-control studies of cancer are published, some of which examine a large number of possible exposures; if no reference to EMF is made in the abstract, title, or keywords, for example, these studies may not have been identified using our search strategy. The most informative studies in this field, however, will be identified by our search strategy.

[8] EMF, magnetic fields, electric fields, or electromagnetic.

[9] Cancer (cancer, leukemia, lymphoma, carcinogenesis), neurodegenerative disease (neurodegenerative disease, Alzheimer's disease, amyotrophic lateral sclerosis, or Lou Gehrig's disease), cardiovascular effects (cardiovascular or heart rate), or reproductive outcomes (miscarriage, reproduction or development).

[10] A study evaluating occupational EMF exposure and uveal melanoma was not evaluated further (Behrens et al. 2010), since this is the only study available of this cancer type.

vitro studies were not systematically evaluated, since this field of study is less informative to the risk assessment process (IARC, 2002). We rely on the conclusions of the WHO report (as described in Section 5) with regard to mechanistic data from *in vitro* studies. Furthermore, only *in vivo* studies of carcinogenicity were evaluated in this review; the review relies on the conclusions of the WHO with regard to *in vivo* studies in the areas of reproduction, development, neurology, and cardiology.

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

Methodological research is now being pursued in many areas of EMF research to identify the possible impact of certain aspects of study design or biases on the studies' results. Therefore, articles evaluating the impact of methodological aspects of epidemiology studies in this field are discussed, where appropriate. Systematic review articles of relevant topics are also noted, where appropriate. Articles published prior to the scope of this update are noted in certain circumstances to provide context.

Human studies are evaluated below first by outcome (childhood cancer; adult cancer; reproductive or developmental effects; neurodegenerative diseases; and cardiovascular effects), followed by an evaluation of *in vivo* research in the field of cancer and other outcomes. Tables 3-10 list the relevant studies that were published January 1, 2006 through May 1, 2011 in these areas, including the study authors and the title of the article.

Childhood leukemia

In 2002, the IARC assembled and reviewed research related to ELF EMF to evaluate the strength of the evidence in support of carcinogenicity. The IARC expert panel noted that, when studies with the relevant information were combined in a pooled analysis, a statistically significant two-fold association was observed between childhood leukemia and estimated exposure to high, average levels of magnetic fields (i.e., greater than 3-4 mG of average 24- and 48-hour exposure). This evidence was classified as "limited evidence" in support of carcinogenicity, falling short of "sufficient evidence" because chance, bias, and confounding could not be ruled out with "reasonable confidence." Largely as a result of the findings related to childhood leukemia, the IARC classified magnetic fields as "possibly carcinogenic," a category that describes exposures with limited epidemiologic evidence and inadequate evidence from *in vivo* studies. The classification "possibly carcinogenic" was confirmed by the WHO in June 2007.

Recent studies (January 2006-May 2011)

A number of studies investigating childhood leukemia and magnetic fields have been published since the WHO review (Table 3). Most notably, Kheifets et al. (2010a) conducted a pooled analysis of studies published between 2000 and 2010 to mirror the earlier pooled analyses of studies published between 1979 and 1999 (Ahlbom et al., 2000; Greenland et al., 2000). Kheifets et al. (2010a) identified six studies for the main analysis that met their inclusion criteria (i.e., population-based studies of childhood leukemia that measured or calculated magnetic fields inside the home); three of the studies in this analysis were considered in the WHO review, while two are described here (i.e., Kroll et al., 2010; Malagoli et al., 2010).[11] An additional Brazilian study remains unpublished, but the results were provided via personal communication to Kheifets et al. (Wunsch Filho, personal communication, 2009).[12] A large number of childhood leukemia cases were included in Kheifets et al. (10,865), but a relatively small number of cases (23) were classified in the highest exposure category (>3 mG). A positive association was reported (OR=1.44), but it was weaker than the previous pooled estimates and not statistically significant (95% CI=0.88–2.36); a dose-response relationship was apparent and the association was stronger when the Brazilian study, which was the most influential to the analysis, was excluded.

The largest number of cases in Kheifets et al. (2010a) was from a large, case-control study conducted in the United Kingdom by Kroll et al. (2010). Kroll et al. (2010) expanded upon an earlier study (Draper et al., 2005) by replacing residential distance to nearby transmission lines as the exposure metric with calculated magnetic fields from nearby transmission lines; both studies included all children diagnosed with cancer in the United Kingdom from 1962 through 1995. Neither study reported an association with brain cancer or childhood cancers. Draper et al. (2005) reported that children with leukemia were more likely to have lived at birth within 600 meters (m) of a high-voltage transmission line, although the authors questioned the significance of this finding since magnetic fields from power lines do not extend to distances of 600 m.[13] Kroll et al. (2010) calculated average, annual residential magnetic-field levels for children living within 400 m of power lines at birth; 400 m was used because modeling estimated that magnetic-field levels above 1 mG could be predicted reliability only at residences within 400 m of a transmission line. Only 1% of children in the study had a residence at birth within 400 m of a transmission line and only 0.07% had calculated exposures greater than 1 mG. Furthermore, nearly 25% of the residences within 400 m of a transmission line lacked data to calculate residential magnetic-field levels. An OR of 2.0 was calculated based upon two cases of childhood leukemia and one control with calculated magnetic fields greater than 4 mG (95% CI=0.18 to 22.04); no dose-response relationship was apparent. As a result of small numbers and incomplete information, no strong conclusions can be drawn from this study. The authors stated that the study "slightly strengthens" the evidence for an association between magnetic fields and childhood leukemia.

The recent study by Malagoli et al. (2010) was also included in the pooled analysis. This Italian study identified all childhood hematological malignancies diagnosed between 1967 and 2007 in two Italian municipalities (64 cases) and recruited four controls per case matched on sex, age,

[11] A seventh study was included in Kheifets et al. (2010a), but only in the pooled analysis of childhood leukemia and residential distance to power lines (Lowenthal et al., 2007). This study is not discussed further in this section because published findings only report on a combined category of lymphoproliferative and myeloproliferative disorders for both adults and children combined.

[12] The case-control study included children less than eight years of age with ALL and measured exposure using 24-hour measurements in the bedroom of the child's home at diagnosis. No further information on this study is currently available.

[13] The WHO concluded the following with respect to the Draper et al. (2005) findings: "[the] observation of the excess risk so far from the power lines, both noted by the authors and others, is surprising. Furthermore, distance is known to be a very poor predictor of magnetic field exposure, and therefore, results of this material based on calculated magnetic fields, when completed, should be much more informative" (p. 270, WHO 2007a).

and municipality of residence.[14] Exposure was defined as having lived for at least 6 months prior to diagnosis at a residence with calculated power-line magnetic-field levels above 1 mG or above 4 mG; magnetic-field levels were calculated using 2001 average line loading, rather than loading during the year of birth or diagnosis. Few children lived in a residence with power-line magnetic-field levels above 1 mG (2 cases and 5 controls) or 4 mG (1 case and 2 controls); thus, estimated associations were unstable. The RR for leukemia and residence in an area with exposure ≥1 mG was 3.2 (6.7 adjusting for socioeconomic status [SES]), but the estimate was statistically unstable (95% CI=0.4-23.4), and there was no indication of a dose-response relationship. Similar to Kroll et al. (2010), this study's strength is that no participation was required from the study participants since exposure was based on publicly available data and, as a result, selection bias was not a concern. The study is limited by small numbers, the related imprecision, and the lack of an exposure-response relationship.

Both Kroll et al. (2010) and Malagoli et al. (2010) used calculations from nearby power lines to estimate magnetic-field exposure. The recent case-control study by Does et al. (2011), on the other hand, measured magnetic fields inside the home, which takes into account all residential magnetic-field sources. Does et al. (2011) enrolled 245 childhood leukemia cases 2000-2007 and 269 sex-, age-, and ethnicity-matched controls using California birth records; spot measurements were taken in the main rooms of each participant's home and the average of a 30-minute measurement was used in the room with the median value.[15] No statistically significant associations were observed between childhood leukemia and residential magnetic-field levels in this study.

Kheifets et al. (2010a) also pooled data on distance and childhood leukemia from recent studies (Bianchi et al., 2000; Draper et al., 2005; Kabuto et al., 2006; Lowenthal et al., 2007; Wunsch Filho, personal communication, 2009; Malagoli et al., 2010) and confirmed an elevated OR at residential distances less than 200 m; the association reached statistical significance at distances ≤50 m. The association remains unexplained, however, since it is known that distance is a poor proxy for residential magnetic-field levels. A recent study by Maslanyj et al. (2009) estimated that only 13% of children's homes in a 100 m corridor of 220-440-kV power lines had a measured magnetic-field level above 2 mG. Three other small studies published since the WHO review, and excluded from the pooled analysis by Kheifets et al. (2010a) because they were hospital-based, also reported an association with residential distance to power lines and childhood leukemia in Iran and Malaysia (Feizi and Arabi, 2007 [< 500 m vs. >500 m]; Abdul Rahman et al., 2008 [< 200 m vs. >200 m]; Sohrabi et al., 2010 [<400 m vs. >400 m]); these studies did not evaluate dose-response patterns. While the consistency of the association between distance and childhood leukemia in the recent literature is noteworthy, these studies do not provide strong evidence because of their limited quality. Methodological limitations include a hospital-based design; lack of report of participation rates; lack of control for SES, which could introduce selection bias; and the use of distance as a proxy for magnetic-field exposure.

Other recent studies were not included in the pooled analysis by Kheifets et al. (2010a) because they reported on magnetic fields and subgroups of leukemia. These studies reported that

[14] Hematological cancers include all types of leukemias, lymphomas, and Hodgkin's disease.
[15] An abstract of the study by Does et al. (2011) was not included in the Kheifets et al. (2010a) pooled analysis since no long-term magnetic-field measurements were made.

children with leukemia and estimates of average magnetic-field exposures greater than 3-4 mG had poorer survival (Foliart et al., 2006, 2007; Svendsen et al., 2007); children with Down syndrome and childhood leukemia were more likely to have spot measurements at the door of their home greater than 6 mG compared to children with Down syndrome only (Mejia-Arangure et al., 2007); and one genetic polymorphism related to DNA repair (but with no known relationship to leukemia) was reported to be more common among children with leukemia living close to an electrical installation compared to children with leukemia living at a distance (Yang et al., 2008). The results of these recent studies were limited by small numbers, incomplete adjustment for potential risk factors, and the lack of a biological explanation to explain the observed associations, among other methodological issues. Additional epidemiologic and biological research is required in these new fields of inquiry.

Another new field of inquiry is the relevance of pre- or post-conception EMF exposure of a parent to cancer in their offspring. Hug et al. (2010) studied the pre-conception occupational exposures of parents of children with leukemia and compared them to the exposures of parents of healthy children. No association was found between childhood leukemia and magnetic-field exposure pre-conception in either parent.

Recent methodological work (January 2006-May 2011)

A statistical association can represent a true causal relationship between the identified exposure and disease, or it may be an artifact of an error in the study's design or conduct. In the absence of experimental data to support a causal relationship, the WHO identified several possible errors that may explain the observed statistical association between childhood leukemia and magnetic-field exposure, including chance, misclassification of the true magnetic-field exposure in the study subjects due to poor exposure assessment methods, uncontrolled confounding of hypothesized or unknown risk factors, and control selection bias.

EMF presents unique challenges in exposure assessment because it is ubiquitous, imperceptible, and has many sources (Kheifets and Oksuzyan, 2008). No target exposure parameter or exposure window has been identified, and the numerous methods of estimating exposure (personal measurements, calculations, distance from power lines, etc.) likely result in a different degree of error within and between studies. Two recent studies provide information relevant to exposure misclassification (Maslanyj et al., 2009; Urayama et al., 2009). Urayama et al. evaluated the full residential history of a group of children with leukemia and reported that the children were highly mobile, with 66% having changed residences at least once between birth and the date of diagnosis. This finding is significant because most of the studies of childhood leukemia and magnetic-field exposure estimated exposure using the home of residence during or post-diagnosis, which would not capture the full history of the child's possible magnetic-field exposure. This analysis suggests that there are serious implications to using a single residential location (e.g., birth or diagnosis address) to determine exposure (e.g., Draper et al., 2005).

Another report described the error in interpretation that can occur when distance from power lines is considered a valid proxy for magnetic-field exposure. Maslanyj et al. (2009) reported that only 23% of homes in a 200 m corridor (and 19% of homes in a 50 m corridor) of 220-kV – 440-kV lines had a residential magnetic-field level above 2 mG. The study suggests that distance is not a sensitive or specific proxy of residential magnetic-field exposure and calls into question the relevance of the associations reported in studies such as Draper et al. (2005).

Finally, a recent study confirmed that exposure misclassification is not due to the time of day when magnetic-field measurements are made. Schüz et al. (2007) reported no difference in the magnitude or pattern of results for nighttime vs. 24-hour or 48-hour magnetic-field measurements. This study refutes the hypothesis that nighttime exposures are more strongly associated with childhood leukemia because magnetic fields might affect carcinogenesis through a melatonin-driven pathway.

The first studies to investigate contact current exposure as a possible confounder of the magnetic field-childhood leukemia association were recently published. Exposure to contact current may occur when the body is in contact with two conductive surfaces with different electrical potentials. The hypothesis is that a child may experience a contact current from touching a metal plumbing fixture or a conductive drain while bathing and these contact currents are responsible for the statistical link with childhood leukemia. To be a confounder, contact currents would need to be associated with both residential magnetic-field levels and childhood leukemia. Kavet and Hooper (2009) reported that contact currents from residential grounding systems were associated with residential magnetic-field levels in a sample of 15 homes, and the large case-control study by Does et al. (2011) found a weak correlation between magnetic fields and indoor and outdoor contact voltage. Does et al. (2011), however, did not find any evidence of an association between childhood leukemia and measured indoor or outdoor contact currents. The authors noted that low exposure prevalence may have limited the study's power to detect a significant OR.

Recent studies confirmed that control selection bias appears to be operating in case-control studies of childhood leukemia and magnetic fields, although the exact degree of its influence is still unknown (Mezei and Kheifets, 2006; Mezei et al., 2008a, 2008b).

Assessment

Recent studies continue to support a weak association between elevated magnetic-field levels and childhood leukemia, but they lack the methodological improvements required to advance this field; the epidemiologic evidence remains limited and the observed statistical association is still unexplained. One of the major limitations of recent work is the validity of exposure assessment; no recent studies have estimated the association using measured *personal* magnetic-field levels; rather, magnetic-field estimates have been based on calculated levels from nearby power lines; distance from nearby power lines; and measured, short-term residential levels. Some scientists have opined that epidemiology has reached its limits in this area and any future research must demonstrate a significant methodological advancement (e.g., an improved exposure metric or a large sample size in high exposure categories) to be justified (Savitz, 2010; Schmiedel and Blettner, 2010).

In particular, scientific data published since the WHO review:

- highlights the rarity of living in close proximity to a power line in developed countries or having estimated or measured exposures greater than 1 mG;

- is consistent with a positive association using pooled data between average magnetic-field levels greater than 3 mG and childhood leukemia, but the association cannot be distinguished from chance due to small numbers (Kheifets et al., 2010a);

- includes additional studies reporting associations between residential proximity to power lines and childhood leukemia, but also indicates that distance is not a reliable predictor of in-home magnetic-field levels; and,

- suggests that control selection bias may play some role in the observed association.

These findings do not alter previous conclusions of the WHO and other reviews that the epidemiologic evidence on magnetic fields and childhood leukemia is "limited" from the IARC classification perspective. Chance, confounding, and several sources of bias still cannot be ruled out. Conclusions from recent reviews (Kheifets and Oksuzyan, 2008; Pelissari et al., 2009; Schüz and Ahlbom, 2008; Calvente et al., 2010; Eden, 2010) and scientific organizations (SSI, 2007; SSI, 2008; HCN, 2009; SCENIHR, 2009) published since the WHO review support this conclusion.

Researchers will continue to investigate the magnetic field-childhood leukemia association. It is important to note, however, that magnetic fields are just one area of study in the large body of research on the possible causes of childhood leukemia. There are other hypotheses under investigation that point to possible genetic, environmental, and infectious explanations for childhood leukemia (e.g., McNally and Parker, 2006; Belson et al., 2007; Rossig and Juergens, 2008; Bartley et al., 2010 [diagnostic x-rays]; Amigou et al., 2011 [road traffic]).

Table 3**.** Relevant studies of childhood leukemia published after the WHO review

Author	Year	Study Title
Abdul Rahman et al.	2008	A case-control study on the association between environmental factors and the occurrence of acute leukemia among children in Klang Valley, Malaysia
Does et al.	2011	Exposure to electrical contact currents and the risk of childhood leukemia
Fezei and Arabi	2007	Acute childhood leukemias and exposure to magnetic fields generated by high voltage overhead power lines – a risk factor in Iran
Foliart et al.	2006	Magnetic field exposure and long-term survival among children with leukaemia
Foliart et al.	2007	Magnetic field exposure and prognostic factors in childhood leukemia
Hug et al.	2010	Parental occupational exposure to extremely low frequency magnetic fields and childhood cancer: a German case-control study
Kheifets et al.	2010a	Pooled analysis of recent studies on magnetic fields and childhood leukaemia
Kroll et al.	2010	Childhood cancer and magnetic fields from high-voltage power lines in England and Wales: a case-control study
Malagoli et al.	2010	Risk of hematological malignancies associated with magnetic fields exposure from power lines: a case control study in two municipalities in northern Italy

Author	Year	Study Title
Maslanyj et al.	2009	Power frequency magnetic fields and risk of childhood leukaemia: Misclassification of exposure from the use of the 'distance from power line' exposure surrogate
Mejia-Arangure et al.	2007	Magnetic fields and acute leukemia in children with Down syndrome
Mezei and Kheifets	2006	Selection bias and its implications for case-control studies: A case study of magnetic field exposure and childhood leukaemia
Mezei et al.	2008a	Assessment of selection bias in the Canadian case-control study of residential magnetic field exposure and childhood leukemia
Schüz et al.	2007	Nighttime exposure to electromagnetic fields and childhood leukemia: An extended pooled analysis
Svendson et al.	2007	Exposure to magnetic fields and survival after diagnosis of childhood leukemia: An extended pooled analysis
Sohrabi et al.	2010	Living near overhead high voltage transmission power lines as a risk factor for childhood acute lymphoblastic leukemia: a case-control study
Urayama et al.	2009	Factors associated with residential mobility in children with leukemia: Implications for assigning exposures
Yang et al.	2008	Case-only of interactions between DNA repair genes (hMLH1, APEX1, MGMT, XRCC1, and XPD) and low frequency electromagnetic fields in childhood acute leukemia

Childhood brain cancer

Compared to the research on magnetic fields and childhood leukemia, there have been fewer studies of childhood brain cancer. The data are less consistent and limited by even smaller numbers of exposed cases than studies of childhood leukemia. The WHO review recommended the following:

> As with childhood leukaemia, a pooled analysis of childhood brain cancer studies should be very informative and is therefore recommended. A pooled analysis of this kind can inexpensively provide a greater and improved insight into the existing data, including the possibility of selection bias and, if the studies are sufficiently homogeneous, can offer the best estimate of risk (p. 18, WHO 2007).

Recent studies (January 2006-May 2011)

Table 4 below provides a list of the studies of childhood brain cancer and magnetic-field exposure published since the WHO report. In response to the WHO recommendation above, both a meta- and pooled analysis of studies on childhood brain tumors and residential magnetic-field exposure were conducted by Mezei et al. (2008b) and Kheifets et al. (2010b), respectively. In Mezei et al. (2008b), 13 epidemiologic studies were identified that used various proxies of residential magnetic-field exposure (distance, wire codes, calculated magnetic fields, and measured magnetic fields). The combined effect estimate was close to 1.0 and not statistically significant, indicating no association between magnetic-field exposure and childhood brain tumors. A sub-group of five studies, however, with information on childhood brain tumors and calculated or measured magnetic fields greater than 3-4 mG reported a combined OR that was elevated but not statistically significant (OR=1.68, 95% CI=0.83-3.43). The authors suggested two explanations for this elevated OR. First, they stated an increased risk of childhood brain tumors could not be excluded at high exposure levels (i.e., >3-4 mG). Second, they stated that the similarity of this result to the findings of the pooled analyses of childhood leukemia suggests that control selection bias is operating in both analyses. Overall, the authors concluded that the analysis did not find a significant increase in childhood brain cancer risk using various proxies of residential exposure to magnetic fields.

The pooled analysis by Kheifets et al. (2010b) provides stronger data compared to the meta-analysis described above because original data were used, various sub-group analyses were conducted, and there was adjustment for possible confounding variables (e.g., SES and mobility). The pooled analysis included data from 10 studies published from 1979-2010 of childhood brain or central nervous system cancer with long-term measurements, calculated fields, or spot measurements of residential magnetic-field exposure. Similar to childhood leukemia, few cases of childhood brain cancer had estimated magnetic-field exposures greater than 3-4 mG. None of the analyses showed statistically significant increases and, while some categories of high exposure had an OR $\geq$1.0, the overall patterns were not consistent with an association and no dose-response patterns were apparent. The authors concluded that their results provide little evidence for an association between magnetic fields and childhood brain tumors.

The pooled analysis included two case-control studies published after the WHO 2007 review (Kroll et al., 2010; Saito et al., 2010). Nearly 80% of the childhood brain cancer cases in the pooled analysis were contributed by Kroll et al. (2010), which evaluated 47 childhood brain cancer cases diagnosed over a 33-year period in the United Kingdom with their birth address within 400 m of a high-voltage transmission line. No associations with calculated magnetic-field exposure from nearby transmission lines were reported in any analysis of brain cancer in this large study, including calculated magnetic fields $\geq$1-2 mG, 2-4 mG, and 4mG.

In a case-control study of 55 cases of childhood brain cancer, Saito et al. (2010) reported that children with brain cancer were more likely to have average magnetic-field exposure levels greater than 4 mG, compared to children without brain cancer.[16] The association was based on three cases and one control; interpretations of the data were, therefore, limited by small numbers in the upper exposure category. The study was also limited by very poor participation rates among study subjects; poor participation rates introduce the possibility of selection bias, among other biases. The strength of this study was its exposure assessment. Measurements were taken continuously over a weeklong period in the child's bedroom approximately 1 year post-diagnosis.

In a recent pooled analysis of two Canadian case-control studies, Li et al. (2009) calculated individual maternal occupational magnetic-field exposure pre- and post-conception and analyzed these estimates in relation to brain cancer in offspring. Associations were reported between childhood brain cancer and average magnetic-field exposures greater than approximately 3 mG for exposure during the 2 years prior to conception and during conception; no associations were found using the cumulative and peak exposure metrics. Previous studies of parental occupational

[16] The unpublished results of this study were included in Mezei et al. (2008b).

magnetic-field exposure and childhood brain tumors have produced inconsistent results. More research is required in this area.

Assessment

Overall, recent studies were inconsistent, but the weight of the recent data does not support an association between magnetic-field exposures and the development of childhood brain cancer. The larger and more methodologically advanced work (Kheifets et al., 2010b; Kroll et al., 2010) does not support an association. The recent data do not alter the classification of the epidemiologic data in this field as inadequate.

Table 4. Relevant studies of childhood brain cancer published after the WHO review

Authors	Year	Study
Kheifets et al.	2010b	A pooled analysis of extremely low-frequency magnetic fields and childhood brain tumors
Kroll et al.	2010	Childhood cancer and magnetic fields from high-voltage power lines in England and Wales: A case-control study
Li et al.	2009	Maternal occupational exposure to extremely low frequency magnetic fields and the risk of brain cancer in the offspring
Mezei et al.	2008b	Residential magnetic field exposure and childhood brain cancer: A meta-analysis
Saito et al.	2010	Power frequency magnetic fields and childhood brain tumors: A case-control study in Japan

Breast cancer

The WHO reviewed studies of breast cancer and residential magnetic-field exposure, electric blanket usage, and occupational magnetic-field exposure. These studies did not report consistent associations between magnetic-field exposure and breast cancer. The WHO concluded that the recent body of research on this topic was less susceptible to bias compared with previous studies, and, as a result, it provided strong support to previous consensus statements that magnetic-field exposure does not influence the risk of breast cancer. Specifically, the WHO stated:

> Subsequent to the IARC monograph a number of reports have been published concerning the risk of female breast cancer in adults associated with ELF magnetic field exposure. These studies are larger than the previous ones and less susceptible to bias, and overall are negative. With these studies, the evidence for an association between ELF exposure and the risk of breast cancer is weakened considerably and does not support an association of this kind (p. 307, WHO 2007).

The WHO recommended no specific research with respect to breast cancer and magnetic-field exposure.

Recent studies (January 2006-May 2011)

Two case-control studies (McElroy et al., 2007; Ray et al., 2007) and one cohort study (Johansen et al., 2007) have recently been published in this field, all of which evaluated occupational magnetic-field exposure.[17] In addition, a meta-analysis of 15 studies of breast cancer and magnetic-field exposure was published (Chen et al., 2010), which included one of the recent case-control studies (McElroy et al., 2007).

Chen et al. (2010) meta-analyzed 15 studies published from 2000-2009 that examined residential or occupational magnetic-field exposure or electric blanket usage. The authors crudely re-categorized data from the original studies to reflect a common comparison of <2 mG and >2 mG and reported an overall OR of 0.99 (95% CI=0.90–1.1). The advantage of this meta-analysis is its very large size (24,338 cases and 60,628 controls). Its main limitation, however, is that data from a wide range of exposure definitions and cut-points were combined.

Ray et al. (2007) was a case-control study nested in a cohort of approximately 250,000 female textile workers in China followed for breast cancer incidence, and McElroy et al. (2007) evaluated occupational exposures to high, low, medium, or background EMF levels in a large number of breast cancer cases and controls. Neither study observed a significant association between breast cancer and estimates of high magnetic-field exposure. A large cohort study of utility workers in Denmark also reported that women exposed to higher occupational magnetic-field levels did not have higher rates of breast cancer (Johansen et al., 2007).

Recent methodological work for adult cancers (January 2006-May 2011)

Much of the research on EMF and adult cancers is related to occupational exposures, given the higher range of exposures encountered in the occupational environment. The main limitation of these studies, however, has been the methods used to assess exposure, with early studies relying simply on a person’s occupational title (often taken from a death certificate) and later studies linking a person’s full or partial occupational history to representative average exposures for each occupation (i.e., a JEM). The latter method, while advanced, still has some important limitations, as highlighted recently in a review by Kheifets et al. (2009) summarizing an expert panel’s findings.[18] While a person’s occupation may provide some indication of the overall magnitude of their occupational magnetic-field exposure, it does not take into account the possible variation in exposure due to different job tasks within occupational titles, the frequency and intensity of contact to relevant exposure sources, or variation by calendar time. Furthermore, since scientists do not know any mechanism by which magnetic fields could lead to cancer, an appropriate exposure metric is unknown. The expert panel concluded the following:

[17] In addition to the studies described in the text, Peplonska et al. (2007) is a case-control study of female breast cancer reporting associations for a wide range of occupations and industries. It is not considered in this report because no qualitative or quantitative estimates of magnetic-field exposure were made, beyond occupation and industry titles.

[18] Kheifets et al. (2009) reported on the conclusions of an independent panel organized by the Energy Networks Association in the United Kingdom in 2006 to review the current status of the science on occupational EMF exposure and identify the highest priority research needs.

> Inconsistent results for many of the outcomes [related to occupational EMF exposure] may be attributable to numerous shortcomings in the studies, most notably in exposure assessment. There is, however, no obvious correlation between exposure assessment quality and observed associations … To better assess exposure, we call for the development of a more complete job-exposure matrix that combines job title, work environment and task, and an index of exposure to electric fields, magnetic fields, spark discharge, contact current, and other chemical and physical agents (quoted in Kheifets et al., 2009)

Mee et al. (2009) measured the personal magnetic-field exposures of a proportion of their study participants in an ongoing case-control study of brain cancer in the United Kingdom (the UK Adult Brain Tumour Study). Personal magnetic-field measurements were taken for a minimum of 3 days by 317 persons (cases, controls, or proxies of either), and statistical analyses were performed to establish whether crude occupational classifications, which are traditionally employed in JEM, accounted for the observed variation in measured occupational magnetic-field exposures. The analysis confirmed that JEMs could be improved by linking occupational classifications with industry or information on participation in certain tasks of interest (e.g., use of welding equipment or work near power lines). Similarly, a recent study of the 48-hour exposure of 543 workers in Italy found that JEMs were a poor indicator of actual occupational, magnetic-field exposure levels; half of the occupations classified in the same JEM categories included significantly different individual TWAs (Gobba et al., 2011).

Assessment

These studies, particularly the meta-analysis and the large cohort of utility workers, add to growing support against a causal role for magnetic fields in breast cancer. These studies should receive weight in the overall assessment because of their large size, but the studies are still limited by deficiencies in exposure measures. Recent review papers (Feychting and Forssén 2006; Hulka and Moorman, 2008) and expert groups (SCENIHR, 2009) support the conclusion that magnetic-field exposure does not influence the risk of breast cancer.

Table 5. Relevant studies of breast cancer published after the WHO review

Authors	Year	Study
Chen et al.	2010	Extremely low-frequency electromagnetic fields exposure and female breast cancer risk: A meta-analysis based on 24,338 cases and 60,628 controls
Johansen et al.	2007	Risk for leukaemia and brain and breast cancer among Danish utility workers: A second follow-up
McElroy et al.	2007	Occupational exposure to electromagnetic field and breast cancer risk in a large, population-based, case-control study in the United States
Ray et al.	2007	Occupational exposures and breast cancer among women textile workers in Shanghai

Adult brain cancer

Brain cancer was studied along with leukemia in many of the occupational studies of EMF. The findings were inconsistent, and there was no pattern of stronger findings in studies with more advanced methods, although a small association could not be ruled out. The WHO classified the epidemiologic data on adult brain cancer as inadequate and recommended (1) updating the existing cohorts of occupationally-exposed individuals in Europe and (2) pooling the epidemiologic data on brain cancer and adult leukemia to confirm the absence of an association.

The WHO stated the following:

> In the case of adult brain cancer and leukaemia, the new studies published after the IARC monograph do not change the conclusion that the overall evidence for an association between ELF [EMF] and the risk of these disease remains inadequate (p. 307, WHO 2007).

Recent studies (January 2006-May 2011)

Epidemiologic studies published after 2005 on adult brain cancer and EMF exposure are listed in Table 6 and include four case-control studies, two cohort studies, and a meta-analysis.

In response to the WHO's recommendation, two cohorts of approximately 20,000 occupationally-exposed persons each were updated: a cohort of utility workers in Denmark and a cohort of railway workers in Switzerland (Johansen et al., 2007; Röösli et al, 2007a). In both cohorts, brain cancer rates were similar between jobs with high magnetic-field exposure and jobs with lower exposures, although a meta-analysis of earlier studies found a small, but statistically significant, increase in brain cancer risk for the highest category of occupational magnetic-field exposure (OR=1.14, 95% CI=1.07 – 1.22; Kheifets et al., 2008). Several findings, however, led the authors to conclude that magnetic-field exposure is not responsible for the observed association in this meta-analysis. For example, the recent meta-analysis reported a weaker association for brain cancer and magnetic-field exposure than the previous meta-analysis; a stronger association would be expected since the quality of studies has increased over time. The authors concluded "the lack of a clear pattern of EMF exposure and outcome risk does not support a hypothesis that these exposures are responsible for the observed excess risk" (p. 677).

Coble et al. (2009) was the highest quality, recent case-control study of magnetic-field exposure and adult brain cancer. The study authors evaluated the occupational exposures in the United States for gliomas and meningiomas, the two most common types of brain cancer. For the first time, the exposure metric in this study incorporated the frequency of exposure to EMF sources, as well as the distance people worked from these sources, on an individual basis. The authors also evaluated exposure metrics in addition to the TWA exposure (maximum exposed job, total years of exposure above 1.5 mG, cumulative lifetime exposure, and average lifetime exposure). No association was reported between any of these exposure metrics and brain cancer (including in separate analyses of gliomas and meningiomas). Using a standard JEM, a recent case-control study of gliomas in Australia reported no associations with higher estimates of magnetic-field exposure (Karipidis et al., 2007a).

The most recently published case-control study did not utilize advanced exposure assessment techniques (Baldi et al., 2010). Occupational exposure was based on a crude Swedish JEM that categorized participants as exposed or unexposed, and residential exposure was based on distance from the home at diagnosis (<100 m) to nearby power lines. ORs were elevated for occupational ELF EMF exposure and residence at diagnosis within 100 m of a power line, although findings were only statistically significant for occupational exposure to ELF EMF for meningiomas (OR=3.02, 95% CI=1.10-8.25).
In addition, Forssén et al. (2006) performed a large registry-based case-control study of acoustic neuroma and reported no association between higher occupational magnetic-field exposures and this benign and rare brain cancer type.

Assessment

Some recent studies have reduced possible exposure misclassification by improving exposure assessment methods (i.e., the expanded JEM in Coble et al., 2009) and attempted to clarify inconsistencies by updating studies and meta-analyzing data (Johansen et al., 2007; Röösli et al., 2007a; Kheifets et al., 2008); however, despite these advancements, an association has not been consistently observed in these studies. While an association still cannot be *entirely* ruled out because of the remaining deficiencies in exposure assessment methods and the lack of data on specific brain cancer subtypes, the current database of studies provides weak evidence of an association between magnetic fields and brain cancer.[19] The recent report by the SCENIHR described the data on brain cancers as "uncertain" (p. 43, SCENIHR 2009).

Table 6. Relevant studies of adult brain cancer published after WHO review

Authors	Year	Study
Baldi et al.	2010	Occupational and residential exposure to electromagnetic fields and risk of brain tumors in adults: A case-control study in Gironde, France
Coble et al.	2009	Occupational exposure to magnetic fields and the risk of brain tumors
Forssén et al.	2006	Occupational magnetic field exposure and the risk of acoustic neuroma
Johansen et al.	2007	Risk for leukaemia and brain and breast cancer among Danish utility workers: A second follow-up
Karipidis et al.	2007a	Occupational exposure to low frequency magnetic fields and the risk of low grade and high grade glioma
Kheifets et al.	2008	Occupational electromagnetic fields and leukemia and brain cancer: An update to two meta-analyses
Röösli et al.	2007a	Leukaemia, brain tumours and exposure to extremely low frequency magnetic fields: cohort study of Swiss railway employees

[19] A recent consensus statement by the National Cancer Institute's Brain Tumor Epidemiology Consortium confirms this statement. They classified residential power frequency EMF in the category "probably not risk factors" and described the epidemiologic data as "unresolved" (p. 1958, Bondy et al., 2008).

Adult leukemia and lymphoma

There is a vast amount of literature on adult leukemia and EMF, most of which is related to occupational exposures. Overall, the findings of these studies are inconsistent—with some studies reporting a positive association between measures of EMF and leukemia and other studies showing no association. No pattern has been identified whereby studies of higher quality or design are more likely to produce positive or negative associations. The WHO subsequently classified the epidemiologic evidence for adult leukemia as "inadequate." They recommended updating the existing occupationally-exposed cohorts in Europe and updating a meta-analysis on occupational magnetic-field exposure.

Recent studies (January 2006-May 2011)

Two cohorts of occupationally-exposed workers and a meta-analysis of occupational magnetic-field exposure (all of which were described above) reported on the possible association of occupational magnetic-field exposure and adult leukemia. Also, a case-control study described patterns of estimated residential magnetic-field exposure and combined lymphoma and leukemia diagnostic categories (Lowenthal et al., 2007).

In the occupational cohort of Swiss railway workers, the authors noted a stronger association among occupations with higher estimates of magnetic-field exposures, but the associations were not statistically significant (Röösli et al., 2007a). In the study of Danish utility workers, no increases in leukemia rates were observed in job titles that involved higher exposures to magnetic fields (Johansen et al., 2007). The updated meta-analysis by Kheifets et al. (2008) reported a weak association between estimated occupational magnetic-field exposure and leukemia, but the authors felt that the data was not indicative of a true association.

Lowenthal et al. (2007) grouped cases in five diagnostic categories as lymphoproliferative disorders (LPD) (including acute ALL) and cases in three diagnostic categories (as myeloproliferative disorders (MPD) (including acute myeloid leukemia [AML] and other leukemias). These groups included both adults and children of all ages. The authors estimated exposure by obtaining a lifetime residential history and assessing distance of residences from 88-kV, 110-kV, and 220-kV power lines. They reported elevated, but not statistically significant, ORs for those who lived within 50 m of any of these power lines, and an indication of decreasing ORs with increasing distance. This study adds very little to the existing database of information on adult leukemia and residential exposure, however, because of fundamental limitations. Most notable, different cancer types were combined as were different ages of diagnosis. It is well known that cancer etiology varies by cancer type, cancer subtype, and diagnostic age.[20]

Very little is known about the etiology of non-Hodgkin lymphoma (NHL), and few studies have been conducted in relation to magnetic-field exposure. In one of the first studies to estimate cumulative occupational magnetic-field exposure among NHL cases, Karipidis et al. (2007b) reported a statistically significant association between NHL and the highest category of exposure (OR=1.59, 95% CI=1.07-2.36). Overall, the study was well conducted, with its most significant

[20] The recent meta-analysis by Kheifets et al. (2010) implies that data are available from Lowenthal et al. (2007) for childhood leukemia as a separate diagnostic category. This information is not publicly accessible, however.

limitation being the possibility of uncontrolled confounding. In another case-control study of NHL, Wong et al. (2010) identified 649 cases from a hospital in Shanghai. Among numerous questions in the interview, cases and controls were asked whether they had ever lived within 100 m of a high-voltage power line. Results showed no association (i.e., no differences in residential history between cases and controls), but the strength of the study is limited by the use of distance as a proxy for exposure. Of note, the cohort of railway workers in Switzerland did not report an increase in NHL deaths among the more highly exposed workers (Röösli et al, 2007a). Further research in this area is required.

The recent literature also includes two observational studies of the biological responses in adults occupationally exposed to magnetic fields, which are relevant to an assessment of adult cancer risk. Gobba et al. (2008) examined whether there are differences in the activity of the natural killer (NK) cell, which is known to control cancer development, among persons occupationally exposed to magnetic fields. Higher measured magnetic-field levels during three complete work shifts (i.e., >10 mG) were associated with reduced NK activity. The existing literature related to immunology includes other human experimental and observational studies, *in vivo* studies, and *in vitro* studies. The WHO noted the inconsistency of these studies:

> Evidence for the effects of ELF electric or magnetic fields on components of the immune system is generally inconsistent. Many of the cell populations and functional markers were unaffected by exposure. However, in some human studies with fields from 10 μT to 2 mT, changes were observed in natural killer cells, which showed both increased and decreased cell numbers … In animal studies reduced natural killer cell activity was seen in female, but not male mice or in rats of either sex … Overall therefore, the evidence for effects of ELF electric or magnetic fields on the immune system and haematological system is considered inadequate (p. 237; WHO, 2007).

Sharifian et al. (2009) conducted a study of magnetic-field spot measurements among welders in the car manufacturing business in Iran, which ranged from 88 to 840 mG. The antioxidant activity of the workers' blood was compared to a control group of workers in the same factory that did not perform spot welding; no significant difference was found for the measure of total antioxidant activity, although a decrease in activity was found in the exposed group for two specific enzymes. These enzymes play a role in controlling free radicals, which can damage DNA. According to the WHO report, however, existing studies have not confirmed any induction of DNA damage by magnetic fields (p. 347, WHO, 2007).

In contrast to Sharifian et al., scientists at the National Laboratories of Health Canada measured the levels of damaged DNA in the blood of 20 persons exposed to magnetic-field levels of 2,000 mG for 4 hours and found no significant elevations in DNA damage above that observed in unexposed control subjects (Albert et al., 2009).

Thus, recent studies examined biological responses to magnetic fields, but their findings merely add to the existing database of inconsistent findings. Future studies are required to replicate these findings.

Assessment

A number of studies of adult leukemia have attempted to clarify inconsistencies by updating studies and meta-analyzing data (Johansen et al., 2007; Röösli et al, 2007a; Kheifets et al., 2008); however, despite these advancements, no clear or statistically significant association has been observed. While an association still cannot be *entirely* ruled out because of the remaining deficiencies in exposure assessment methods, the current database of studies provides weak evidence of an association between magnetic fields and leukemia. Preliminary results related to NHL have been published and require further investigation.

Table 7. Relevant studies of adult leukemia/lymphoma published after the WHO review

Authors	Year	Study
Johansen et al.	2007	Risk for leukaemia and brain and breast cancer among Danish utility workers: A second follow-up
Karipidis et al.	2007b	Occupational exposure to power frequency magnetic fields and risk of non-Hodgkin lymphoma
Kheifets et al.	2008	Occupational electromagnetic fields and leukemia and brain cancer: An update to two meta-analyses
Lowenthal et al.	2007	Residential exposure to electric power transmission lines and risk of lymphoproliferative and myeloproliferative disorders: A case-control study
Röösli et al.	2007a	Leukaemia, brain tumours and exposure to extremely low frequency magnetic fields: Cohort study of Swiss railway employees
Wong et al.	2010	A hospital-based case-control study of non-Hodgkin lymphoid neoplasms in Shanghai: Analysis of personal characteristics, lifestyle, and environmental risk factors by subtypes of the WHO classification

Reproductive/developmental effects

Two studies received considerable attention because of a reported association between peak magnetic field exposure greater than approximately 16 mG and miscarriage: a prospective cohort study of women in early pregnancy (Li et al., 2002) and a nested case-control study of women who miscarried compared to their late-pregnancy counterparts (Lee et al., 2002).

These two studies improved on the existing body of literature because average exposure was assessed using 24-hour personal magnetic-field measurements (early studies on miscarriage were limited because they used surrogate measures of exposure, including visual display terminal use, electric blanket use, or wire code data). Following the publication of these two studies, however, a hypothesis was put forth that the observed association may be the result of behavioral differences between women with “healthy” pregnancies that went to term (less physically active) and women who miscarried (more physically active) (Savitz, 2002). It was proposed that physical activity is associated with an increased opportunity for peak magnetic-field exposures, and the nausea experienced in early, healthy pregnancies and the cumbersomeness of late, healthy pregnancies would reduce physical activity levels, thereby decreasing the opportunity for exposure to peak magnetic fields. Furthermore, nearly half of women who had miscarriages reported in the cohort by Li et al. (2002) had magnetic-field measurements taken after miscarriage occurred, when changes in physical activity may have already occurred, and all measurements in Lee et al. (2002) occurred post-miscarriage.

The scientific panels that have considered these two studies concluded that the possibility of this bias precludes making any conclusions about the effect of magnetic fields on miscarriage (NRPB, 2004; FPTRPC, 2005; WHO, 2007). The WHO concluded, "There is some evidence for increased risk of miscarriage associated with measured maternal magnetic-field exposure, but this evidence is inadequate" (p. 254, WHO 2007). The WHO stated that, given the potentially high public health impact of such an association, further epidemiologic research is recommended.

Recent studies (January 2006-May 2011)

Epidemiologic studies of ELF EMF and reproductive and developmental effects are summarized in Table 8. No new original studies on magnetic-field exposure and miscarriage have been conducted; however, recent methodological studies, as described below, evaluated the likelihood that the observed association was due to bias.

Two additional studies were published related to developmental outcomes and growth. Fadel et al. (2006) conducted a cross-sectional study in Egypt of 390 children 0-12 years of age living in an area within 50 m of an electrical power line and 390 children 0-12 years of age living in a region with no power lines in close proximity. Measurements were taken as proxies of growth retardation, and radiological assessments were performed on carpal bones. The authors reported that children living in the region near power lines had a statistically significant lower weight at birth and a reduced head and chest circumference and height at all ages. The authors concluded that "exposure to low frequency electromagnetic fields emerged [*sic*] from high voltage electric power lines increases the incidence of growth retardation among children" (p. 211). This conclusion, however, fails to adequately take into account the many limitations of their cross-sectional analysis (namely, inadequate control for the possible confounding effects of nutritional status and SES). Public health statistics indicate that detrimental birth outcomes, including pre-term birth, low birth weight, or small for gestational age, occur more frequently in populations of lower SES (HHS, 2004); thus, analyses of adverse birth outcomes should be adjusted for these factors. The pre-existing body of literature does not support such an association (WHO, 2007).

Auger et al. (2011) studied whether maternal residence near transmission lines was associated with adverse birth outcomes, adjusting for socioeconomic factors, among all live births in Montreal and Canada between 1990 and 2004. Maternal residential distances were measured within 400 m of nearby transmission lines for over 700,000 live births, and the proportion of adverse events was compared between mothers living >400 m and within 400 m, adjusting for mother's age, education, household income, and other potential confounding factors. The analysis found no association with distances in 50 m increments for any of the outcomes: pre-term birth, low birth weight, small for gestational age, or proportion of male births. The use of distance as a surrogate of EMF exposure limits the value of this study, however.

Recent methodological work (January 2006-May 2011)

It is not possible to directly "test" for the effects of this bias in the original studies of miscarriage, but two recent analyses examined whether reduced physical activity was associated with a lower probability of encountering peak magnetic fields (Mezei et al., 2006; Savitz et al., 2006). In a 7-day study of personal magnetic-field measurements in 100 pregnant women, Savitz et al. (2006) reported that active pregnant women were more likely to encounter peak magnetic fields. In addition, an analysis by Mezei et al. (2006) of pre-existing databases of magnetic-field measurements among pregnant and non-pregnant women found that increased activity levels were associated with peak magnetic fields. These findings are broadly supportive of the hypothesis that reduced activity among women (in early pregnancies because of nausea and in later pregnancies because of cumbersomeness) may explain the observed association between peak magnetic fields and miscarriage. As noted in a recent commentary on this issue, however, the possibility that there is a relationship between peak magnetic-field exposure and miscarriage still cannot be excluded and further research that accounts for this possible bias should be conducted (Neutra and Li, 2008; Mezei et al., 2006). There remains no biological basis, however, to indicate that magnetic-field exposure increases the risk of miscarriage (WHO, 2007).

Assessment

Thus, the recent epidemiologic research does not provide sufficient evidence to alter the conclusion that the evidence for reproductive or developmental effects is inadequate.

Table 8. Relevant studies of reproductive and developmental effects published after the WHO review

Authors	Year	Study
Auger et al.	2011	The relationship between residential proximity to extremely low frequency power transmission lines and adverse birth outcomes
Fadel et al.	2006	Growth assessment of children exposed to low frequency electromagnetic fields at the Abu Sultan area in Ismailia (Egypt)
Mezei et al.	2006	Analyses of magnetic-field peak-exposure summary measures
Neutra and Li	2008	Letter to the Editor – Magnetic fields and miscarriage: A commentary on Mezei et al., JESEE 2006
Savitz et al.	2006	Physical activity and magnetic field exposure in pregnancy

Neurodegenerative diseases

Research into the possible effect of magnetic fields on the development of neurodegenerative diseases began in 1995, and the majority of research since then has focused on AD and a specific type of motor neuron disease called ALS, which is also known as Lou Gehrig’s disease. Early studies on ALS, which had no obvious biases and were well conducted, reported an association between ALS mortality and estimated occupational magnetic-field exposure. The review panels, however, were hesitant to conclude that the associations provided strong support for a causal relationship. Rather, they felt that an alternative explanation (i.e., electric shocks received at work) may be the source of the observed association.

The majority of the more recent studies discussed by the WHO reported statistically significant associations between occupational magnetic-field exposure and mortality from AD and ALS, although the design and methods of these studies were relatively weak (e.g., disease status was based on death certificate data, exposure was based on incomplete occupational information from census data, and there was no control for confounding factors). Furthermore, there was no biological data to support an association between magnetic fields and neurodegenerative diseases. The WHO panel concluded that there is "inadequate" data in support of an association between magnetic fields and AD or ALS. The panel recommended more research in this area using better methods; in particular, studies that enrolled incident AD cases (rather than ascertaining cases from death certificates) and studies that estimated electrical shock history in ALS cases were recommended. Specifically, the WHO concluded, "When evaluated across all the studies, there is only very limited evidence of an association between estimated ELF exposure and [Alzheimer's] disease risk" (p. 194, WHO 2007).

Recent studies (January 2006-May 2011)

Seven studies have been published since the WHO review. Two occupational cohorts were followed for neurodegenerative diseases—approximately 20,000 railroad workers in Switzerland (Röösli et al., 2007b) and over 80,000 electrical and generation workers in the United Kingdom (Sorahan and Kheifets, 2007). Three case-control studies collected incident cases of AD and estimated occupational magnetic-field exposure (Davanipour et al., 2007; Seidler et al., 2007; Andel et al., 2010), and a meta-analysis was conducted of occupational magnetic-field exposure and AD studies (García et al., 2008). The first study of non-occupational exposure and neurodegenerative diseases followed the Swiss population to evaluate associations with residential distance to power lines and death due to neurodegenerative diseases (Huss et al., 2009).

García et al. (2008) identified 14 epidemiologic studies with information on AD and occupational EMF exposure; the WHO considered the majority of these studies in their 2007 review. A statistically significant association between AD and occupational EMF exposure was observed for both case-control and cohort studies (OR=2.03, 95% CI=1.38-3.00 and RR=1.62, 95% CI=1.16-2.27, respectively), although the results from the individual studies were so different that the authors cautioned against the validity of these combined results. While some subgroup analyses had statistically significant increased risks and were not significantly heterogeneous between studies, the findings were contradictory between study design types (e.g., elevated pooled risk estimates were reported for *men* in cohort studies and elevated pooled risk estimates were reported for *women* in case-control studies). The authors concluded that their results suggest an association between Alzheimer's disease and occupational magnetic-field exposure, but noted the numerous limitations associated with these studies, including the difficulty of assessing EMF exposure during the appropriate time period, case ascertainment issues due to diagnostic difficulties, and differences in control selection. They recommended further research that uses more advanced methods.

Davanipour et al. (2007) extended an earlier hypothesis-generating study by Sobel et al. (1996) by collecting cases from eight California Alzheimer's Disease Diagnostic and Treatment Centers. Self-reported primary occupation was collected from patients with verified diagnoses of AD and compared to occupational information collected from persons diagnosed with other dementia-related problems at the Centers. The results of this study were consistent with the previous studies by Sobel et al.; cases were approximately twice as likely to be classified as having medium/high magnetic-field exposures, compared with controls. The strengths of this study included its large size and self-reported occupational information. The main limitation of this study was that the exposure assessment only considered a person's primary occupation, classified as low, medium, or high magnetic-field exposure. The WHO noted limitations of the 1996 publication that are relevant to this publication as well, including the use of controls with dementia (which some studies report have an increased risk of AD) and the classification of seamstresses, dressmakers, and tailors as “high exposure” occupations, which drives the increase in risk.

Seidler et al. (2007) conducted a similar case-control study in Germany, except cases included all types of dementia (55% of which had Alzheimer’s disease). Cumulative magnetic-field exposure was estimated from occupational histories taken from proxy respondents, and no difference was reported between cases of dementia or probable AD and controls, although an association was reported among electrical and electronics workers. The authors reported that exposure misclassification was likely to be a significant problem and concluded that their results indicate a strong effect of low-dose EMF is “rather improbable” (p. 114).

Sorahan and Kheifets (2007) followed a cohort of approximately 84,000 electrical and generation workers in the United Kingdom for deaths attributed to neurodegenerative disease on death certificates. Cumulative magnetic-field exposure was calculated for each worker, using job and facility information. The authors reported that the cohort did not have a significantly greater number of deaths due to AD or motor neuron disease compared to the general population in the United Kingdom. They also reported that persons with higher estimated magnetic-field exposures did not have a consistent excess of death due to AD or motor neuron disease compared to persons with lower estimated magnetic-field exposure. A statistically significant excess of deaths due to Parkinson’s disease was observed in the cohort, although there was no association between calculated magnetic-field exposure and Parkinson’s disease. The authors concluded “our results provide no convincing evidence for an association between occupational exposure to magnetic fields and neurodegenerative disease” (p. 14). This result is consistent with two other Alzheimer’s mortality follow-up studies of electric utility workers in the United States (Savitz et al., 1998) and Denmark (Johansen and Olsen, 1998). The findings may be limited by the use of death certificate data, but are strengthened by the detailed exposure assessment.

Death from several neurodegenerative conditions was also evaluated in a cohort of more than 20,000 Swiss railway workers (Röösli et al., 2007b). Magnetic-field exposure was characterized by specific job titles as recorded in employment records; stationmasters were considered to be in the lowest exposure category and were, therefore, used as the reference group. Train drivers were considered to have the highest exposure, and shunting yard engineers and train attendants were considered to have exposure intermediate to stationmasters and train drivers. Cumulative magnetic-field exposure was also estimated for each occupation using on-site measurements and modeling of past exposures. The authors reported an excess of senile dementia disease among train drivers, compared to station masters, however, the difference was not statistically significant. The association was larger when restricted to AD, but was still not statistically significant (hazard ratio [HR]=3.15, 95% CI=0.90-11.04); an association was observed between cumulative magnetic-field exposure and AD/senile dementia. No elevation in mortality was reported for multiple sclerosis, Parkinson’s disease, or ALS among train drivers, shunting yard engineers, or train attendants, compared with stationmasters, nor were more deaths from these causes observed for higher estimated magnetic-field exposures. Similar to another recent Swedish study (Feychting et al., 2003), the authors reported that recent exposure was more strongly associated with AD than past exposure.

There are several strengths of this study relative to the existing body of data. First, there is little turnover among Swiss railway employees, which means that study participants are enrolled in the cohort and possibly exposed for long periods of time. The wide variation in exposure levels between different occupations in the same industry allows for comparison of similar workers with different levels of exposure. Another advantage is that the company maintained detailed registers of employees, which means there is less potential for bias in the enumeration of the cohort and reconstruction of exposures. Finally, the authors reported that exposures to chemicals or electric shocks, which often occur in other occupational settings (for example, in electric utility workers or welders), are rare in this occupation.

Another cohort study conducted in Switzerland linked all persons older than 30 years of age at the 2000 census with a national database of death certificates from 2000 through 2005 (Huss et al., 2009). Residential location was extracted from 1990 and 2000 census data, and the closest distance of a person's home in 2000 to nearby 220-380 kV transmission lines was calculated. The authors reported that persons living within 50 m of these high-voltage transmission lines were more likely to have died from AD, compared to those living farther than 600 m, although chance could not be ruled out as an explanation (HR=1.24, 95% CI=0.80-1.92). The association was stronger for persons that lived at the residence for at least 15 years (HR=2.00, 95% CI=1.21-3.33). Associations of similar magnitude were reported for senile dementia and residence within 50 m of a high-voltage line. No associations were reported beyond 50 m for AD or senile dementia, and no associations were reported at any distance for Parkinson's disease, ALS, or multiple sclerosis.

The study's main limitation is the use of residential distance from transmission lines as a proxy for magnetic-field exposure (Maslanyj et al., 2009). It is also limited by the use of death certificate data, which are known to under-report AD, and the lack of a full residential and occupational history. Furthermore, while the underlying cohort was very large, relatively few cases of AD lived within 50 m of a high-voltage transmission line—20 cases total and 15 cases who lived at the residence for at least 15 years. This means that misclassification of a small number of cases could have a large impact on the risk estimate.

These limitations, along with others, were recently noted in a letter from the HCN's Electromagnetic Fields Committee.[21] The letter evaluated the study by Huss et al. (2009) and the pre-existing literature, including a recent cohort study of railway workers in Switzerland that reported an elevated risk of dying from AD among the most highly exposed workers (Röösli et al., 2007b). The letter concluded the following:

> The Committee considers the study by Huss et al. on residents near power lines to be of interest. The results of this study indicate that there might be an elevated risk of death caused by or with Alzheimer's disease in persons who have resided at a distance of less than 50 metres from an overhead power line for more than 10 years. Due to the restrictions stated above, no conclusion on a causal relationship can be drawn from this single study on the relationship between residing in the vicinity of power lines and Alzheimer's disease: it is not possible to pronounce upon the question of

[21] http://www.gezondheidsraad.nl/sites/default/files/200905E.pdf

> whether this elevated risk is also related to the exposure to the low-frequency magnetic fields generated by the power lines. Even though other studies, such as the one on Swiss railway employees, provide indications of an elevated risk of Alzheimer's disease in relation to exposure to low-frequency magnetic fields, prospective research is required in order to draw any conclusions. Factors that make an unambiguous interpretation more difficult will have to be controlled in these studies. More information is also required on possible biological mechanisms that could play a role in the effect of low-frequency magnetic fields on the initiation or development of Alzheimer's disease.

Another recent study used Sweden's large twin registry to assess occupational EMF exposure and dementia/AD (Andel et al., 2010). Twins over the age of 65 were interviewed by phone to screen for possible dementia, and cases were identified for further evaluation to determine whether they had dementia or AD; study subjects without either diagnosis were considered the control group. Study subjects or their proxies were asked to identify their major lifetime occupation, which was linked with a JEM to categorize EMF exposure into three, broad categories. In the overall twin population, EMF exposure was not associated with either dementia or AD. An association with EMF was observed for those employed in manual labor and for those with early onset dementia ($\leq$ 75 years at diagnosis), but not AD. This study's strength is the recruitment of living cases; however, small numbers limited the subgroup analyses and robust associations were not found.

Recent methodological work (January 2006-May 2011)

Santibáñez et al. (2007) documented the relatively poor quality of the studies included in the meta-analysis by García et al. (2008). Santibáñez et al. (2007) evaluated studies related to occupational exposure and AD, which included seven of the studies in the García et al. (2008) meta-analysis. Two epidemiologists blindly evaluated each of these studies using a questionnaire to assess the possibility of a number of biases, with a score assigned to each study that represented the percentage of possible points that the study obtained (range 0-100%). Only one of the seven studies obtained a score above 50% (a retrospective cohort study by Savitz et al. in 1998), and disease and exposure misclassifications were the most prevalent biases.

Assessment

In summary, two cohort studies of the Swiss population were followed for death due to neurodegenerative disease and found associations with AD/senile dementia mortality and occupational magnetic-field exposure and living within 50 m of a high-voltage transmission line for at least 15 years. Neither study reported an association with any other neurodegenerative disease, including ALS. A cohort of utility workers, however, did not confirm an association with AD mortality and magnetic-field exposure. The meta-analysis and supporting evaluation of study quality by García, Santibáñez, and colleagues confirmed that the associations reported in previous occupational studies are highly inconsistent and the studies have many limitations. The three recent case-control studies did not provide strong evidence either for or against an association.

The main limitations of these studies include the difficulty in diagnosing AD; the difficulty of identifying a relevant exposure window given the long and nebulous course of this disease; the difficulty of estimating magnetic-field exposure prior to the appearance of the disease; the under-reporting of AD on death certificates; crude exposure evaluations that are often based on the recollection of occupational histories by friends and family given the cognitive impairment of the study participants; and the lack of consideration of both residential and occupational exposures or confounding variables.

The recent epidemiologic studies do not alter the conclusion that there is inadequate data on AD and ALS. While seven new studies have been published since the WHO review, little progress has been made on clarifying these associations. Further research is still required, particularly on electrical occupations and ALS (Kheifets et al., 2008). Röösli recommended a cohort study with systematic disease screening, prospective collection of exposure information, and the collection of residential and occupational magnetic-field exposure (Röösli, 2008). There is currently no body of *in vivo* research to suggest an effect and two studies reported no effect of magnetic fields on ALS progression (Seyhan and Canseven, 2006; Poulletier de Gannes et al., 2008). These conclusions are consistent with the recent review by the SCENIHR (SCENIHR, 2009).

Table 9. Relevant studies of neurodegenerative disease published after the WHO review

Authors	Year	Study
Andel et al.	2010	Work-related exposure to extremely low-frequency magnetic fields and dementia: Results from the population-based study of dementia in Swedish twins
Davanipour et al.	2007	A case-control study of occupational magnetic field exposure and Alzheimer's disease: Results from the California Alzheimer's Disease Diagnosis and Treatment Centers
García, et al.	2008	Occupational exposure to extremely low frequency electric and magnetic fields and Alzheimer disease: a meta-analysis
Huss, et al.	2009	Residence near power lines and mortality from neurodegenerative diseases: longitudinal study of the Swiss population
Röösli, et al.	2007b	Mortality from neurodegenerative disease and exposure to extremely low-frequency magnetic fields: 31 years of observations on Swiss railway employees
Santibáñez, et al.	2007	Occupational risk factors in Alzheimer's disease: A review assessing the quality of published epidemiological studies
Seidler et al.	2007	Occupational exposure to low frequency magnetic fields and dementia: A case-control study
Sorahan and Kheifets	2007	Mortality from Alzheimer's, motor neurone and Parkinson's disease in relation to magnetic field exposure: Findings from the study of UK electricity generation and transmission workers, 1973-2004

Cardiovascular disease

It has been hypothesized that magnetic-field exposure reduces heart rate variability, which in turn increases the risk for AMI. In a large cohort of utility workers, Savitz et al. (1999) reported an increased risk of arrhythmia-related deaths and deaths due to AMI. Previous and subsequent studies did not report a statistically significant increase in cardiovascular disease (CVD) mortality or incidence related to occupational magnetic-field exposure (WHO, 2007).

The WHO concluded:

> Experimental studies of both short- and long-term exposure indicate that, while electric shock is an obvious health hazard, other hazardous cardiovascular effects associated with ELF fields are unlikely to occur at exposure levels commonly encountered environmentally or occupationally. Although various cardiovascular changes have been reported in the literature, the majority of effects are small and the results have not been consistent within and between studies. With one exception [Savitz et al. 1999], none of the studies of cardiovascular disease morbidity and mortality has shown an association with exposure. Whether a specific association exists between exposure and altered autonomic control of the heart remains speculative. Overall, the evidence does not support an association between ELF exposure and cardiovascular disease." (p. 220; WHO, 2007)

Recent studies (January 2006-May 2011)

The recent literature includes a cohort representative of the general working population in the United States that was assembled from a census-derived database (the National Longitudinal Mortality Study [NLMS]) and linked to the National Death Index for follow-up of death due to CVD through 1989 (Cooper et al., 2009). The NLMS includes persons selected from the United States census 1979–1981 and their last or current job title, which was linked to an average occupational magnetic-field exposure based on a JEM. No increase in CVD mortality overall, or for specific CVD types, was reported with indirect control for smoking and some demographic risk factors.

The study by Cooper et al. (2009) is limited by incomplete information in the NLMS (e.g., a full occupational history and potential confounding variables), as well as a crude JEM. Although limited, the study's findings are consistent with the WHO conclusion that the evidence does not support an association. A recent systematic review by McNamee et al. (2009) also noted that the epidemiologic literature does not support an association, although future research is still needed given the limitations of the existing literature.

Another recent study by McNamee et al. (2011) evaluated whether magnetic fields affect human heart rate and heart rate variability. Forty-eight study participants were exposed for 1 hour to a 18,000 mG magnetic field in a controlled fashion, and no effects on cardiovascular parameters were observed.

Assessment

Recent studies, while limited, are consistent with the conclusion that there is no association between magnetic fields and CVD or cardiovascular parameters related to CVD.

Table 10. Relevant studies of cardiovascular disease published after the WHO review

Authors	Year	Study title
Cooper et al.	2009	A population-based cohort study of occupational exposure to magnetic fields and cardiovascular disease mortality
McNamee et al.	2011	The response of the human circulatory system to an acute 200-μT, 60-Hz magnetic field exposure

In vivo studies of carcinogenesis

In the field of ELF EMF research, a number of research laboratories have exposed rodents, including those with a particular genetic susceptibility to cancer, to high levels of magnetic fields over the course of the animals' lifetime and performed tissue evaluations to assess the incidence of cancer in many organs. In these studies, magnetic-field exposure has been administered alone (to test for the ability of magnetic fields to act as a complete carcinogen), in combination with a known carcinogen (to test for a promotional or co-carcinogenetic effect), or in combination with a known carcinogen and a known promoter (to test for a co-promotional effect).

The WHO review described four large-scale, long-term studies of rodents exposed to magnetic fields over the course of their lifetime that did not report increases in any type of cancer (Mandeville et al., 1997; Yasui et al., 1997; Boorman et al., 1999a, 1999b; McCormick et al., 1999). No directly relevant animal model for childhood ALL existed at the time of the WHO report. Some animals, however, develop a type of lymphoma similar to childhood ALL and studies exposing predisposed transgenic mice to ELF magnetic fields did not report an increased incidence of this lymphoma type (Harris et al., 1998; McCormick et al., 1998; Sommer and Lerchel, 2004).

Studies investigating whether exposure to magnetic fields can promote cancer or act as a co-carcinogen used known cancer-causing agents, such as ionizing radiation, ultraviolet radiation, or other chemicals. No effects were observed for studies on chemically-induced preneoplastic liver lesions, leukemia or lymphoma, skin tumors, or brain tumors; however, the incidence of 7,12-dimethylbenz[a]anthracene (DMBA)-induced mammary tumors was increased with magnetic-field exposure in a series of experiments in Germany (Löscher et al., 1993, 1994, 1997; Mevissen et al., 1993a,1993b, 1996a, 1996b, 1998; Baum et al., 1995; Löscher and Mevissen, 1995), suggesting that magnetic-field exposure increased the proliferation of mammary tumor cells. These results were not replicated in a subsequent series of experiments in a laboratory in the United States (Anderson et al., 1999; Boorman et al.1999a, 1999b), possibly due to differences in experimental protocol and the species strain. In Fedrowitz et al. (2004), exposure enhanced mammary tumor development in one sub-strain (Fischer 344 rats), but not in another sub-strain that was obtained from the same breeder, which argues against a promotional effect of magnetic fields.[22]

Some studies have reported an increase in genotoxic effects among exposed animals (e.g., DNA strand breaks in the brains of mice [Lai and Singh, 2004]), although the results have not been replicated.

In summary, the WHO concluded the following with respect to *in vivo* research: “There is no evidence that ELF exposure alone causes tumours. The evidence that ELF field exposure can enhance tumour development in combination with carcinogens is inadequate” (p. 322, WHO 2007). Recommendations for future research included the development of a rodent model for childhood ALL and the continued investigation of whether magnetic fields can act as a promoter or co-carcinogen.

Recent studies (January 2006-May 2011)

In view of the available evidence that exposure to magnetic fields *alone* does not increase the occurrence of cancer, the literature published following the WHO review includes numerous *in vivo* studies testing different hypotheses of cancer promotion, including effects on brain cancer (Chung et al., 2008), breast cancer (Fedrowitz and Löscher, 2008), and lymphoma or leukemia (Bernard et al., 2008; Negishi et al., 2008), as referenced below.[23] In each of these studies, the animals were treated first with chemicals known to initiate the cancer process. Initiated animals are more likely to develop cancer, and a subsequent exposure, known as a promoter, is often needed for an initiated cell to reproduce into many cancer cells. Studies treated the animals with the initiators ethylnitrosourea (ENU) (Chung et al., 2008), n-butylnitrosourea (BNU) (Bernard et al., 2008), and DMBA (Fedrowitz and Löscher, 2008; Negishi et al., 2008).

Chung et al. (2008) examined the possible role of 60-Hz magnetic fields in promoting brain tumors initiated by ENU injections *in utero*; the authors concluded that there was no evidence that exposure to 60-Hz magnetic fields up to 5,000 mG promoted tumor development in this study.

The study by Bernard et al. (2008) provides a significant development, in that it is the first study to use an animal model of ALL, the most common leukemia type in children. All rats were exposed to BNU to initiate the leukemogenic process, and a sub-group of rats was exposed to magnetic fields of 1,000 mG for 18 hours per day for 52 weeks. No difference in leukemia incidence was observed between the BNU-treated group exposed to magnetic fields and the BNU-treated unexposed group. This study supports the hypothesis that magnetic fields do not affect the development of ALL and provides additional support to the conclusion that experimental data is not supportive for a role of magnetic fields in the incidence of childhood leukemia. The researchers followed guidelines for the experimentation and care of laboratory

[22] The WHO concluded with respect to the German studies of mammary carcinogenesis, “Inconsistent results were obtained that may be due in whole or in part to differences in experimental protocols, such as the use of specific substrains” (p. 321, WHO 2007a).

[23] Studies of genotoxicity and oxidative damage *in vivo* have also been published since 2006, but these studies are only conceptually linked to carcinogenicity; this summary focuses on studies of tumor progression since these studies are the most relevant.

animals and conducted the analyses blind to the treatment group. Experience with this strain of rat is limited, however, so it is unclear whether the results are more or less reliable than other animal models; replication is required.

Fedrowitz and Löscher (2008) is the most recent study from the German laboratory that previously reported increases in DMBA-induced mammary tumors with high magnetic-field exposure. In this recent study, the researchers exposed DMBA-treated Fischer 344 rats (the strain of inbred rats used in previous experiments) to either high levels of magnetic fields (1,000 mG) or no exposure for 26 weeks and reported that the incidence of mammary tumors was significantly elevated in the group exposed to magnetic fields (Fedrowitz and Löscher, 2008). No independent replication of this experiment has occurred, and questions still remain about the effect of experimental protocol and species strain.

Negishi et al. (2008) treated newborn mice with DMBA and magnetic fields up to 3,500 mG. The authors reported that the percentage of mice with lymphoma or lymphatic leukemia was not higher in magnetic-field exposed groups, compared to the sham-exposed group.

In another study of lymphatic system cancers, Sommer and Lerchel (2006) tested whether magnetic fields alone increased the incidence of lymphoma in mice virally predisposed to lymphoblastic lymphoma. It is a follow-up to an earlier study (Sommer and Lerchl, 2004) that reported no increases in lymphoma among predisposed animals chronically exposed to magnetic fields (up to 1,000 mG for 24 hours per day for 32 weeks). Sommer and Lerchl (2006) increased magnetic-field exposure to 10,000 mG and exposed some of the animals only during the night to test the hypothesis that nighttime exposure may have a stronger effect than continuous exposure. Magnetic fields did not influence body weight, time to tumor, cancer incidence, or survival time in this study.

Chung et al (2010) also evaluated the effect of magnetic fields on lymphoma in a study of AKR mice, which are genetically predisposed to thymic lymphoblastic lymphoma. Exposures ranged from 50-500 mG for 21 hours per day for 40 weeks, and cancer incidence was compared with a sham-exposed control group. Potential confounding variables (such as temperature, humidity, and magnetic-field variations) were monitored daily. The experiment was performed blind to ensure that biases were not introduced by investigator knowledge of exposure conditions. Magnetic-field exposures were not associated with changes in body weight, survival time, or the incidence of lymphoma compared to sham-treated controls. Exposure also did not affect components of the blood, micronuclei formation, or gene expression in the thymus.

Table 11. Relevant *in vivo* studies of carcinogenesis published after the WHO review

Authors	Year	Study
Bernard et al.	2008	Assessing the potential leukemogenic effects of 50 Hz and their harmonics using an animal leukemia model
Chung et al.	2008	Lack of a co-promotion effect of 60 Hz rotating magnetic fields on n-ethyl-n-nitrosourea induced neurogenic tumors in F344 rats
Chung et al.	2010	Lack of a co-promotion effect of 60 Hz rotating magnetic fields on N-ethyl-N-nitrosourea induced neurogenic tumors in F344 rats
Fedrowitz and Löscher	2008	Exposure of Fischer 344 rats to a weak power frequency magnetic field facilitates mammary tumorigenesis in the DMBA model of breast cancer
Negishi et al.	2008	Lack of promotion effects of 50 Hz magnetic fields on 7,12-dimethylbenz(a)anthracene-induced malignant lymphoma/lymphatic leukemia in mice
Sommer and Lerchl	2006	50 Hz magnetic fields of 1 mT do not promote lymphoma development in AKR/J mice

Assessment

Thus, aside from the most recent replication of enhanced mammary carcinogenesis in a specific sub-strain of rats in a German laboratory, recent studies provide further evidence against a role for magnetic fields as a carcinogen or co-carcinogen. These studies strengthen the conclusion that there is inadequate evidence of carcinogenicity from *in vivo* research, although independent confirmation of the German results is of high priority.

7 Recently Published Reviews by Scientific Organizations

A number of national and international scientific organizations have published reports or scientific statements with regard to the possible health effects of ELF EMF since January 2006. Although none of these documents represents a cumulative weight-of-evidence review of the caliber of the WHO review published in June 2007, their conclusions are of relevance. In general, the conclusions of these reviews are consistent with the scientific consensus articulated in Section 6.

The following list indicates the scientific organization and a link to the online reports or statements.

- **The Health Council of Netherlands**
    - http://www.gezondheidsraad.nl/en/publications/advisory-letter-power-lines-and-alzheimer-s-disease (HCN, 2009a)
    - http://www.gezondheidsraad.nl/sites/default/files/200902.pdf (HCN, 2009b)
    - http://www.gezondheidsraad.nl/en/publications/bioinitiative-report-0 (HCN, 2008a)
    - http://www.gezondheidsraad.nl/en/publications/high-voltage-power-lines-0 (HCN, 2008b)
- **The Health Protection Agency (United Kingdom)**
    - http://www.hpa.org.uk/Publications/Radiation/DocumentsOfTheHPA/RCE01PowerFrequencyElectromagneticFieldsRCE1/ (HPA, 2006)
- **The International Commission on Non-Ionizing Radiation Protection**
    - http://www.icnirp.de/documents/LFgdl.pdf (ICNIRP, 2010)
- **The Scientific Committee on Emerging and Newly Identified Health Risks (European Union)**
    - http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scenihr_o_007.pdf (SCENIHR, 2007)
    - http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scenihr_o_022.pdf (SCENIHR, 2009)

- **The Swedish Radiation Protection Authority**
  - http://www.who.int/peh-emf/publications/reports/SWEDENssi_rapp_2006.pdf (SSI, 2007)
  - http://www.who.int/peh-emf/publications/reports/SWEDENssi_rapp_2007.pdf (SSI, 2008)
- **The Swedish Radiation Safety Authority**
  - http://www.stralsakerhetsmyndigheten.se/Global/Publikationer/Rapport/Stralskydd/2009/SSM-Rapport-2009-36.pdf (SSM, 2009)
  - http://www.stralsakerhetsmyndigheten.se/Global/Publikationer/Rapport/Stralskydd/2010/SSM-Rapport-2010-44.pdf (SSM, 2010)

8 Summary

A number of epidemiologic and *in vivo* studies have been published on EMF and health since the WHO 2007 report in June 2007. The weak statistical association between high, average magnetic fields and childhood leukemia remains largely unexplained and unsupported by the experimental data. The recent *in vivo* studies confirm the lack of experimental data supporting a leukemogenic risk associated with magnetic-field exposure.

Overall, the current body of research supports the conclusion that there is no association between magnetic fields and adult cancer or cardiovascular disease, although future research is needed that improves upon exposure estimations. Recent literature suggested an association with magnetic fields and AD, but firm no conclusions can be drawn from this literature set regarding causation.

In conclusion, no recent studies provide evidence to alter the conclusion that the research suggests EMF exposure is not the cause of cancer or any other disease process at the levels we encounter in our everyday environment.

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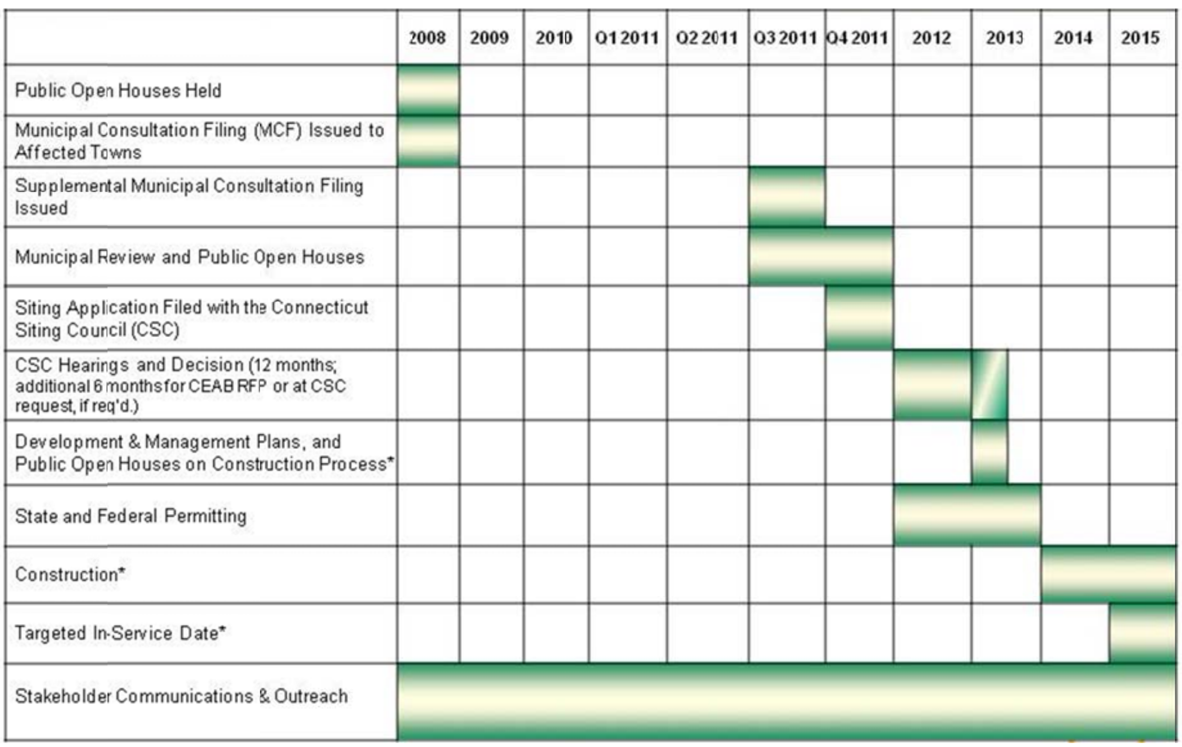
SECTION 8

PROPOSED PROJECT SCHEDULE

8. PROPOSED PROJECT SCHEDULE

Figure 8-1 illustrates the key activities in CL&P's proposed schedule for developing the Connecticut portion of the Interstate Reliability Project. Although not depicted on the schedule, initial Project planning began in 2004. As indicated on the schedule, CL&P issued the initial MCF for the Project in August 2008. Subsequently, additional planning, engineering analyses, and environmental investigations were conducted; community outreach efforts also continued. The schedule in Figure 8-1 does not illustrate the Project activities that CL&P performed prior to the issuance of the Supplemental MCF in July 2011, but rather focuses on the future Project timeline.

Figure 8-1: Connecticut Portion of the Interstate Reliability Project – Estimated Timeline



*Pending receipt of approvals from the Council and federal / state regulatory agencies.
*Note that the construction timeline refers to the installation of the new 345-kV transmission lines and station modifications, and does not necessarily include the completion of all ROW restoration and post-installation monitoring activities.

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SECTION 9

PERMITS, APPROVALS, AND CONSULTATIONS

9. PERMITS, APPROVALS, AND CONSULTATIONS

As part of the Project planning process, CL&P has coordinated extensively, over a multi-year period, with the public and representatives of the 11 towns that would be traversed by the new 345-kV transmission lines along the Proposed Route, as well as with representatives of the federal and state regulatory agencies from whom approvals for the Project would be required. CL&P also consulted with the Town of Windham, the only additional municipality that would be affected by the route variations (refer to Volume 1A, Section 15.5). CL&P will continue such consultations as the planning and review of the Project proceeds. This section identifies the permits and approvals that would be required for the construction and operation of the Connecticut portion of the Interstate Reliability Project[1], and summarizes the federal and state agency and municipal consultations that CL&P has conducted to date concerning the Project.

9.1 AGENCY PERMITS AND APPROVALS REQUIRED FOR THE PROJECT

In addition to a Certificate of Environmental Compatibility and Public Need from the Council, the Project would require various permits and approvals from other Connecticut and federal agencies. At the federal level, the entire three-state Interstate Reliability Project must comply with the Clean Water Act (CWA), Endangered Species Act, and National Historic Preservation Act. Furthermore, CL&P would need USACE approval for the expansion of the existing ROW across the USACE-owned properties in the Mansfield Hollow area.[2]

At the state level, along with compliance with the Council's requirements, CL&P would have to obtain Project-specific permits or approvals pertaining to water quality (pursuant to Section 401 of the CWA),

[1] The portions of the Interstate Reliability Project in Rhode Island and Massachusetts will require additional state-specific approvals, which are not identified herein.

[2] Configuration options for the development of the new 345-kV transmission line across the USACE-owned properties in the Mansfield Hollow area are described in Section 10. Two of these options, including the Proposed Route, would involve ROW expansion on federally-owned properties, while the third option would allow the development of the new 345-kV line within the existing 150-foot-wide ROW (no ROW expansion).

stormwater management, threatened and endangered species, and cultural resources. Additional state approvals may be required, depending on the final design of the Project.

Table 9-1 summarizes the federal and state permits and approvals expected to be required for the proposed Project. This summary is based on currently available data concerning the Project, and may be modified as the Project planning, design, and review process moves forward.

9.2 FEDERAL AND STATE AGENCY CONSULTATIONS

In conjunction with the overall Project planning, CL&P initiated consultations with the federal and state agencies likely to be involved in the review or approval of the Project. The purpose of these initial consultations was to provide the agencies with preliminary information regarding the proposed Project, and to solicit from the agencies baseline information concerning the Project area or potential Project-related issues.

Table 9-2 summarizes the federal and state agency consultations conducted to date. Volume 4 includes copies of correspondence to and from agencies regarding the Project. As Table 9-2 illustrates, certain agency consultations date to 2004, when CL&P first began to evaluate possible transmission line solutions involving northeastern Connecticut.

Most recently, between mid-June and the end of October 2011, CL&P conducted pre-application meetings regarding the Project with the USACE, the U.S. Environmental Protection Agency, and CT DEEP. CL&P expects to continue to coordinate closely with these and other regulatory agencies during the permit application submission and review phases of the Project.

Table 9-1: Potential Permits, Reviews, and Approvals Required for the Project

Agency	Certificate, Permit, Review, Approval or Confirmation	Activity Regulated
FEDERAL		
U.S. Army Corps of Engineers (USACE), New England District	Section 404 CWA Easement Expansion Approval	Discharge of dredge or fill material into waters of the U.S. (wetlands or watercourses) Real Estate Approval: easement expansion across Mansfield Hollow properties
U.S. Fish and Wildlife Service	Coordinates with USACE regarding endangered or threatened species (non-marine); provides input to USACE permit application review	Construction or operation activities that may affect federally-listed endangered or threatened species
U.S. Environmental Protection Agency	Provides input to USACE permit application review	Construction or operation activities that may affect water, air, or other resources
Advisory Council on Historic Preservation	Involved if cultural resource sites would be potentially affected by the Project	Section 106 National Historic Preservation Act compliance; input to USACE permit review, if applicable
CONNECTICUT		
Connecticut Siting Council	Certificate of Environmental Compatibility and Public Need Development & Management Plan approval prior to construction	General transmission line need, siting, construction, environmental compatibility, safety, and operation / maintenance and ROW management procedures
Department of Energy and Environmental Protection (CT DEEP)	401 Water Quality Certification	Conformance to Section 401 of the CWA; Section 401 approval from CTDEEP is required prior to USACE permit issuance
	General Permit	Stormwater management during construction
	Stream Channel Encroachment Line (SCEL) Permit: Span of Willimantic River	Construction activities riverward of SCEL (if applicable; currently, no new structures are proposed within the SCEL)
	Water Diversion Permit	Installation of permanent culverts across streams with a watershed of 100 acres or more
	Threatened, Endangered, and Special Concern Species	Approval of species-specific mitigation plans as part of Council's process, 401 Water Quality Certification approval
CT DEEP Public Utilities Regulatory Authority	Approval pursuant to C.G.S. Section 16-243	Method & Manner of Construction Approval to Energize Lines
State Historic Preservation Office (SHPO)[3]	Approval of proposed Project consistency with the National Historic Preservation Act; comments during Council and USACE processes	Construction and operation activities that may affect archaeological or historic resources.
Connecticut Department of Transportation (ConnDOT)	Encroachment permit	Transmission line crossing of state highways

[3] The SHPO is part of the Connecticut Commission on Culture and Tourism, Historic Preservation and Museum Division.

Table 9-2: List of Federal and State Agency Consultations to Date

AGENCY	DATE	AGENCY CONTACT
FEDERAL		
USACE, New England District	10/24/07 4/9/08 6/15/2011 6/20/2011 8/22/2011 9/16/2011	Susan Lee Michael Sheehan J. Johnson P. Bradstreet Michael Elliot Dave Keddell Paul Minkin Paul Sargent J. Redlinger
U.S. Environmental Protection Agency	9/16/2011	E. Reiner
U.S. Department of Interior - Fish & Wildlife Service	7/20/04 7/30/07 9/4/07 10/11/07 11/21/07 1/1/08 1/2/09 3/17/09 4/10/09 5/13/09 3/19/10	Michael J. Amaral Anthony P. Tur Thomas R. Chapman Eric R. Derleth
Federal Aviation Administration	Spring 2009	General
CONNECTICUT		
CT DEEP	3/26/08, 12/2010 6/17/2011 10/28/2011 12/5/2011 12/7/2011	Neal Hagstrom, S. Gephard M. Salter C. Clark S. Peterson
CT DEEP – Franklin Wildlife Management Area	8/2/04 2/25/08 4/15/08 6/16/09	Julie Victoria
CT DEEP - Natural/Diversity Database	7/20/04 10/6/04 10/11/07 3/17/08 3/17/09 6/2/09 6/8/09 3/8/10	Dawn M. McKay Nancy Murray Julie Victoria
SHPO	6/5/08	David A Poirier Daniel Forrest

9.3 MUNICIPAL, PUBLIC, AND OTHER CONSULTATIONS

CL&P has conducted extensive community outreach throughout the planning and municipal consultation phases of the Project. During this time, public officials of the 12 towns in which the Proposed Route and route variations would be located were informed and consulted. Additionally, key state and federal elected officials, non-governmental environmental groups, and other stakeholders were offered briefings and consulted regarding the proposed Project. This comprehensive public outreach process included conformance to the Council's requirements for a Municipal Consultation Filing (MCF). CL&P plans to continue this proactive outreach as the Project moves forward.

As a primary mechanism both for informing the public about the Project and for soliciting comments on the Project from local leadership and the public, CL&P conducted extensive municipal consultations, in accordance with the Council's MCF requirements. The MCF, which is a key component of the Council's application process, requires applicants intending to apply for a Council Certificate of Environmental Compatibility and Public Need to consult with potentially affected municipalities at least 60 days prior to the Application filing date. The pre-application consultation must include, but not be limited to, good faith efforts to meet with the chief elected official of each potentially affected municipality and to provide technical reports concerning the public need, site selection process, and environmental effects of the proposed facilities.

In August 2008, CL&P submitted an initial, five-volume MCF for the Project. This MCF was duly noticed and provided to all 12 of the towns in which the then-identified primary route under consideration and any potential route variations were planned for location. During the municipal consultation period, CL&P offered to meet with each of these towns to review the MCF in more detail, both to present an overview of the Project and the siting process and to review the methods available for each town to provide input to the Project's siting process. At these meetings, CL&P gained input from the municipal officials regarding concerns or special considerations associated with the proposed route in their particular town.

In the fall of 2008, CL&P held four public “open house” meetings to discuss the Project with residents and to obtain comments. Members of the Project team were available at these open house sessions to provide information and to answer specific questions.

In July 2011, CL&P submitted a Supplemental MCF that augmented and updated the original August 2008 MCF. The 2011 Supplemental MCF, which also was provided to all of the towns along the Proposed Route and potential route variations, consisted of multiple volumes that provided details regarding the Project need, technical specifications and environmental characteristics of the Proposed Route, the alternatives considered (including the six route variations), and potential environmental effects. The Supplemental MCF also included aerial-photography-based maps that illustrate the locations of the Proposed Route and route variations in relation to land uses and environmental features.

In conjunction with the submission of the Supplemental MCF, CL&P again offered to meet with the chief elected officials of each of the 11 towns along the Proposed Route, as well as with officials from the Town of Windham (which would be traversed by two of the route variations). Briefings were also offered to key state and federal elected officials, non-governmental environmental groups, and other stakeholders to discuss the reaffirmed need for the Project and to provide an update of the Project planning efforts conducted after the 2008 MCF.

In addition, after the issuance of the Supplemental MCF, CL&P held two additional “open houses” – in the towns of Killingly (Danielson area) and Mansfield – to again provide the public with the opportunity to obtain information about and provide comments on the Project. These open houses were held on August 23, 2011 (Killingly / Danielson) and on December 8, 2011 (Mansfield).

The overall objective of the municipal consultation process was to obtain input regarding the proposed Project from representatives of each of the towns potentially affected by the proposed transmission facilities, as well as from the interested public. In accordance with the Council's requirements, within 15 days of filing the Application for the Project, CL&P will provide to the Council a summary of the consultations with the towns, including any comments or recommendations issued by the municipalities as well as copies of comments received from the public.

Table 9-3 summarizes the primary meetings CL&P has held to date with municipal officials, state and federal officials, and other key stakeholder groups. Table 9-4 lists the "open houses" that CL&P held in conjunction with both the 2008 MCF and the 2011 Supplemental MCF.

Table 9-3: Meetings Held To-Date with Municipal Officials, State and Federal Officials, and Other Key Stakeholder Groups

Stakeholder Group	Date of Meeting	Purpose of Meeting
Municipal Officials		
Town of Brooklyn	9/6/07 3/17/11 8/4/11	Project Introduction – First Selectman New Chief Executive Official Briefing Supplemental MCF Briefing – First Selectman
Town of Chaplin	9/26/07 9/16/08 4/21/11 7/21/11	Project Introduction – First Selectman MCF Briefing – First Selectman New Chief Executive Official Briefing Supplemental MCF Briefing – First Selectman
Town of Columbia	9/21/07 9/8/08 3/24/11 7/29/11	Project Introduction – First Selectman MCF Briefing – First Selectman New Chief Executive Official Briefing Supplemental MCF Briefing – First Selectman
Town of Coventry	9/25/07 8/22/08 8/4/11	Project Introduction – First Selectman MCF Briefing – Town Manager Supplemental MCF Briefing – Town Manager
Town of Hampton	9/6/07 10/21/08 3/24/11 8/4/11 11/7/11 12/5/11	Project Introduction – First Selectman MCF Briefing - Conservation Commission New Chief Executive Official Briefing Supplemental MCF Briefing – First Selectman Supplemental MCF Briefing – Board of Selectmen
Town of Killingly	8/28/07 10/21/08 7/27/11	Project Introduction – Town Manager MCF Briefing – Town Manager Supplemental MCF Briefing – Town Manager
Town of Lebanon	9/11/07 8/14/08 8/13/09 7/29/11	Project Introduction – First Selectman MCF Briefing – First Selectman Project Update – First Selectman Supplemental MCF Briefing – First Selectman
Town of Mansfield	10/2/07 10/1/08 11/10/08 7/15/11 8/22/11	Project Introduction – Town Manager MCF Briefing – Town Manager MCF Briefing – Town Council Supplemental MCF Briefing – Town Manager Supplemental MCF Briefing – Town Council
Town of Pomfret	9/25/07 8/1/11	Project Introduction – First Selectman Supplemental MCF Briefing - Board of Selectman
Town of Putnam	10/2/07 7/27/11	Project Introduction – Mayor Supplemental MCF Briefing - Mayor
Town of Thompson	8/28/07 7/27/11	Project Introduction – First Selectman Supplemental MCF Briefing – First Selectman
Town of Windham	9/26/07 9/16/08 5/24/11	Project Introduction – First Selectman MCF Briefing – Board of Selectmen New Chief Executive Official Briefing – Mayor & Town Manager
Windham Regional Council of Governments	1/21/09	Project Update

Stakeholder Group	Date of Meeting	Purpose of Meeting
State and Federal Officials		
Senate Democrats – Assistant Chief of Staff Gregg Haddad	10/20/08	MCF Briefing
State Senator Edith Prague (D-19)	10/20/08	MCF Briefing
State Representative Denise Merrill (D-54)	10/20/08	MCF Briefing
CT Attorney General George Jepsen and Assistant Attorney General Mike Wertheimer	6/28/11	Supplemental MCF Briefing
U.S. Representative Joseph Courtney	6/28/11	Supplemental MCF Briefing
State Senator Donald Williams (D-29)	6/30/11	Supplemental MCF Briefing
U.S. Senator Richard Blumenthal	7/8/11	Supplemental MCF Briefing
U.S. Senator Joseph Lieberman	7/14/11	Supplemental MCF Briefing
Connecticut DEEP Commissioner Daniel Esty and Staff	7/15/11	New official briefing
State Representative Susan Johnson (D-49)	7/18/11	Supplemental MCF Briefing
State Representative Mike Alberts (D-50)	7/18/11	Supplemental MCF Briefing
State Senator Edith Prague (D-19)	8/5/11	Supplemental MCF Briefing
State Representative Gregg Haddad ((D-54)	8/11/11	Supplemental MCF Briefing
State Representative Max Flexer (D-44)	8/11/11	Supplemental MCF Briefing
Environmental Groups		
Connecticut Forest & Parks Association	11/10/08 8/11/11	MCF Briefing Supplemental MCF Briefing
The Last Green Valley, Inc. (Representing the Quinebaug-Shetucket Heritage Corridor)	11/12/08 10/6/11	MCF Briefing Supplemental MCF Briefing
Friends of Mansfield Hollow	8/11/11	Supplemental MCF Briefing
Other Stakeholder Groups		
Mount Hope Montessori School, Mansfield	8/13/08 1/23/09	MCF Briefing – School Director Project Update – Board of Directors
Hawthorne Lane, Mansfield	11/3/09 8/10/11	Private landowner land swap - Potential ROW shift Private landowner land swap - Potential ROW shift

Table 9-4: Public Open Houses

CL&P Public "Open Houses"	Date of Open House	Location
For all interested residents and stakeholders	9/24/08	Brooklyn
	9/30/08	Willimantic
	10/22/08	Mansfield
	11/5/08	Danielson (Killingly)
	8/23/11	Danielson (Killingly)
	12/8/11	Mansfield

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Connecticut Light & Power
The Northeast Utilities System

NEW ENGLAND EAST–WEST SOLUTION

SECTION 10

TRANSMISSION LINE DESIGN AND RIGHT-OF-WAY CONFIGURATION OPTIONS IN MANSFIELD HOLLOW

10. TRANSMISSION LINE DESIGN AND RIGHT-OF-WAY CONFIGURATION OPTIONS IN MANSFIELD HOLLOW

10.1 INTRODUCTION AND RATIONALE FOR THE CONFIGURATION OPTIONS

Along the 36.8-mile Proposed Route, the new overhead 345-kV transmission line would follow CL&P's existing ROWs across two segments of federally-owned property, totaling 1.4 miles, in the Mansfield Hollow portion of the towns of Mansfield and Chaplin. These federal lands, which are owned by the USACE and are leased to the CT DEEP, are identified in relation to CL&P's ROW as follows (refer to Figure 10-1)[1]:

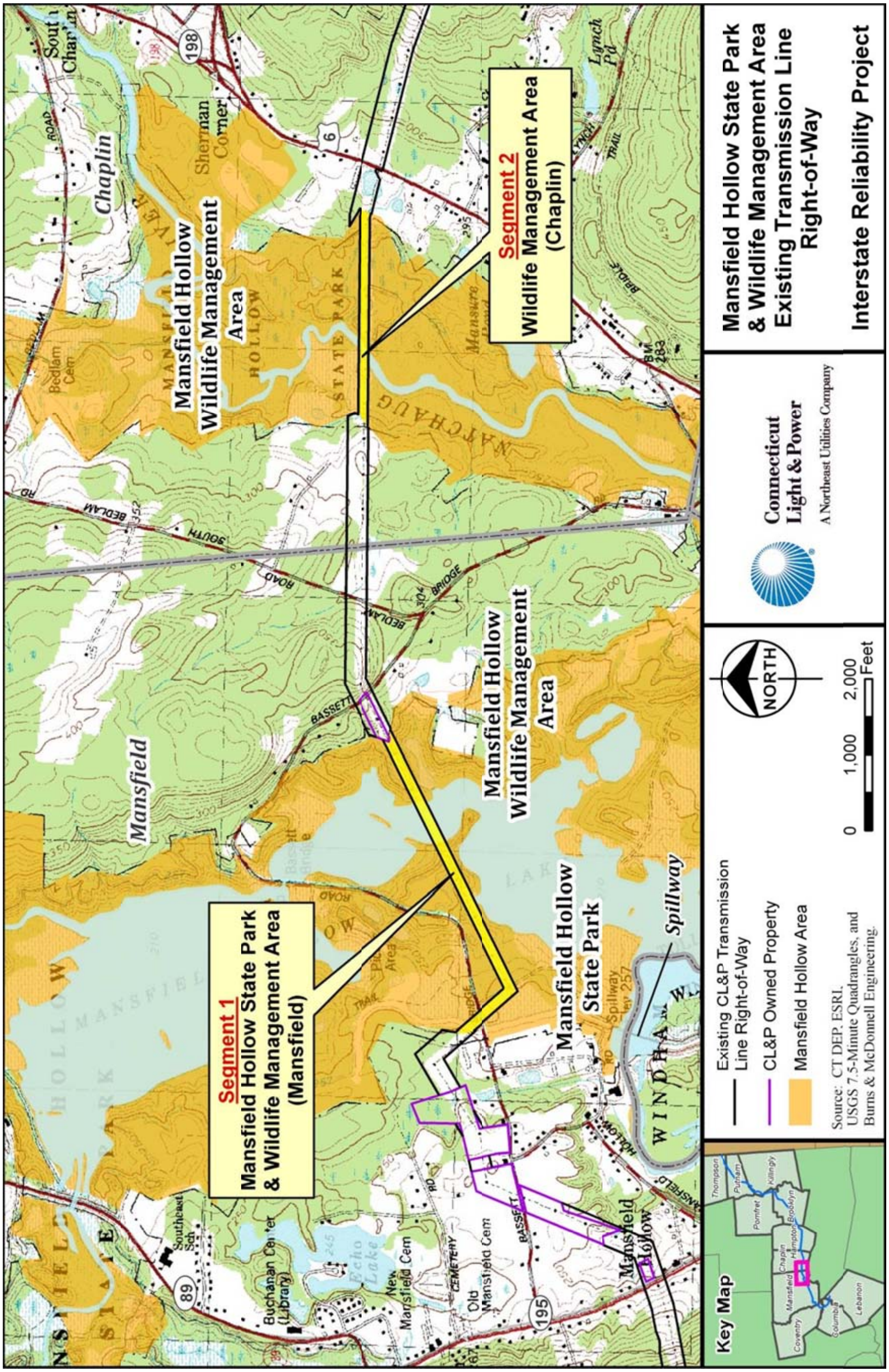
- Segment 1: An approximately 0.9-mile segment of CL&P's existing transmission line ROW traverses Mansfield Hollow State Park, including an approximately 600-foot span of Mansfield Hollow Lake, as well as a portion of the Mansfield Hollow WMA on the eastern side of the lake (Town of Mansfield, Tolland County).

- Segment 2: CL&P's existing transmission line ROW traverses a second portion of the WMA for approximately 0.5 mile across and in the vicinity of the Natchaug River (Town of Chaplin, Windham County).

Across these federally-owned properties, CL&P's existing ROW is 150 feet wide. CL&P's existing 345-kV transmission line (i.e., the 330 Line, which extends between the Card Street Substation and Lake Road Switching Station) is generally positioned in the center of both of these ROW segments. Because of needed conductor separations, the 150-foot easement is not wide enough to accommodate the new 3271 Line as proposed (i.e., using structure types that would match the existing 345-kV line structure types in each segment) alongside the existing 330 Line.

[1] Through Segments 1 and 2, the Proposed Configuration along the Proposed Route (as discussed in the preceding sections of this Volume and as shown on the Proposed Route maps in Volume 9) is depicted on XS-3 and XS-5, respectively.

Figure 10-1: Location of the Existing CL&P ROWs across the Mansfield Hollow Federally-Owned Properties: Segments 1 and 2



To construct and operate the new overhead 345-kV transmission line north of and adjacent to the existing 330 Line through the 1.4 miles of federally-owned lands, CL&P proposes that the USACE grant a conveyance of expanded easement rights. Specifically, CL&P's Proposed Configuration through the Mansfield Hollow properties (as described in the preceding sections of this volume) would involve expanding the 150-foot-wide easement by 55 feet (approximately 5.8 acres) along Segment 1 in the Town of Mansfield and by 85 feet (approximately 5.2 acres) along Segment 2 in the Town of Chaplin.

The expanded easement, which would total approximately 11 acres, would allow the development of the new 345-kV transmission line parallel and adjacent to (north of) the existing 330 Line. This wider easement would allow CL&P to build the new transmission line using structures that would generally match (in terms of appearance and height) the existing 330 Line structure types. This Proposed Configuration would minimize visual resource effects by using new transmission line structures that are similar in appearance to the existing structures through both Segments 1 and 2, and also would represent the least cost alternative. Therefore, CL&P's preference is to construct the Project in the Proposed Configuration through Mansfield Hollow.

However, CL&P has identified two configuration options that also would allow the development of the new 345-kV transmission line adjacent to the 330 Line across the federal property.[2] CL&P would be prepared to use either of these configuration options, should the Proposed Configuration not be acceptable to the USACE, and is in the process of consulting with the USACE regarding the Proposed Configuration and the configuration options discussed in this section.

[2] In addition to these configuration options for constructing the new 345-kV line across the federally-owned properties, CL&P identified and evaluated two route variations that would avoid Mansfield Hollow. These route variations, the Willimantic South Overhead Variation and the Willimantic South Underground Variation, would replace the western 11 to 12 miles of the Proposed Route, generally between Card Street Substation and U.S. Route 6 in the Town of Chaplin. As detailed in Volume 1A, Section 15.5, CL&P determined that any of the Mansfield Hollow configuration options would be preferable to the Willimantic South Variations, based on cost and environmental factors.

These configuration options are:

- **No ROW Expansion Option**. In the event that a grant of conveyance for the additional easement rights cannot be obtained from the USACE, this overhead line design option would allow the installation of the proposed 345-kV transmission line within the existing 150-foot-wide ROW through the Mansfield Hollow area. This option would involve complex construction sequencing and outages, requiring the removal and reconstruction of the existing 330 Line closer to the southern edge of the 150-foot-wide ROW and the development of the new 345-kV overhead line adjacent to and north of the reconfigured 330 Line. Under this option, no additional easements from the USACE would be required, but both 345-kV lines through Mansfield Hollow would be constructed using vertical conductor configurations and taller monopole structures.

- **Minimal ROW Expansion Option**. This configuration option would limit the amount of additional easement required from the USACE to approximately 4.8 acres by using taller monopole structures to support the new 345-kV line, north of and adjacent to the existing 330 Line, within both Segments 1 and 2. The existing 330 Line would remain in place. Using this overhead transmission line design, 25 feet of additional easement width would be required along Segment 1, while 35 feet would be required along Segment 2.

The following sections provide background information concerning CL&P’s existing ROW across the Mansfield Hollow area and chronicle CL&P’s investigations of options for aligning the proposed 345-kV transmission line alongside the existing 330 Line in Mansfield Hollow. Detailed information is provided concerning both the No ROW Expansion Option and the Minimal ROW Expansion Option, including comparisons of each configuration option to the Proposed Configuration.

Appendices 10A (No ROW Expansion Option) and 10B (Minimal ROW Expansion Option) include cross-sections and photo-simulations depicting each configuration option along Segments 1 and 2. The two configuration options also are illustrated on the Volume 9 maps (refer to the Mansfield Hollow Design Option section [Exhibit 2A] of the map volume). Appendix 10C includes photo-simulations that illustrate the appearance of each of the different configuration options along a representative portion of the Segment 1 ROW. Photo-simulations are provided for both “leaf off” and “leaf on” conditions. (Note that photo-simulations are not included for Segment 2 because there is no public access to this segment of the WMA along the ROW.)

10.2 BACKGROUND INFORMATION CONCERNING THE EXISTING ROW ON FEDERAL PROPERTY IN MANSFIELD HOLLOW

The federal government (USACE) owns approximately 2,472 acres of property in the Mansfield Hollow area. The property was acquired approximately 60 years ago to allow the construction of the Mansfield Hollow Dam at the confluence of the Natchaug, Fenton, and Mount Hope rivers. The purpose of the dam, which was completed in 1952, is to control flooding within the Thames River basin. The 450-acre Mansfield Hollow Lake was created as a result of the dam. The federally-owned properties surround the dam and lake, extending south into the Town of Windham, as well as north and east along both sides of the Natchaug, Fenton, and Mount Hope rivers. Figure 10-2 generally illustrates the extent of the lake and associated federally-owned properties, as well as the surrounding topography.

Although the federal lands in the Mansfield Hollow area are administered by the USACE, approximately 2,300 acres are leased to and managed by the CT DEEP for a variety of outdoor recreational purposes. These leased areas encompass Mansfield Hollow Lake and consist of Mansfield Hollow State Park (251 acres) and Mansfield Hollow WMA (2,012 acres). Both areas are used year-round for a variety of recreational activities, such as fishing, hunting, biking, boating, hiking, camping, cross-country skiing, dog training, and nature viewing.

CL&P's existing 330 Line was installed across the federally-owned properties in the early 1970s. Records indicate that although CL&P proposed a 300-foot-wide ROW across the federally-owned lands, corresponding to the typical 300-foot-wide easement for the remainder of the 330 Line, negotiations resulted in the grant of easement only for a width of 150 feet. As Figures 10-1 and 10-2 illustrate, CL&P's existing transmission line ROW traverses 1.4 miles across the south-central portion of the Mansfield Hollow property.

Figure 10-2: General Location of CL&P ROW and Mansfield Hollow USACE-Owned and CT DEEP-Leased Recreational Lands: Tolland and Windham Counties

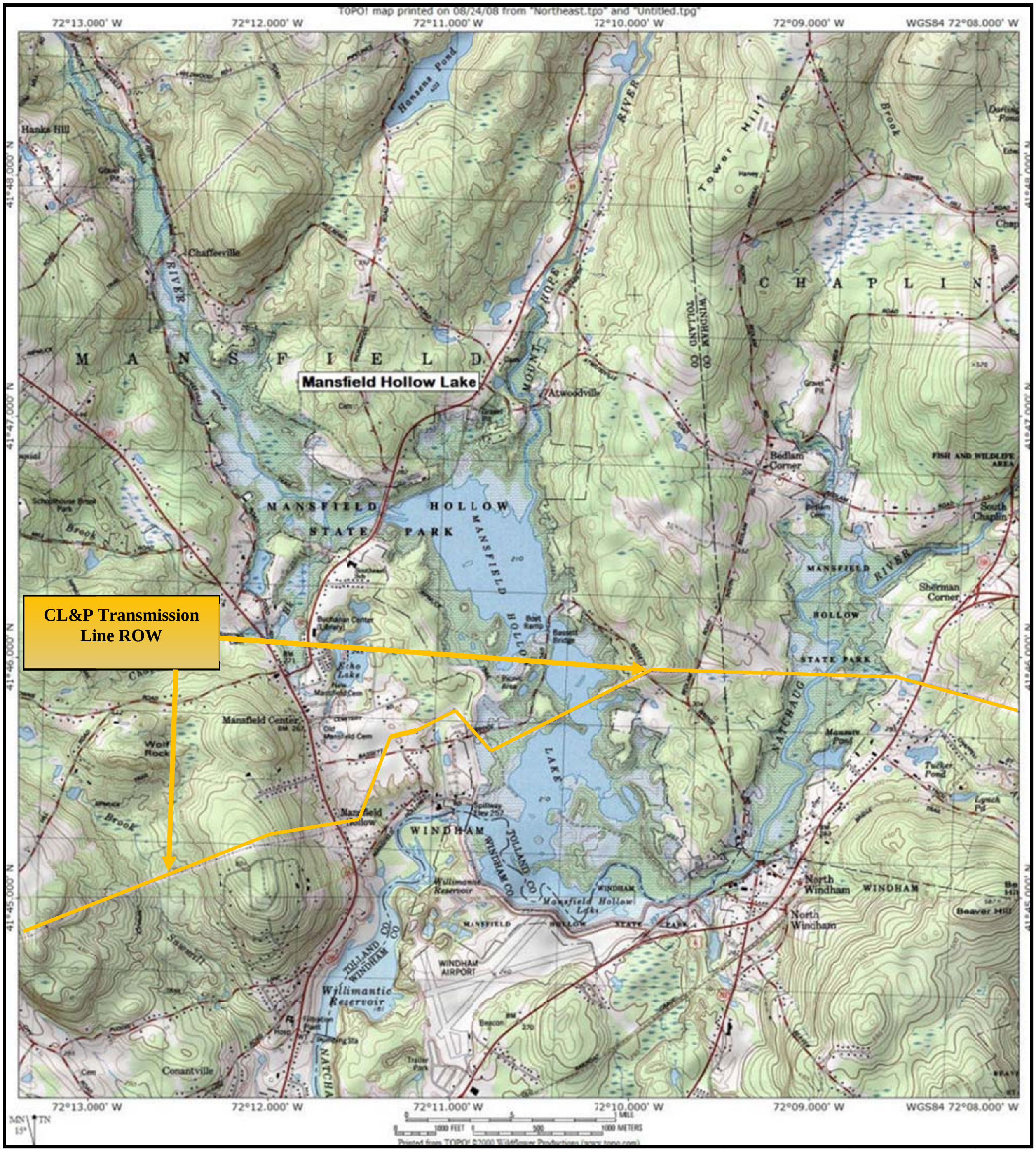


Table 10-1 summarizes the characteristics of CL&P's existing ROW across each of the two segments in the Mansfield Hollow area. As this table shows, CL&P's existing 345-kV line across Mansfield Hollow State Park and WMA in Mansfield (i.e., Segment 1) is supported on steel-monopole "Delta" configuration structures with an average height of 115 feet above ground, whereas the existing 345-kV line through the WMA in Chaplin (i.e., Segment 2) is configured on wood-pole H-frame structures with an average height of 75 feet above ground. Cross-sections XS-3 and XS-5 (refer to Appendix 3A in this volume) and the Volume 9 maps of the Proposed Route (refer to mapsheets 9 through 11) illustrate these structure types.

Along the ROW across the federally-owned properties, CL&P manages the vegetation to promote low-growth species, consistent with overhead transmission line operation and maintenance practices. Within Segment 1, approximately 100 feet of the 150-foot-wide ROW is presently managed in such scrub-shrub type vegetation. Within Segment 2, approximately 140 feet of the ROW is subject to management in low-growth vegetation.

The vegetation along the remaining portions of the ROW is characterized primarily by forested vegetative communities. The un-managed portions of the ROWs in the Mansfield Hollow area generally include an approximately 25-foot-wide area along the southern and northern boundaries of the ROW in Segment 1 and an approximately 5-foot-wide area along the southern and northern boundaries of the ROW in Segment 2. Within these un-managed areas, taller vegetation predominates, separating the managed ROW from adjacent land uses.

Table 10-1: Summary of Existing Characteristics: 1.4 Miles of 150-Foot-Wide ROW along Segments 1 and 2

Characteristic	150-Foot-Wide ROW Segments Across Federally-Owned Property	
	Segment 1	Segment 2
Town	Mansfield	Chaplin
Length across Federal Lands	0.9 mile	0.5 mile
Principal Land Uses Traversed	• Mansfield Hollow State Park, including Red Trail hiking path and trail on top of levee system for Mansfield Hollow Dam • Mansfield Hollow Lake (600-foot span) • Mansfield WMA, including the Nipmuck Trail (East Branch), a Connecticut Forest & Park Association Blue-Dot Trail	• Mansfield Hollow WMA • Natchaug River (No public access to this area except via river)
Existing Line Structure Appearance	Steel-Pole Delta Structure height range = 106 - 137 feet	Wood-Pole H-Frame Structure height range = 73 – 81 feet
Structure Locations within ROW	Center	Center
Number of Existing 330 Line Structures along Segment / (Structure No.)	6 (9081 to 9086)	5 (9095 to 9099)
Existing Width (Typical) of CL&P-Managed Portions of ROW (Scrub-shrub Vegetation)	100 feet	140 feet
Existing Location / Approx. Width of Vegetation Not Managed within ROW	25 feet (south) 25 feet (north)	5 feet (south) 5 feet (north)
Public Road Access near ROW Segments across Federal Lands	Bassetts Bridge Road (two locations; west and east of Mansfield Hollow Lake). Note: East of Mansfield Hollow Lake and outside of the federal lands, CL&P-owned property abuts Bassetts Bridge Road on the west. The transmission line ROW extends across this CL&P-owned property to the WMA.	South Bedlam Road to Shuba Lane (west) U.S. Route 6 (Willimantic Road) (east)

Segments 1 and 2 are separated by an approximately 0.8-mile section of 300-foot-wide ROW across privately-owned property, including approximately 0.3 mile in the Town of Mansfield and 0.5 mile in the Town of Chaplin. In Mansfield, a 0.1-mile section of the ROW crosses CL&P-owned land adjacent to the WMA and Bassetts Bridge Road (refer to Figure 10-1; XS-4 in Section 3, Appendix 3A; and the Volume 9 and 11 maps). Along this 0.8-mile ROW section, which extends generally from west of Bassett Bridge Road in Mansfield to east of Shuba Lane in Chaplin, CL&P's existing 300-foot easement is sufficiently wide to accommodate the new 345-kV transmission line (in the proposed matching structure configuration) adjacent to the 330 Line.

Along this 0.8-mile segment, the 330 Line is supported on eight wood-pole H-frame structures (nos. 9087 through 9094), typically 80 feet in height. CL&P presently manages approximately 140 feet of the 300-foot-wide ROW in low-growth vegetation.

10.3 CHRONOLOGICAL SUMMARY OF MANSFIELD HOLLOW CONFIGURATION OPTIONS

As the only locations along the proposed 345-kV transmission line route where the existing ROW is not sufficiently wide to accommodate the new 3271 Line using the proposed matching structure configuration, Mansfield Hollow Segments 1 and 2 have been extensively studied as part of CL&P's Project planning process. The following summarizes the chronology of CL&P's alternatives evaluations for the Mansfield Hollow area.

<u>Initial Project Design– 2008</u>

At the outset of the Project design process, CL&P proposed to expand the ROW across Segments 1 and 2 by 150 feet to the north, thereby creating a 300-foot-wide ROW comparable to the other CL&P 345-kV line ROWs in the Project area. The 300-foot-wide ROW would allow the development of the proposed 345-kV line in overhead configurations that would match the line structure types of the existing 330 Line, while leaving un-managed areas of vegetation (typically, forest) within the northern portion of the easement. The width of the un-managed vegetation areas would typically have been 95 feet along Segment 1 and 65 feet along Segment 2. Under this configuration option, approximately 27 acres[3] of additional easement from the USACE would have been required.

This easement expansion configuration option was described as part of CL&P's Primary Route under Consideration in the Project's August 2008 MCF. Also, as part of the 2008 MCF, CL&P identified both of the Willimantic South Variations (overhead and underground) as route alternatives that would avoid the Mansfield Hollow area entirely. These two variations, which would align the western portion of the new 345-kV transmission line through the towns of Lebanon, Windham and Chaplin (avoiding the towns of Columbia, Coventry, and Mansfield), offer routing options to the alignment of the new 345-kV transmission line across the federally-owned Mansfield Hollow properties.

However, both of these variations would involve the creation of new "greenfield" utility corridors, which would be in addition to the existing CL&P ROWs along which the 330 Line is located. Thus, the use of either of the Willimantic South variations would result in two utility corridors extending easterly from Card Street Substation (one along the existing ROW and one along the new "greenfield" ROW) to the vicinity of U.S. Route 6 in the Town of Chaplin. Due to overriding cost and environmental issues, neither variation is preferred (refer to Volume 1A, Section 15.5 for further discussion of these variations).

2009

After initial discussions with the USACE and the CTDEP, the initially-identified 150-foot-wide uniform easement expansion option across the Mansfield Hollow federally-owned properties was dismissed from consideration. Instead, CL&P identified the current Proposed Configuration that would limit the easement expansion to the lands necessary to allow the installation of the new 345-kV line using structure

[3] Assumes the easement expansion area would uniformly be 150 feet along the entire 1.4 miles of federally-owned lands.

types that would match the existing 330 Line in Segments 1 and 2, but without any un-managed vegetation areas within the northern portions of the easement.

As explained in the preceding sections of this volume, as planned for the Proposed Configuration, CL&P would acquire approximately 11 additional acres of easement from the USACE. Specifically, the ROW along Segment 1 would be expanded by 55 feet to the north, whereas the ROW along Segment 2 would increase by 85 feet to the north. The difference in proposed easement expansion widths reflects the differences in the existing 330 Line structure types that would be matched along each segment (i.e., the taller steel-monopole delta structures along Segment 1 require less ROW width than the shorter and wider H-frame structures that characterize Segment 2).

Woody vegetation within the entire 11-acre easement expansion area would be removed during the construction of the proposed 345-kV line. Subsequently, CL&P would manage the 11-acre expanded ROW areas in scrub-shrub vegetation, consistent with overhead transmission line operation.

Also in 2009, CL&P initially identified and investigated the No ROW Expansion Option. This design configuration was identified as an option in the event that a grant of conveyance for the additional easement rights could not be obtained from the USACE. Although construction would be more complicated and costly, this option would allow the installation of the new 345-kV transmission line within the existing 150-foot-wide ROW through the Mansfield Hollow area, thereby avoiding the need for any additional easement from the USACE. In addition, compared to the Willimantic South Variations (which also would avoid a ROW expansion through the USACE property), this configuration option was determined to be more viable, less environmentally damaging, and more cost-effective.

<u>2010-2011</u>

In 2010, CL&P and National Grid commenced additional planning and investigations for the proposed Project, in anticipation of submission of applications to state siting agencies in the latter half of 2011.

Accordingly, CL&P conducted additional engineering and environmental studies of the configuration options for aligning the proposed 345-kV line across the Mansfield Hollow area, including the Proposed Route with matching structures, as well as the No ROW Expansion Option and the Minimal ROW Expansion Option.[4] As a result of these investigations, CL&P determined that all three of the configuration options (i.e., the Proposed Configuration with 11-acre easement expansion to allow matching structures; the Minimal ROW Expansion Option with 4.8-acre easement expansion; and the No ROW Expansion Option) represent viable designs for the development of the new 345-kV transmission line in the Mansfield Hollow area. In the Supplemental MCF, issued in July 2011, CL&P presented all three configuration options for public review and comment.

10.4 NO ROW EXPANSION OPTION

The No ROW Expansion Option would involve the development of the new 345-kV line within CL&P's existing 150-foot-wide ROW through the federally-owned properties along Segments 1 and 2. To accommodate both 345-kV lines within the 150-foot-wide ROW, the existing 330 Line would have to be rebuilt and both that reconstructed line and the new 345-kV line would require taller line structures than those presently used in either Segments 1 or 2. Overall, construction would be more complex and costly. Moreover, all of the vegetation within the existing 150-foot-wide ROW would have to be removed, including the existing forest vegetation along the southern portion of the ROW. Vegetation within the entire 150-foot-wide ROW would be converted to scrub-shrub communities.

The No ROW Expansion Option would entail the use of complex construction sequencing in order to first remove the existing 330 Line in each segment and then to install both the new 345-kV line and rebuild the 330 Line within the confines of the 150-foot-wide ROW. During the process of removing and relocating the 330 Line, circuit outages and temporary line construction would be required. Appendix 10A (included at the end of this section) provides cross-sections (refer to XS-3-MH-NRE and XS-5-MH-NRE)

[4] Additional analyses also were performed of the Willimantic South Variations, as discussed in Volume 1A, Section 15.5.

and details regarding the proposed sequence for constructing this configuration option (refer to construction sequence drawings CS-3-MH-NRE and CS-5-MH-NRE) across Segments 1 and 2. [Note that while the length of the ROW across the federally-owned lands is 1.4 miles, the length of the No ROW Expansion Option is 1.5 miles due to structure placement. The additional 0.1 mile is on privately-owned land, where CL&P's existing easement is 300 feet wide.]

10.4.1 Technical Description (Design, Appearance, Land Requirements, Cost)

Land Requirements. CL&P's existing easement through the federal lands allows the development of additional transmission lines within the 150-foot-wide ROW. The use of the No ROW Expansion Option would not require the acquisition of any additional easements from the USACE. On the federally-owned properties, all access roads and construction staging areas would be located within the existing 150-foot-wide ROW.

Design and Appearance. To accommodate the collocation of the two 345-kV lines within the 150-foot-wide ROW without violating conductor clearance requirements, both the rebuilt 330 Line and the new 345-kV transmission line would have to be supported on steel-monopole structures along Segments 1 and 2. Table 10-2 identifies the design and heights of the rebuilt 330 Line structures and new 345-kV line structures, compared to the design and heights of the existing 330 Line structures through the Mansfield Hollow area. The Volume 9 maps illustrate the configurations of the rebuilt 330 Line and the proposed 3271 Line under the No ROW Expansion Option.

As Table 10-2 shows, along Segment 1, five existing 330 Line steel-pole delta structures and one existing steel-pole vertical structure, ranging in height from 106 feet to 137 feet, would be removed. Within Segment 1, the 330 Line would be reconstructed near the southern edge of the ROW on six, taller steel-monopole structures, ranging from 130 to 160 feet in height.

Table 10-2: Comparison of Structure Types and Heights: Existing 330 Line to No ROW Expansion Option

Existing 330 Line				No ROW Expansion Configuration Option							
(Line 330 Structures to be Removed shown in Shading)				Rebuilt 330 Line				New 3271 Line			
Structure No.	Height (feet)	Base Elevation (feet)	Structure Type	Structure No.	Height (feet)	Base Elevation (feet)	Structure Type	Structure No.	Height (feet)	Base Elevation (feet)	Structure Type
Segment 1				Segment 1							
9081	117	252.5	Delta Tangent	9081	150	254.2	Vertical Strain	82	150	253.5	Vertical Strain
9082	137	258.2	Vertical Deadend	9082	130	258.4	Vertical DE	83	130	258.0	Vertical DE
9083	117	235.1	Delta Tangent	9083	150	234.3	Vertical Tangent	84	150	233.9	Vertical Tangent
9084	106	262.2	Delta Tangent	9084	135	257.0	Vertical Tangent	85	130	262.1	Vertical Tangent
9085	111	256.0	Delta Tangent	9085	160	250.7	Vertical Tangent	86	150	261.0	Vertical Tangent
9086	116	255.0	Delta Tangent	9086	160	251.7	Vertical Tangent	87	155	256.2	Vertical Tangent
0.8-mile Privately-Owned ROW Segment				0.8-mile Privately-Owned ROW Segment							
9087	103	267.9	H-Frame Tangent	9087	160	266.6	Vertical Strain	88	160	268.8	Vertical Strain
9088	81	354.1	3-Pole Deadend	Existing 330 Line Structures to Remain				89	95	364.6	3-Pole Running Angle
9089	83	339.8	H-Frame Tangent					90	80	346.3	H-Frame Tangent
9090	86	297.7	H-Frame Tangent					91	85	299.1	H-Frame Tangent
9091	86	283.4	H-Frame Tangent					92	85	295.0	H-Frame Tangent
9092	86	283.2	H-Frame Tangent					93	80	291.3	H-Frame Tangent
9093	75	297.2	H-Frame Tangent					94	65	299.5	H-Frame Strain
9094	68	275.4	H-Frame Tangent	9094	105	275.2	Vertical Strain	95	105	274.7	Vertical Strain
Segment 2				Segment 2							
9095	81	247.1	H-Frame Tangent	9095	125	238.2	Vertical Tangent	96	115	247.4	Vertical Tangent
9096	77	281.7	H-Frame Tangent	9096	115	280.1	Vertical Tangent	97	115	281.1	Vertical Tangent
9097	73	255.1	H-Frame Tangent	9097	110	258.0	Vertical Tangent	98	115	251.8	Vertical Tangent
9098	80	250.3	H-Frame Tangent	9098	130	253.2	Vertical Tangent	99	135	248.6	Vertical Tangent
9099	75	260.0	3-Pole Running Angle	9099	115	260.7	Vertical Strain	100	120	259.1	Vertical Strain

For illustrations of typical H-frame and steel-pole (i.e., delta, vertical) structures, refer to Appendix 3B.

Similarly, the steel-monopole structures along the new 3271 Line segment would range in height from 130 to 155 feet. XS-3-MH-NRE (refer to Appendix 10A) illustrates the typical configuration of the rebuilt 330 Line and the proposed 3271 Line along Segment 1 under the No ROW Expansion Option.

Through Segment 2, existing conductors and five of the existing 330 Line H-frame structures (which range in height from 73 to 81 feet) would be removed. Like Segment 1, both the rebuilt 330 Line and the new 3271 Line along Segment 2 would be supported on steel-monopole structures. The rebuilt 330 Line structures would range in height from 110 feet to 130 feet, whereas the proposed 3271 Line steel-pole structures would be 115 to 135 feet tall. XS-5-MH-NRE (refer to Appendix 10A) illustrates the typical configuration of the rebuilt 330 Line and the proposed 3271 Line along Segment 2 under the No ROW Expansion Option.

In addition to the removal and reconstruction of the existing 330 Line within Segments 1 and 2, two 330 Line H-frame tangent structures (Structure Nos. 9087 and 9094) within the 0.8-mile ROW segment between the federally-owned properties would have to be removed and reconstructed as vertical strain structures. These structure changes would be required in order to transition from the 150-foot-wide ROW to the 300-foot-wide ROW segment. As summarized in Table 10-2, Structure No. 9087, which is 103 feet tall and located on CL&P-owned property adjacent to and east of the WMA in Mansfield, would be reconstructed as a 160-foot-tall steel-pole strain structure. The proposed 3271 Line structure (Structure No. 88), which would be located generally parallel to and north of Structure No. 9087, would be the same design and height. Likewise, existing 330 Line Structure No. 9094, which is 68 feet tall and located just west of the western border of the WMA in Chaplin, would be removed and reconfigured as a 105-foot-tall vertical strain structure. The corresponding 3271 Line structure (Structure No. 95) would be the same design and height.

Cost. The capital cost of the No ROW Expansion Option is estimated at $28.5 million. This cost is $15.5 million more than the $13.0 million cost of the Proposed Configuration. In addition, Connecticut consumers would likely bear 100% of the cost for the No ROW Expansion Option through Mansfield Hollow that is in excess of the estimated cost of the Proposed Configuration.

10.4.2 Construction Procedures and Sequence

The overhead line construction procedures described in Sections 4.1 and 4.2 of this Volume 1 also would apply to the development of the No ROW Expansion Option. However, the implementation of the No ROW Expansion Option would involve a detailed sequence of construction activities within both Segment 1 and Segment 2, as depicted generally on the Construction Sequence Drawings in Appendix 10A (refer to Drawings CS-3-MH-NRE and CS-5-MH-NRE).

As these drawings illustrate, in order to accommodate two 345-kV circuits within the 150-foot-wide ROW and still maintain necessary conductor separations, the existing 330 Line would first have to be relocated from the center of the ROW along Segments 1 and 2. As a first step in accomplishing this relocation, temporary structures for one phase of the 330 Line would be erected along the southern edge of the ROW.

To minimize circuit outages and associated impacts during the reconstruction of the existing 330 Line segments and the development of the new 345-kV line, construction work would have to be carefully sequenced. The construction sequence would include the following steps:

- Remove vegetation from the entire 150-foot-wide ROW along Segments 1 and 2. (*Note*: Scrub-shrub vegetation along the ROW on the slopes adjacent to Mansfield Hollow Lake and abutting the Natchaug River would not have to be removed because no structures would be removed or installed in these areas.)

- Develop access roads along and to the ROW, where necessary.

- Install a temporary, single-wood-pole line to support one phase of the 330 Line. The poles of this temporary line would be aligned approximately 20 feet from the southern edge of the ROW. The temporary wood-pole line would take over the function of the northerly phase conductors of the existing 330 Line segment.

- Remove the northerly phase conductors and arms of the existing 330 Line segment.

- Install the steel monopoles and vertically-configured conductors for the new 345-kV line segment.

- Temporarily use the new 345-kV transmission line segment as a section of the 330 Line.

- Remove the existing 330 Line (delta steel monopoles and H-frames) and the temporary wood-pole line. The concrete foundations for the existing 330 Line monopole structures in Segment 1 would typically be chipped to 2 feet below grade and then covered with soil. The wood poles for the H-frames along Segment 2 would typically be removed from upland areas, but in wetlands would typically be cut flush with the ground surface and left in place.

- Install the new steel monopoles and conductors for the relocated 330 Line segment.

- Reconnect the 330 Line to its replacement line segment.

- Complete the new 345-kV line using the new line segment.

During the cutover (transfer) of one phase of the 330 Line to the temporary structures, a circuit outage would be required. Likewise, after the new 345-kV transmission line section is installed, a two- to three-day outage would be required to temporarily cutover the 330 Line to the new line segment. Upon completion of the new line segments for the 330 Line, a three- to four-day outage would be required for cutovers to the final configurations of both circuits. These outages could be difficult to schedule and could result in outage-related costs (i.e., running of out-of-merit generation) to consumers.

10.4.3 Existing Environmental Features

The environmental resources along the existing 150-foot-wide ROW that would be affected by the No ROW Expansion Option are illustrated on the Mansfield Hollow Design Option maps in Volume 9 (Exhibit 2A). The existing environmental features along the Segments 1 and 2 ROW are summarized in Table 10-3.

Table 10-3: Summary of Existing Environmental Features: No ROW Expansion Option (Segments 1 and 2: 150-foot-wide ROW)

ENVIRONMENTAL FEATURE	SEGMENT		OPTION TOTAL
	1	2	
ROW Length (miles)	1.0 0.9 (federal land)	0.5	1.5 1.4 (federal land)
Towns	Mansfield	Chaplin	
New ROW Width Required	0	0	0
Water Resources			
Waterbody Crossings (number, name)	1 Mansfield Hollow Lake	2 S20-22 (Natchaug River) S20-24	3
Wetlands Within ROW (number / name)	2 W20-65 W20-66 (Mansfield Hollow Lake border)	4 W20-70 (vernal pool CH-1-VP) W20-72/73 (vernal pool CH-2-VP) W20-75 W20-76	6
Biological Resources			
Existing Vegetation Community Type (Estimated acres within ROW)*			
• Forested Upland	4.2 acres	1.5 acres	5.7 acres
• Forested Wetland	0.1 acre	0.7 acre	0.8 acre
• Scrub-shrub Upland	7.1 acres	4.6 acres	11.7 acres
• Open Field Upland	2.0 acres	0	2.0 acres
• Scrub-shrub Wetland	<0.1 acre	2.3 acres	2.3 acres
Natural Diversity Data Base Areas (No.)	1	1	2
Land Uses			
Recreational Areas (linear miles traversed along ROW)			
• Mansfield Hollow State Park	0.8 mile	0	0.8
• Mansfield Hollow WMA	0.1 mile	0.5 mile	0.6
• Trails	2 Red Trail (within Park) Nipmuck Trail East Branch (within WMA)	0	2
Transportation			
Road Crossings	1 Bassetts Bridge Road	0	1
Cultural Resources			
Designated Historic Sites	1 Mansfield Hollow Dam Historic District	0	1

*Note: Acreages are estimated and exclude the crossings of Mansfield Hollow Lake, Natchaug River, Flood Control Levee Trail, and Bassetts Bridge Road.

10.4.4 Potential Environmental Effects and Mitigation Measures

In evaluating the No ROW Expansion Option, CL&P considered the potential effects to the environmental resources within the ROW segments across the federally-owned properties in Mansfield Hollow, as well as the potential incremental effects on the visual character of the surrounding areas. In general, the types of potential environmental effects and mitigation measures associated with the development of the proposed 3271 Line using the No ROW Expansion Option would be similar to those described in Section 6 for overhead transmission line construction using the Proposed Configuration (matching structure types).

However, because the No ROW Expansion Option would involve the removal and reconstruction of the existing Line 330 structures, construction activities would affect the majority of the ROW along both Segments 1 and 2, thus leaving little flexibility for avoiding in-ROW environmental resources. Table 10-4 summarizes the potential environmental effects of the No ROW Expansion Option.

To construct this configuration option, most vegetation (including all forested areas) within the 150-foot width of the ROW would have to be removed and the entire width of the ROW would likely be directly affected by construction activities. Construction activities would include, in addition to vegetation removal, grading (as necessary), temporary access road construction and use, 330 Line structure removal, temporary pole and conductor installation, new structure and conductor installation, and then the removal of the temporary structures and conductors. After the new 3271 Line and the rebuilt 330 Line are installed, the entire 150-foot-wide ROW would be restored and managed in scrub-shrub vegetation.

Table 10-4: No ROW Expansion Option: Summary of Potential Environmental Effects, by ROW Segment (Assumes use of entire 150-foot-wide ROW)

ENVIRONMENTAL FEATURE	POTENTIAL ENVIRONMENTAL EFFECTS, BY SEGMENT		OPTION TOTAL
	1	2	
ROW Length (miles)	1.0	0.5	1.5
Construction ROW Width (feet)	150	150	
New ROW Width Required (feet)	0	0	0
Water Resources			
Waterbody Crossings (number)	1 span Mansfield Hollow Lake	2 1 span (Natchaug River) 1 crossing (S20-24 with permanent culvert*)	2 spans 1 crossing with permanent culvert)
Wetlands			
Number Affected	2 (W20-65) (W20-66)	5 (W20-70, W20-73, W20-75, W20-76, W20-77)	7
Vernal Pools Affected (number)	0	2 (CH-1-VP and CH-2-VP)	2
Wetlands, Temporary Effects (estimated acres)	0.0 acre	0.3 acre	0.3 acre
Wetlands, Permanent Fill Effects (estimated acres)	0.0 acre	< 0.1 acre	< 0.1 acre
Biological Resources			
Vegetation Potentially Affected (estimated acres)			
• Forested Upland	4.2 acres	1.5 acres	5.7 acres
• Forested Wetland	0.1 acre	0.7 acre	0.8 acre
• Scrub-shrub Upland	7.1 acres	4.6 acres	11.7 acres
• Open Field Upland	2.0 acres	0	2.0 acres
• Scrub-shrub Wetland	<0.1 acre	2.3 acres	2.3 acres
Natural Diversity Data Base Areas (No.)	1	1	2
Land Uses			
Recreational Areas (linear miles traversed along ROW)			
• Mansfield Hollow State Park	0.9 mile	0	0.9 mile
• Mansfield Hollow WMA	0.1 mile	0.5 mile	0.6 mile
• Trails	2 Red Trail (within Park) Nipmuck Trail East Branch (within WMA)	0	2
Visual Resources			
Structure Appearance	Weathering Steel Finish	Weathering Steel Finish	

Notes:
1. All vegetation within the 150-foot-wide ROW assumed to be affected by the complex construction sequence required for this configuration.
2.The wetland bordering Mansfield Hollow Lake (designated as Wetland W20-66) would be spanned.
3.Wetland effects determined based on preliminary locations of structures, crane pads, and access roads. All effects except structure locations and permanent access roads are assumed to be temporary (i.e., crane pads and wood mat roads across wetlands will be removed after the completion of construction. All access roads are assumed to be within the 150-foot-wide ROW. Estimates for forested wetland vegetation clearing assume wetland W20-73 near Natchaug River (Segment 2) would be affected across the entire 150-foot-wide ROW. Stream S20-24 would be crossed on USACE property, but the permanent culvert would be installed on privately-owned easement just to the east of the federal lands.

Moreover, the No ROW Expansion Option has the potential to result in comparatively greater long-term, visual effects due to the use of taller and different types of transmission line structures than those that presently characterize the existing 330 Line through Segments 1 and 2. As summarized in Table 10-2, the rebuilt 330 Line and new 3271 Line structures would mostly range from 29 to 49 feet taller than the existing steel-pole delta structures along Segment 1, and from 34 feet to 55 feet taller than the existing wood-pole H-frame structures along Segment 2. (Along Segment 1, one of the new structures would be slightly shorter than the tallest existing 330 Line structures due to differences in the placement of the structures and topography.)

Appendix 10C includes “leaf off” and “leaf on” photo-simulations that illustrate the anticipated appearance of the ROW along Segment 1, after implementation of the No ROW Expansion Option. Based on field investigations and on photo-simulations, the taller structures required for the No ROW Expansion Option would be potentially more visible than the structures of the Proposed Configuration from various locations in the vicinity of Mansfield Hollow State Park (e.g., Mansfield Hollow Lake and Dam, the levee trail both north and south of the dam, Bassetts Bridge Road, and U.S. Route 6).

However, this effect would be incremental since some of the existing structures are visible from certain locations within the state park and WMA, including from points along the levee trail, the Red Trail within the park, and the Nipmuck Trail (East Branch) within the WMA, as well as from Mansfield Hollow Dam and vantage points along Bassetts Bridge Road and Mansfield Hollow Lake. The presence of the existing structures and ROW do not appear to affect the recreational uses of the state park and WMA, as evidenced by the four-season popularity of these areas.

The difference in structure heights would be most apparent within Segment 2, where the existing H-frames (approximately 80 feet tall) would be replaced with steel-pole structures with heights of 110 feet to 135 feet. In addition, compared to the Proposed Configuration (matching structures), the No ROW

Expansion Option would take longer to construct, thus increasing the time that the ROW across the federally-owned properties would be disturbed and increasing the potential for temporary nuisance effects on recreational users of the state park and WMA. Such effects could include disruptions in traffic patterns on Bassetts Bridge Road and other local roads leading to the Mansfield Hollow State Park and WMA, as well as disturbance to the recreational trails (Red Trail, Nipmuck Trail [East Branch]) that extend across the ROW in Segment 1.

10.4.5 Electric and Magnetic Fields

Electric and magnetic fields were calculated for the No ROW Expansion Option with the rebuilt 330 Line and the new 3271 Line configured as illustrated on Cross-Section XS-3-MH-NRE and XS-5-MH-NRE in Appendix 10A. The magnetic field calculations are for projected annual average loading (AAL) conditions for pre-Project (2015) and post-NEEWS (2020). Refer to Volume 1, Section 7 for details regarding the assumptions for these load conditions and other details concerning the field calculations.

Magnetic field profiles across the ROW produced by the existing, proposed, and NRE configurations along these sections of the ROW at AAL were calculated as shown in Figures 10-3 and 10-4. Note that the northern ROW edge location varies for one of the configurations being compared in these figures.

Figure 10-3: Magnetic Field Profiles for the Existing, Proposed, and No ROW Expansion (NRE) Options at AAL – Mansfield Hollow State Park to Bassetts Bridge Road - XS-3 and XS-3-MH-NRE

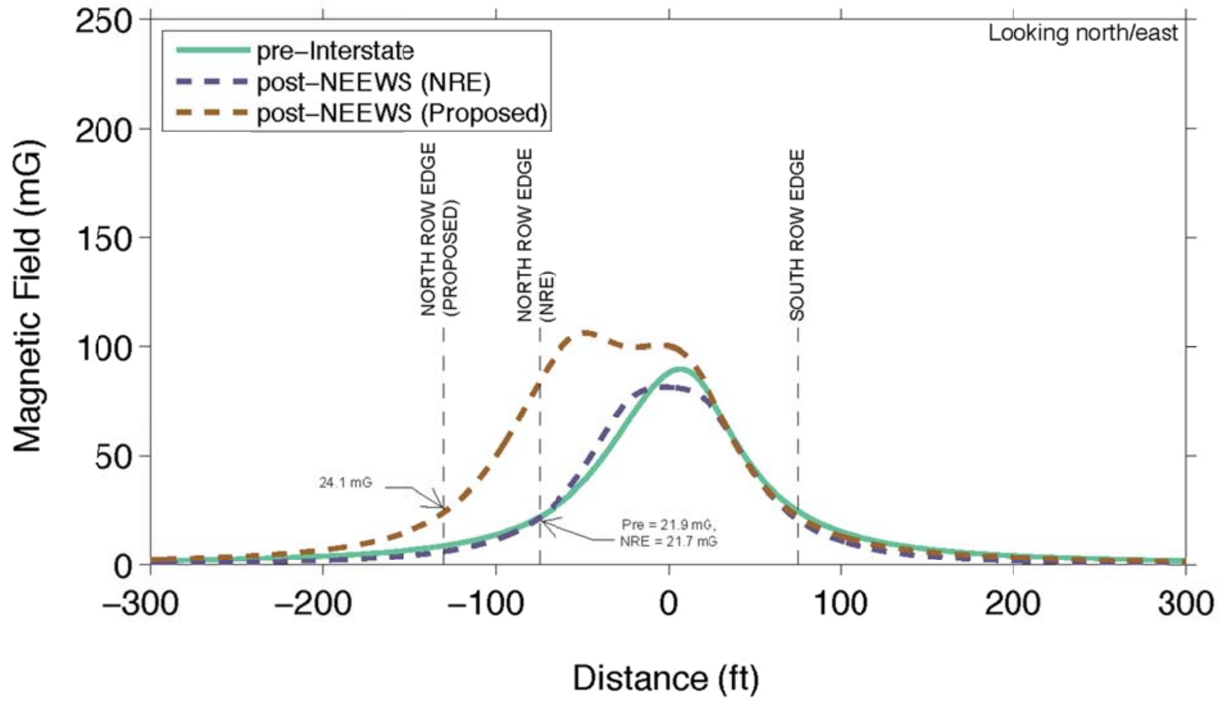
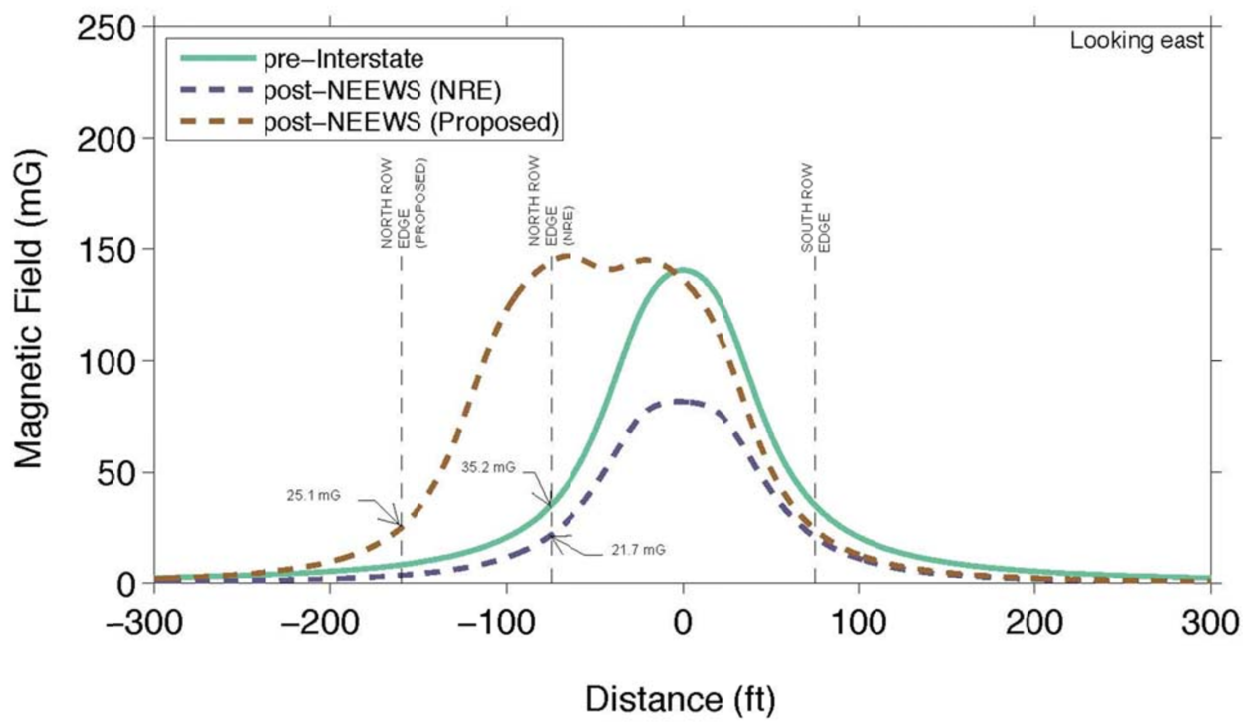


Figure 10-4: Magnetic Field Profiles for the Existing, Proposed, and No ROW Expansion (NRE) Options at AAL – Vicinity of Shuba Lane through Mansfield Hollow WMA to Vicinity of Willimantic Road - XS-5 and XS-5-MH-NRE



As can be seen in Figures 10-3 and 10-4, the NRE option would produce magnetic field levels that are comparable, or even lower, than the pre-Interstate levels along the XS-3 and XS-5 ROW edges and generally across the ROW width for each cross-section. This reduction is most pronounced for XS-5. The proposed configuration for XS-3 increases the field levels across the expanded ROW, but produces only small changes in ROW edge levels; magnetic field levels increase slightly at the north edge and decrease slightly at the south edge relative to the pre-Project levels. Similarly, the proposed configuration for XS-5 yields higher magnetic field levels across the expanded ROW. However, in the case of XS-5, the field levels at both ROW edges are significantly lower than the pre-Project levels. In each case, the NRE option provides the lowest field levels at the ROW edges. Table 10-5 summarizes the magnetic field levels at the ROW edges for each of the cases presented in Figures 10-3 and 10-4.

Table 10-5: Summary of Electric and Magnetic Field Levels at ROW Edges for Existing, Proposed, and the No ROW Expansion Options

Cross-Section	Description	Loading Conditions	Magnetic Field (mG)		Electric Field (kV/m)	
			North ROW Edge[a]	South ROW Edge	North ROW Edge[a]	South ROW Edge
XS-3	Segment 1 Existing	Pre-Interstate (2015)	21.9	24.7	1.10	0.86
XS-3	Segment 1 Proposed	Post-NEEWS (2020)	24.1	22.6	1.47	0.93
XS-3-MH-NRE	Segment 1 No ROW Expansion Option	Post-NEEWS (2020)	21.7	20.8	0.62	0.62
XS-5	Segment 2 Existing	Pre-Interstate (2015)	35.2	35.2	1.63	1.63
XS-5	Segment 2 Proposed	Post-NEEWS (2020)	25.1	24.1	1.66	1.62
XS-5-MH-NRE	Segment 2 No ROW Expansion Option	Post-NEEWS (2020)	21.7	20.8	0.62	0.62

[a] Note that the location of the north edge of the ROW varies for the different design options being compared.

10.4.6 Comparison of the Proposed Configuration (Matching Structures) and the No ROW Expansion Option

The No ROW Expansion Option is a viable configuration for the alignment of the new 345-kV transmission line across the federally-owned properties in Mansfield Hollow. However, the selection of this option over the Proposed Configuration (with matching structures) would involve increased costs to consumers, several outages of the 330 circuit during construction, a longer construction schedule within

Mansfield Hollow State Park and WMA, and more extensive land disturbance and environmental effects within the existing 150-foot-wide ROW.

In comparison, using CL&P's Proposed Configuration, the grant of the 11 additional acres of easement across the federally-owned properties would allow the installation of the new 345-kV transmission line to be accomplished more cost-effectively, using new transmission line structures that would be visually more compatible with the existing 330 Line structures through the Mansfield Hollow properties. While magnetic field levels near the ROW edges are slightly higher for the proposed configuration than the No ROW Expansion Option, the expected increases in field levels are minimal relative to pre-Project levels.

Further, because the existing 330 Line would not have to be removed and rebuilt, the Proposed Configuration would result in less disturbance along the existing ROW during construction and would not affect the non-managed vegetation along the southern boundary of the ROW. However, land would be disturbed along the northern portion of the existing 150-foot-wide ROW and within the entire 11-acre easement expansion area.

Table 10-6 compares the No ROW Expansion Option to the Proposed Configuration, and Table 10-7 provides cost estimates for the two options. As Table 10-7 shows, the No ROW Expansion Option would cost approximately $28.5 million, compared to an estimated $13.0 million for the alignment of the new 345-kV line across the federally-owned Mansfield Hollow properties using the Proposed Configuration involving the 11 acres of additional easement. In addition, Table 10-7 summarizes the estimated cost to Connecticut consumers for both the No ROW Expansion Option and the Proposed Configuration. If the No ROW Expansion Option is selected, Connecticut consumers would likely bear 100% of the cost for construction through Mansfield Hollow, in excess of the estimated cost of the Proposed Configuration.

Table 10-6: Comparison of Proposed Project Configuration and No ROW Expansion Option

Factor	Segment 1		Segment 2	
	Proposed Configuration	No ROW Expansion Option	Proposed Configuration	No ROW Expansion Option
Location, Design, and Appearance				
Length (miles)	1.0	1.0	0.5	0.5
New ROW Required (acres)	5.8	0	5.2	0
Structure Height Range (feet) (Existing 330 Line Structure Height Ranges are 106-137 feet in Segment 1 and 68-81 feet in Segment 2)	115-145	130-160 (rebuilt 330 Line) 130-155 (new 3271 Line)	70-85	110-130 (rebuilt 330 Line) 115-135 (new 3271 Line)
Environmental Resources				
Water Resources				
Waterbody crossings (number)	1 (Mansfield Hollow Lake)	1 (Mansfield Hollow Lake)	3 Natchaug River (S20-22; S20-23; S20-24)	2 Natchaug River (S20-22; S20-24)
Wetlands, Temporary Effects (acres)	0	0	0.4 acre	0.3 acre
Wetlands, Permanent Effects (fill) (acres)	0	0	< 0.1 acre	< 0.1 acre
Vegetation				
Wetlands, Forested Vegetation Removal (acres)	0.1 acre*	0.1 acre	2.7 acres*	0.7 acre
Wetlands, Scrub-Shrub Vegetation Potentially Affected (acres)	< 0.1 acre	< 0.1 acre	2.3 acres	2.3 acres
Upland Forested Vegetation Removal (acres)	6.0 acres*	4.2 acres	3.5 acres*	1.5 acres
Upland Scrub-Shrub Vegetation Potentially Affected (acres)	7.5 acres	7.1 acres	4.7 acres	4.6 acres
Open Field Upland Vegetation Potentially Affected (acres)	2.3 acres	2.0 acres	0	0
Biological Resources				
Vernal Pools Potentially Affected	0	0	2 (CH-1-VP in W20-70 and CH-2-VP in W20-72/73)	2 (CH-1-VP in W20-70 and CH-2-VP in W20-72/73)
State-listed Species Habitat Traversed	1	1	1	1
Visual Resources				
Difference (in feet, range) in existing and proposed structure heights	7 feet shorter-24 taller	8 feet shorter-44 taller	13 feet shorter - 13 feet taller	34-53 feet taller

Note: For each configuration option, potential environmental effects are based on preliminary locations of structures, crane pads, and access roads, as well as initial estimates of the construction workspace and vegetation clearing required. Vegetation types were determined by land use data and delineated wetland boundaries. The Proposed Configuration impact analysis assumes the 11-acre ROW expansion with the existing 330 Line left in place, whereas the No ROW Expansion Option assumes construction disturbance (including vegetation removal) within the entire 150-foot-wide ROW (refer to XS-3-NRE and XS-5-NRE).
* Assumes that the forested areas south of Line 330 (totaling approximately 3.5 acres) would remain in place and would not be affected by the proposed Project (refer to XS-3 and XS-5).

Table 10-7: Cost Comparison of Proposed Project Configuration and No ROW Expansion Option

Cost ($ Million in 2010 dollars)	Proposed Configuration	No ROW Expansion Option
Capital Cost	$13.0 million	$28.5 million
Cost to Connecticut Consumers[1]	$3.5 million	$19.0 million

1. Assumes that the cost of the Proposed Configuration is regionalized (i.e., 27% of cost applied to Connecticut consumers) and any expenditures in excess of the Proposed Configuration costs are localized (i.e., Connecticut consumers bear 100% of costs).

10.5 MINIMAL ROW EXPANSION OPTION

The Minimal ROW Expansion Option would limit the amount of additional easement required from the USACE by using taller monopole structures, with vertically-configured conductors, to support the new 3271 Line. The existing 330 Line (consisting of steel-monopole delta structures along Segment 1 and wood pole H-frame structures along Segment 2) would remain in place. Under this configuration option, the new 3271 Line structures would not match the design or appearance of the existing 330 Line structures. [Note that while the length of the ROW across the federally-owned lands is 1.4 miles, the length of the Minimal ROW Expansion Option is 1.5 miles due to structure placement. The additional 0.1 mile is on privately-owned property where CL&P's existing easement is 300 feet wide.]

10.5.1 Technical Description (Design, Appearance, Land Requirements, Cost)

Land Requirements. For the Minimal ROW Expansion Option, 25 feet of additional easement would be required through the federal lands along Segment 1, while 35 feet of additional easement would be required across Segment 2. Overall, approximately 4.8 acres of additional easement would be required from the federal government (approximately 2.6acres along Segment 1 and 2.2 acres along Segment 2).

Design and Appearance. Along both Segments 1 and 2, the new 345-kV transmission line would be supported on steel-monopole structures with vertically-configured conductors. Appendix 10B (included at the end of this section) provides cross-sections (XS-3-MH-MRE and XS-5-MH-MRE) that illustrate the design and appearance of these structures, as well as the additional easement width that would be required along Segments 1 and 2.

Table 10-8 identifies the design and heights of the new 345-kV line structures, compared to the design and heights of the existing 330 Line structures through the Mansfield Hollow area. The Volume 9 maps illustrate the configurations of the existing 330 Line and the proposed 3271 Line under the Minimal ROW Expansion Option.

Table 10-8: Comparison of Structure Types and Heights: Existing 330 Line and Minimal ROW Expansion Option

Existing 330 Line				New 3271 Line			
Structure No.	Height (feet)	Base Elevation (feet)	Structure Type	Structure No.	Height (feet)	Base Elevation (feet)	Structure Type
Segment 1				**Segment 1**			
9081	117	252.5	Delta Tangent	82	150	253.5	Vertical Strain
9082	137	258.2	Vertical Deadend	83	130	258.0	Vertical Deadend
9083	117	235.1	Delta Tangent	84	150	233.9	Vertical Tangent
9084	106	262.2	Delta Tangent	85	130	262.1	Vertical Tangent
9085	111	256.0	Delta Tangent	86	150	261.0	Vertical Tangent
9086	116	255.0	Delta Tangent	87	155	256.2	Vertical Tangent
0.8-mile Privately-Owned ROW Segment				**0.8-mile Privately-Owned ROW Segment**			
9087	103	267.9	H-Frame Tangent	88	160	268.2	Vertical Tangent
9088	81	354.1	3-Pole Deadend	89	95	364.6	3-Pole Running Angle
9089	83	339.8	H-Frame Tangent	90	80	346.3	H-Frame Tangent
9090	86	297.7	H-Frame Tangent	91	85	299.1	H-Frame Tangent
9091	86	283.4	H-Frame Tangent	92	85	295.0	H-Frame Tangent
9092	86	283.2	H-Frame Tangent	93	80	291.3	H-Frame Tangent
9093	75	297.2	H-Frame Tangent	94	65	299.5	H-Frame Strain
9094	68	275.4	H-Frame Tangent	95	110	272.8	Vertical Tangent
Segment 2				**Segment 2**			
9095	81	247.1	H-Frame Tangent	96	115	247.4	Vertical Tangent
9096	77	281.7	H-Frame Tangent	97	115	281.1	Vertical Tangent
9097	73	255.1	H-Frame Tangent	98	120	251.8	Vertical Tangent
9098	80	250.3	H-Frame Tangent	99	120	248.6	Vertical Tangent
9099	75	260.0	3-Pole Running Angle	100	135	259.1	Vertical Strain

Notes:
For illustrations of typical H-frame and steel-pole (i.e., delta, vertical) structures, refer to Appendix 3B.

Within both Segment 1 and Segment 2, the new 3271 Line would be constructed near the northern edge of the expanded ROW. As summarized in Table 10-8, the new steel-monopole structures along Segment

1 would range from 130 to 155 feet in height. Through Segment 2, the 3271 Line's steel-pole structures would be 115 to 135 feet tall.

Cost. The capital cost of the Minimal ROW Expansion Option is estimated at $14.3 million. Thus, this option would cost $1.3 million more than the $13.0 million estimated for the Proposed Configuration. In addition, Connecticut consumers would likely bear 100% of the cost for the Minimal ROW Expansion Option through the Mansfield Hollow area that is in excess of the estimated cost of the Proposed Configuration.

10.5.2 Construction Procedures and Sequence

The typical overhead line construction procedures described in Sections 4.1 and 4.2 of this Volume 1 also would apply to the development of the Minimal ROW Expansion Option. Because the existing 330 Line would remain in place, no special construction sequence (as described in Section 10.4.2 for the NO ROW Expansion Option) would be required. The construction activities would include the following:

- Remove vegetation along the northern portions of the ROW along Segments 1 and 2.
  - Along Segment 1, woody vegetation would be removed along a 50-foot-wide area (encompassing both the 25-foot-wide portion of the existing 150-foot-wide ROW that is not presently managed and the 25-foot-wide expanded easement area).
  - Along Segment 2, woody vegetation would be removed along a 40-foot-wide area (including the 5-foot-wide portion of the existing ROW that is not presently managed and the 35-foot-wide expanded easement area).

    (*Note*: Scrub-shrub vegetation along the ROW on the slopes adjacent to Mansfield Hollow Lake and abutting the Natchaug River would not have to be removed because no structures would be removed or installed in these areas. Tree removal or trimming would be performed as required for consistency with overhead transmission line standards.)
- Develop access roads along and to the ROW, where necessary.
- Install the steel monopoles and vertically-configured conductors for the new 345-kV line segments.
- Restore and reseed disturbed portions of the ROW.

After the installation of the new 3271 Line, 150 feet of the total 175-foot-wide ROW along Segment 1 would be managed in low-maturing vegetative species. The existing forested vegetation along the southern boundary of the ROW (south of the existing 330 Line) would not be affected. Similarly, along Segment 2, 180 feet of the total 185-foot-wide expanded ROW would be managed in low-maturing vegetation. The approximately 5-foot-wide strip of existing forested vegetation located along the southern boundary of the ROW would not be affected.

10.5.3 Existing Environmental Features

The environmental resources that would be affected by the Minimal ROW Expansion Option are illustrated on the Mansfield Hollow Design Option maps in Volume 9 (Exhibit 2A) and are summarized in Table 10-9.

10.5.4 Potential Environmental Effects and Mitigation Measures

The types of potential environmental effects and mitigation measures associated with the development of the proposed 3271 Line using the Minimal ROW Expansion Option would be similar to those described in Section 6 for overhead transmission line construction using the Proposed Configuration (matching structure) design. Table 10-10 summarizes the potential environmental effects of the Minimal ROW Expansion Option.

The Minimal ROW Expansion Option would require only approximately 4.8 acres of additional easement from the USACE, rather than the 11 acres that would be involved in the Proposed Configuration through the federally-owned properties. Compared to both the Proposed Configuration and the No ROW Expansion Option, this configuration option also would minimize the amount of vegetation clearing and soil disturbance.

Table 10-9: Summary of Existing Environmental Features: Minimal ROW Expansion Option (Segment 1 [175-foot-wide ROW] and Segment 2 [185-foot-wide ROW])*

ENVIRONMENTAL FEATURE	SEGMENT 1	SEGMENT 2	OPTION TOTAL
ROW Length (miles)	1.0 (0.9 mile federal land)	0.5	1.5 (1.4 miles federal land)
Towns	Mansfield	Chaplin	-
New ROW Width Required (feet / acres)	25 (2.6 acres)	35 (2.2 acres)	- 4.8 acres
Water Resources			
Waterbody Crossings (number, name)	1 Mansfield Hollow Lake	2 S20-22 (Natchaug River) S20-24	3
Wetlands Within Portions of ROW Affected by Construction (number / name)	1 W20-66 (Mansfield Hollow Lake border)	5 W20-70 (vernal pool CH-1-VP) W20-72/73 (vernal pool CH-2-VP) W20-74 W20-75 W20-76	6
Biological Resources			
Existing Vegetation Community Type (Estimated acres within Expansion Option ROW)			
• Forested Upland	6.1 acres	2.6 acres	8.7 acres
• Forested Wetland	0.1 acre	1.7 acres	1.8 acres
• Scrub-shrub Upland	7.3 acres	4.7 acres	12.0 acres
• Open Field Upland	2.1 acres	0	2.1 acres
• Scrub-shrub Wetland	< 0.1 acre	2.3 acres	2.3 acres
Natural Diversity Data Base Areas (No.)	1	1	2
Land Uses			
Recreational Areas (linear miles traversed along ROW)			
• Mansfield Hollow State Park	0.8 mile	0	0.8 mile
• Mansfield Hollow WMA	0.1 mile	0.5 mile	0.6 mile
• Trails	2 Red Trail (within Park) Nipmuck Trail East Branch (within WMA)	0	2
Transportation			
Road Crossings	1 Bassetts Bridge Road	0	1
Cultural Resources			
Designated Historic Sites	1 Mansfield Hollow Dam Historic District	0	1

*Note: Information reflects environmental resources within the entire 150-foot-wide existing ROW and the potential 25-foot-wide and 35-foot-wide expansion areas north of the existing ROW in Segments 1 and 2, respectively.

Table 10-10: Minimal ROW Expansion Option: Summary of Potential Environmental Effects, by ROW Segment

ENVIRONMENTAL FEATURE	POTENTIAL ENVIRONMENTAL EFFECTS, BY SEGMENT		OPTION TOTAL
	1	2	
ROW Length (miles)	1.0	0.5	1.5
Construction ROW Width (feet)	70	80	
New ROW Width Required (feet)	25	35	0
Water Resources			
Waterbody Crossings (number)	1 span Mansfield Hollow Lake	3 1 span (Natchaug River) 1 crossing (S20-23); permanent culvert at S20-24	2 spans 2 crossings (1 permanent culvert)
Wetlands			
Number Affected	1 (W20-66, Mansfield Hollow Lake border, possible tree trimming)	5 (W20-70, W20-72/73, W20-74, W20-75, W20-76)	6
Vernal Pools Affected (number)	0	2 (CH-1-VP, CH-2, VP)	2
Wetlands, Temporary Effects (estimated acres)	0	0.3 acre	0.3 acre
Wetlands, Permanent Fill Effects (estimated acres)	0	<0.1 acre	<0.1 acre
Biological Resources			
Vegetation Potentially Affected (estimated acres)			
• Forested Upland Vegetation Removal (Permanent)	3.7 acres*	1.7 acres*	5.4 acres*
• Forested Wetland Vegetation Removal (Permanent)	< 0.1 acre*	1.5 acres*	1.5 acres*
• Scrub-shrub Upland Vegetation Potentially Affected	7.3 acres	4.7 acres	12.0 acres
• Open Field Upland Vegetation Potentially Affected	2.1 acres	0	2.1 acres
• Scrub-shrub Wetland Vegetation Potentially Affected	< 0.1 acre	2.3 acre	2.3 acres
Natural Diversity Data Base Areas (No.)	1	1	2
Land Uses			
Recreational Areas (linear miles traversed along ROW)			
• Mansfield Hollow State Park	0.9 mile	0	0.9 mile
• Mansfield Hollow WMA	0.1 mile	0.5 mile	0.6 mile
• Trails	2 Red Trail (within Park) Nipmuck Trail East Branch (within WMA)	0	2
Visual Resources			
Structure Appearance	Galvanized Steel Finish	Weathering Steel Finish	

Notes:

1. The wetland bordering Mansfield Hollow Lake (designated as Wetland W20-66) would be spanned. Some tops of trees in this wetland may need to be cut to maintain clearance from conductors.
2. Wetland effects determined based on preliminary locations of structures, crane pads, and access roads. All effects except structure locations and permanent access roads are assumed to be temporary (i.e., crane pads and temporary roads across wetlands will be removed after the completion of construction.). Wetland W20-72/73, which would be traversed along the expanded ROW west of the Natchaug River is assumed to require forested vegetation clearing along a 300-foot length of the 35-foot-wide expanded ROW width.

* Assumes that the forested areas south of Line 330 (totaling approximately 3.5 acres) would remain in place and would not be affected by the proposed Project (refer to XS-3-MRE and XS-5-MRE).

In general, the configuration of the new 345-kV line using the Minimal ROW Expansion Option would affect vegetation, soils, and water resources along the northern portion of the existing 150-foot-wide ROW, as well as within the 4.8 acres of additional easement width (2.6 acres along Segment 1 and 2.2 acres along Segment 2). Environmental resources (e.g., vegetation, soils, wetlands) located along the southern portion of the existing ROW and beneath the existing 330 Line would generally not be affected by the construction and operation of the new 3271 Line.

On the other hand, the steel monopoles with vertically-configured conductors that would be used for the Minimal ROW Expansion Option would not match the appearance or heights of the existing 330 Line structures along either Segment 1 or Segment 2. As a result, this option has the potential to result in comparatively greater long-term visual effects due to the use of taller and different types of transmission line structures than those that presently characterize the existing 330 Line through Segments 1 and 2. As summarized in Table 10-8, the new 3271 Line structures would be up to 39 feet taller than the existing 330 Line's steel-pole delta structures along Segment 1, and up to 60 feet taller than the existing 330 Line's wood-pole H-frame structures along Segment 2.

Appendix 10C includes "leaf on" and "leaf off" photo-simulations that illustrate the anticipated appearance of the ROW along Segment 1, after implementation of the Minimal ROW Expansion Option. Based on field investigations and photo-simulations, the taller structures required for the Minimal ROW Expansion Option would be visible from various locations in the vicinity of Mansfield Hollow State Park (e.g., Mansfield Hollow Lake and Dam, the levee trail both north and south of the dam, Bassetts Bridge Road, and U.S. Route 6). However, as described for the No ROW Expansion Option, this effect would be incremental since the existing structures, particularly along Segment 1, are presently visible from vantage points within the state park and the WMA, as well as from Mansfield Hollow Dam, the levee trail, and the Nipmuck Trail. As also described for the No ROW Expansion Option, the difference in structure heights would be most apparent within Segment 2, where the existing H-frames (typically 80 feet tall) would be replaced with steel-pole structures with typical heights of 130 feet.

10.5.5 Electric and Magnetic Fields

Electric and magnetic fields were calculated for the Minimal ROW Expansion Option (MRE) with the new 3271 Line configured as illustrated on Cross-Sections XS-3-MH-MRE and XS-5-MH-MRE (see Appendix 10B). The magnetic field calculations are for projected annual average loading (AAL) conditions for pre-Project (2015) and post-NEEWS (2020). See Volume 1, Section 7 for details regarding the assumptions for these load conditions and other details concerning the field calculations. Magnetic field profiles across the ROW produced by the existing, proposed, and Minimal ROW Expansion configurations along these sections of the ROW at AAL were calculated as shown in Figures 10-5 and 10-6. Note that the northern ROW edge location varies for the three configurations being compared.

Figure 10-5: Magnetic Field Profiles for the Existing, Proposed, and Minimal ROW Expansion (MRE) Options at AAL – Mansfield Hollow State Park to Bassetts Bridge Road - XS-3 and XS-3-MH-MRE

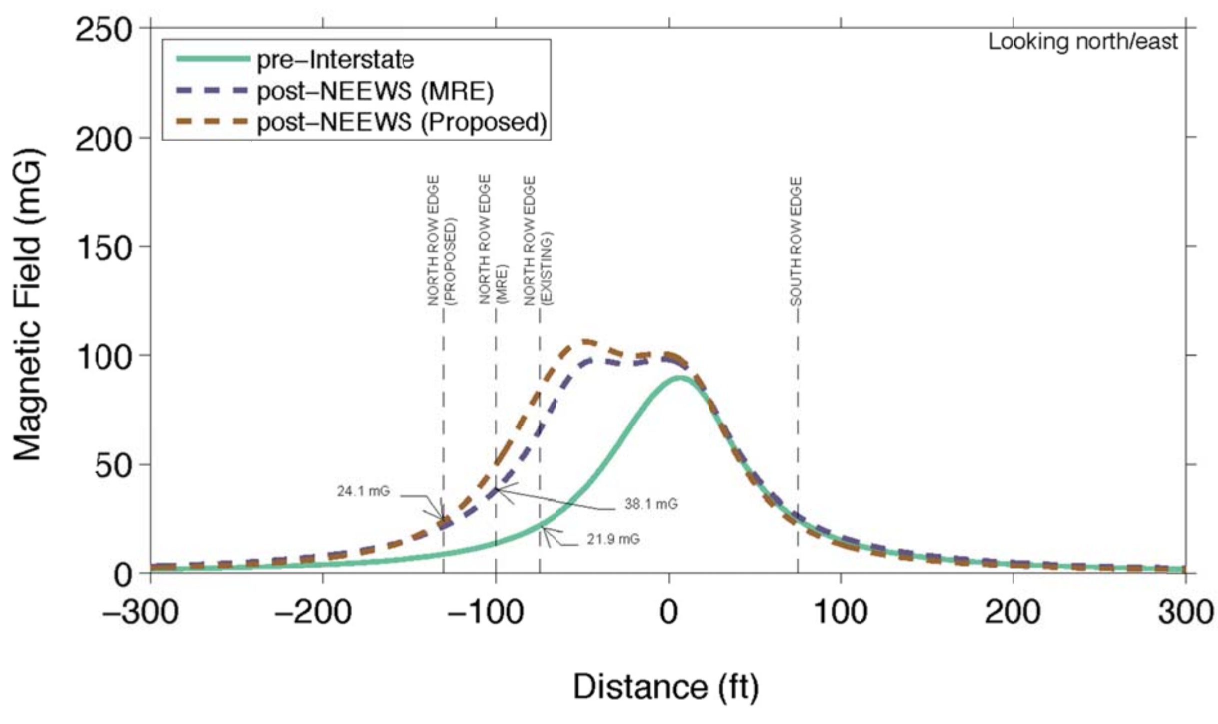
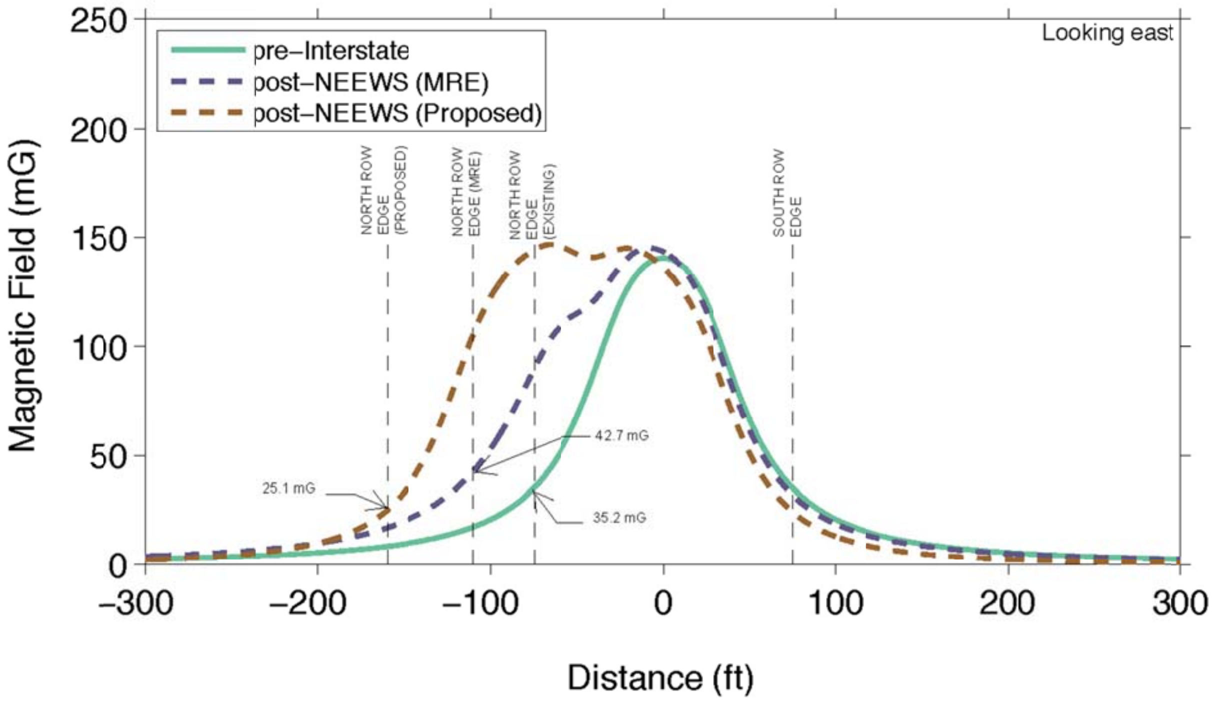


Figure 10-6: Magnetic Field Profiles for the Existing, Proposed, and Minimal ROW Expansion (MRE) Options at AAL – Vicinity of Shuba Lane through Mansfield Hollow WMA to Vicinity of Willimantic Road - XS-5 and XS-5-MH-MRE



As Figures 10-5 and 10-6 illustrate, the proposed configuration yields the lowest post-Project magnetic field levels at ROW edges when compared to the Minimal ROW Expansion Option. The Minimal ROW Expansion Option would produce magnetic field levels that are comparable to pre-Project levels along the south ROW edge, but higher along the north ROW edge nearest the proposed transmission line. Table 10-11 summarizes the magnetic field levels at the ROW edges for each of the cases presented in Figures 10-5 and 10-6.

Table 10-11: Summary of Electric and Magnetic Field Levels at ROW Edges for Existing, Proposed, and the Minimal ROW Expansion Option

Cross-Section	Description	Loading Conditions	Magnetic Field (mG)		Electric Field (kV/m)	
			North ROW Edge[a]	South ROW Edge	North ROW Edge[a]	South ROW Edge
XS-3	Segment 1 Existing	Pre-Interstate (2015)	21.9	24.7	1.10	0.86
XS-3	Segment 1 Proposed	Post-NEEWS (2020)	24.1	22.6	1.47	0.93
XS-3-MH-MRE	Segment 1 Minimal ROW Option	Post-NEEWS (2020)	38.1	26.4	0.70	1.00
XS-5	Segment 2 Existing	Pre-Interstate (2015)	35.2	35.2	1.63	1.63
XS-5	Segment 2 Proposed	Post-NEEWS (2020)	25.1	24.1	1.66	1.62
XS-5-MH-MRE	Segment 2 Minimal ROW Option	Post-NEEWS (2020)	42.7	31.8	0.70	1.80

[a] Note that the location of the north edge of the ROW varies for the different design options being compared.

10.5.6 Comparison of the Proposed Configuration (Matching Structures) and the Minimal ROW Expansion Option

Table 10-12 summarizes and compares the potential effects associated with the Minimal ROW Expansion Option and the Proposed Configuration. As this table shows, compared to the Proposed Configuration, the selection of the Minimal ROW Expansion Option would minimize both the additional easement acreage required from the USACE and the forested vegetation removal required to install the new 3271 Line. Compared to the Proposed Configuration, the use of this design option also would result in slightly greater temporary effects on wetlands, but less conversion of forested wetlands to scrub-shrub wetlands.

However, the Minimal ROW Expansion Option would involve steel monopoles that would be noticeably taller than the existing 330 Line structures, particularly along Segment 2 in Chaplin. These taller structures would create a change in the visual environment in the vicinity of the ROW.

The Minimal ROW Expansion Option would also be more expensive, costing approximately $14.3 million, compared to an estimated $13.0 million for the alignment of the new 345-kV line across the federally-owned Mansfield Hollow properties using the Proposed Configuration involving the 11 acres of additional easement. See Table 10-13 for the cost comparison.

Table 10-12: Comparison of Proposed Project Configuration and Minimal ROW Expansion Option

Factor	Segment 1		Segment 2	
	Proposed Configuration	Minimal ROW Expansion Option	Proposed Configuration	Minimal ROW Expansion Option
Location, Design, and Appearance				
Length (miles)	1.0 (0.9 mile federal land)	1.0 (0.9 mile federal land)	0.5	0.5
New ROW Required (acres)	5.8 acres	2.6 acres	5.2 acres	2.2 acres
Structure Height Range (feet) (Existing 330 Line Structure Height Ranges = 106-137 feet Segment 1; 68-81 feet Segment 2)	115-145	125-155	70-85	115-135
Environmental Resources				
Water Resources				
Waterbody crossings (number)	1 (Mansfield Hollow Lake)	1 (Mansfield Hollow Lake)	3 (Natchaug River (S20-22); S20-23; S20-24	2 (Natchaug River (S20-22); S20-24
Wetlands, Temporary Effects (acres)	0	0	0.4 acre	0.3 acre
Wetlands, Permanent Effects (fill) (acres)	0	0	< 0.1 acre	<0.1 acre
Vegetation				
Wetlands, Forested Vegetation Removal (acres)	0.1 acre	< 0.1 acre	2.7 acres	1.5 acres
Wetlands, Scrub-Shrub Vegetation Potentially Affected (acres)	< 0.1 acre	< 0.1 acre	2.3 acres	2.3 acres
Upland Forested Vegetation Removal (acres)	6.0 acres	3.7 acres	3.5 acres	1.7 acres
Upland Scrub-Shrub Vegetation Potentially Affected (acres)	7.6 acres	7.3 acres	4.7 acres	4.7 acres
Open Field Upland Vegetation Potentially Affected (acres)	2.3 acres	2.1 acres	0	0
Biological Resources				
Vernal Pools Potentially Affected	0	0	2 (CH-1-VP, CH-2-VP)	2 (CH-1-VP, CH-2-VP)
State-listed Species Habitat Traversed	1	1	1	1
Visual Resources				
Difference in existing and proposed structure heights (feet)	7 feet shorter - 24 feet taller	7 feet shorter - 43 feet taller	13 shorter - 13 feet taller	27-59 feet taller

Table 10-13: Cost Comparison of Proposed Project Configuration and Minimal ROW Expansion Option

Cost ($ Million in 2010 dollars) [5]	Proposed Configuration	Minimal ROW Expansion Option
Capital Cost	$13.0 million	$14.3 million
Cost to Connecticut Consumers	$3.5 million	$4.8 million

1. Assumes that the cost of the Proposed Configuration is regionalized (i.e., 27% of cost applied to Connecticut consumers) and any expenditures in excess of the Proposed Configuration costs are localized (i.e., Connecticut consumers bear 100% of costs).

10.6 SUMMARY COMPARISON OF MANSFIELD HOLLOW CONFIGURATION OPTIONS

As currently planned, CL&P's Project incorporates the Proposed Configuration, involving the 11-acre easement expansion across the federally-owned lands in the Mansfield Hollow area. This configuration would allow the new 3271 Line to be constructed on structures that would generally match the existing 330 Line structures through Segments 1 and 2, and would minimize incremental changes to the viewscape, while limiting environmental effects. Moreover, this configuration represents the least cost option.[6] All of the configuration options would result in minimal permanent effects on wetlands.

However, both the No ROW Expansion Option and the Minimal ROW Expansion Option also represent viable configurations for the alignment of the new 345-kV line along Segments 1 and 2. CL&P would be prepared to construct the new 345-kV line across the Mansfield Hollow properties using either of these options, should the USACE not prefer the Proposed Configuration. However, compared to the Proposed Configuration, each of these options offers trade-offs in terms of cost, structure design and appearance, and environmental resource effects (principally forested vegetation clearing). Table 10-14 summarizes and compares the principal characteristics of each of the three configuration options.

As the Table 10-14 comparisons illustrate, the Proposed Configuration represents the least-cost option for aligning the new 345-kV line through the federally-owned Mansfield Hollow properties. Compared to the existing 330 Line, this option would also minimize differences in the appearance (design and height) of the new 345-kV line structures. However, this configuration would require the acquisition of the most new easement from the USACE (11 acres) and the most forested upland and wetland vegetation removal.

[6] Note that the estimated costs for the Proposed Configuration and the Minimal ROW Expansion Option exclude costs for the acquisition of the expanded easement from the USACE.

Table 10-14: Summary Comparison of Mansfield Hollow Configuration Options (Federal Properties: Combined Segments 1 and 2)

Factor	Proposed Configuration	No ROW Expansion Option	Minimal ROW Expansion Option
Location, Design, and Appearance			
Length (miles) [7]	1.5	1.5	1.5
New ROW Required (acres)	11.0	0	4.8
Structure Type	Delta Steel Pole (Segment 1) H-Frame (Segment 2)	Vertical Steel Pole (Segments 1 and 2) Rebuilt 330 Line and 3271 Line	Vertical Steel Pole (Segments 1 and 2)
Structure Height Range (feet) SEE NOTE 1	115-145 (Segment 1) 70-85 (Segment 2)	130-160 (Segment 1) 110-135 (Segment 2)	125-155 (Segment 1) 115-135 (Segment 2)
Environmental Resources			
Water Resources			
Waterbody crossings (No.)	4	3	3
Wetlands, Temporary Effects (acres)	0.4 acre	0.3 acre	0.3 acre
Wetlands, Permanent Effects (fill) (acres)	<0.1 acre	<0.1 acre	<0.1 acre
Vegetation			
Wetlands, Forested Vegetation Removal (acres)	2.8 acres	0.8 acre	1.5 acres
Wetlands, Scrub-Shrub Vegetation Potentially Affected (acres)	2.3 acre	2.3 acres	2.3 acres
Upland Forested Vegetation Removal (acres)	9.5 acres	5.7 acre	5.4 acres
Upland Scrub-Shrub Vegetation Potentially Affected (acres)	12.2 acres	7.1 acres	12.0 acres
Open Field Upland Vegetation Potentially Affected (acres)	2.3 acres	2.0 acres	2.1 acres
Biological Resources			
Vernal Pools Potentially Affected (No.)	2	2	2
State-listed Species Habitat Traversed (No.)	2	2	2
Visual Resources			
Difference in existing and proposed structure heights (feet)	-7 to +24 feet (Segment 1) -13 to +13 feet (Segment 2)	-8 to +49 (Segment 1) +34-55 (Segment 2)	-7 to +39 feet (Segment 1) +27-60 feet (Segment 2)
Estimated Cost			
Capital Cost	$13.0 million	$28.5 million	$14.3 million
Cost to Connecticut Consumers	$3.5 million	$19.0 million	$4.8 million

Notes:

1. Existing 330 Line structure height ranges are 106-137 feet in Segment 1 and 68-81 feet in Segment 2.
2. For each configuration option, preliminary analyses have been performed to identify anticipated locations of structures, crane pads, and access roads. Potential effects on wetlands vary for each configuration as a result of the differences in ROW widths, structure types and locations, anticipated crane pad sites, and access roads. For all configuration options, potential effects on wetlands have been minimized to the extent practical.
3. Assumes that the cost of the Proposed Configuration is regionalized (i.e., 27% of cost applied to Connecticut consumers) and any expenditures in excess of the Proposed Configuration costs are localized (i.e., Connecticut consumers bear 100% of costs).

[7] Each option would include 1.4 miles across federally-owned lands.

In comparison, whereas the No ROW Expansion Option would not require any additional easement from the USACE and would minimize forest vegetation removal, the construction complexities associated with removing and rebuilding the 330 Line make this the most expensive of the three options. Further, to accommodate both the 330 and 3271 Lines within the 150-foot-wide ROW, steel monopoles would have to be used along both Segments 1 and 2. Along Segment 2 in particular, these monopoles would be substantially taller than the existing 330 Line's wood-pole H-frame structures. In addition, all of the forest vegetation within the existing 150-foot-wide ROW would have to be removed, including the forest land along the southern portion of the ROW through Segment 1.

The Minimal ROW Expansion Option provides a configuration that minimizes the amount of additional easement required from the USACE (4.8 acres) by using taller structures. These structures would not match the appearance of the existing 330 Line structures in Segments 1 or 2, and would be the same type and general height as the structures required for the No ROW Expansion Option. However, the Minimal ROW Expansion Option would be substantially less costly than the No ROW Expansion Option, and only $1.3 million more expensive than the Proposed Configuration. In addition, this option would require less upland and wetland forest vegetation removal than either of the other two configuration options.

In sum, CL&P prefers the Proposed Configuration for developing the new 345-kV line across the USACE-owned properties in Mansfield Hollow because it represents the least-cost option and allows matching structures. However, CL&P is prepared to develop the proposed 345-kV line across the federal properties using either of the other two configuration options.

Appendix 10A – No ROW Expansion Option Cross-Sections and Construction Sequencing

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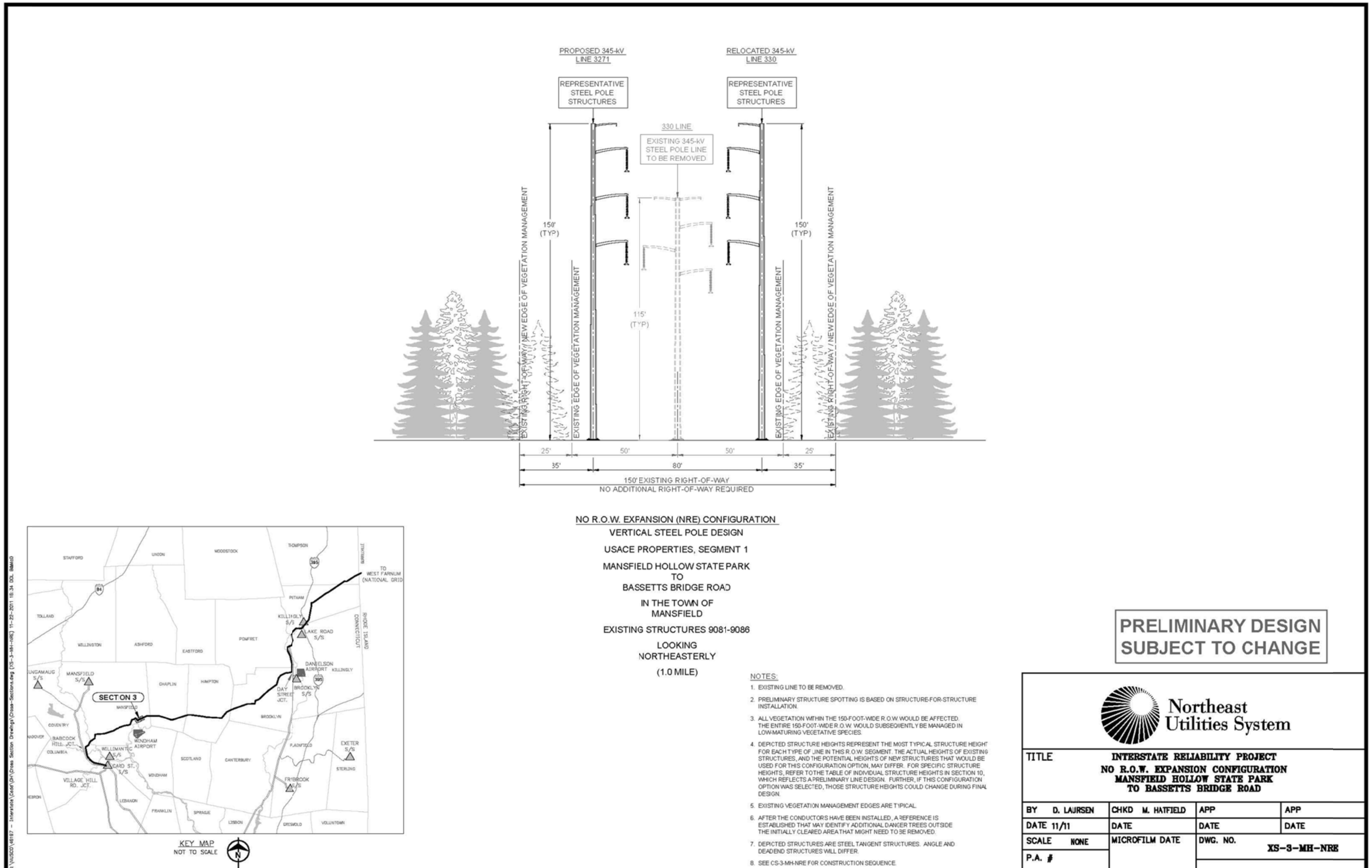
XS-3-MH-NRE: No ROW Expansion Configuration



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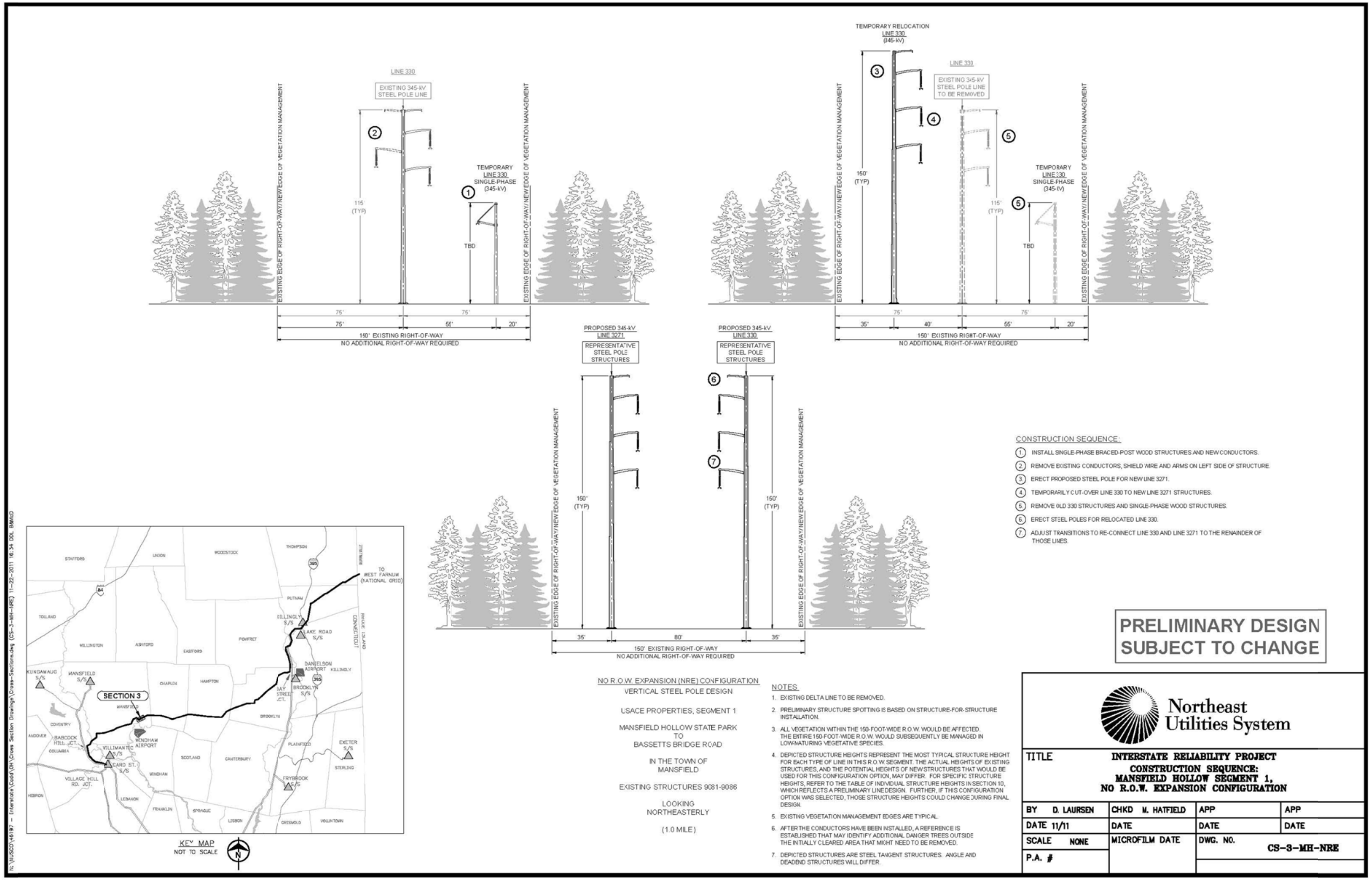
CS-3-MH-NRE: No ROW Expansion Configuration



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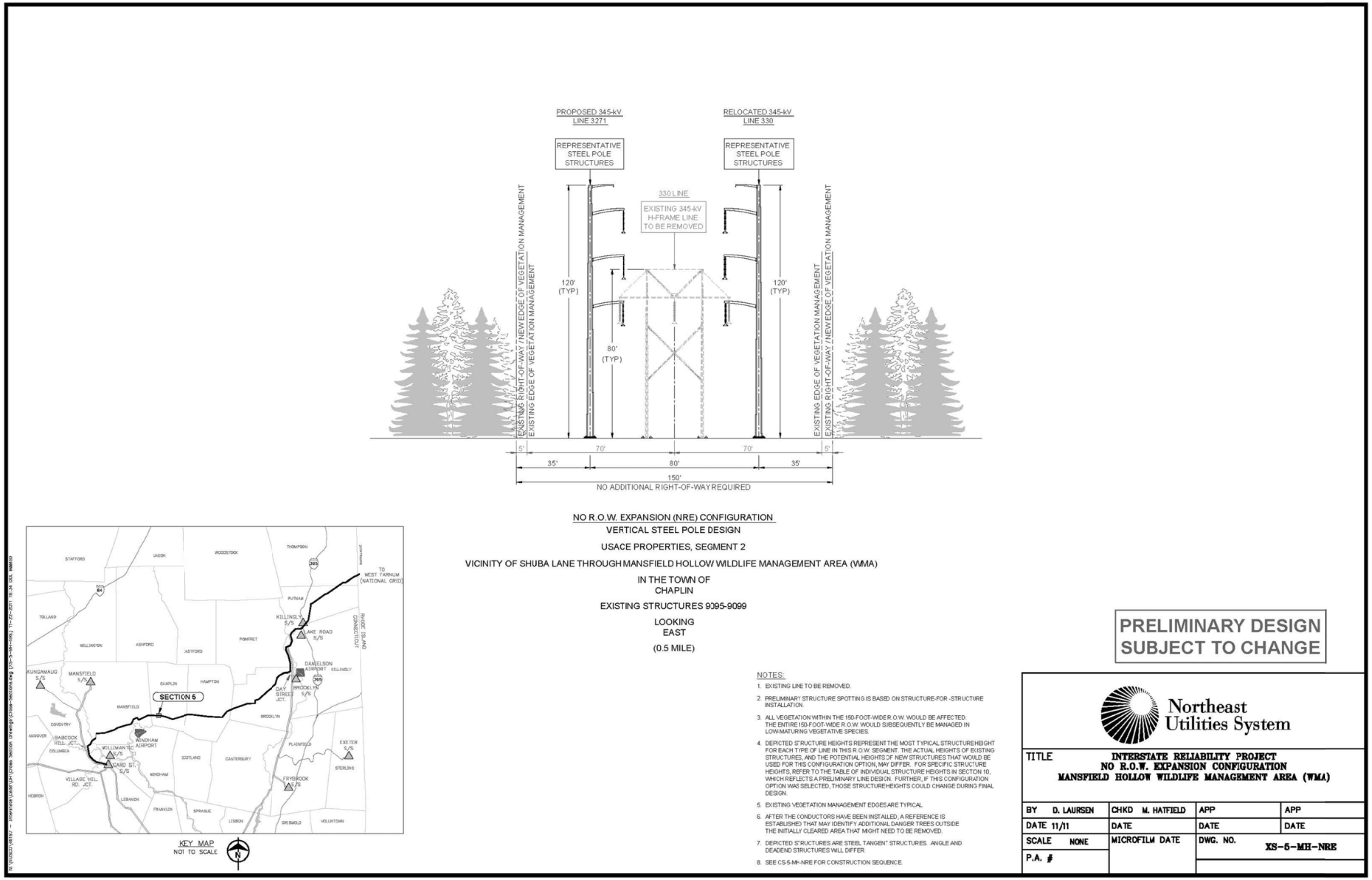
XS-5-MH-NRE: No ROW Expansion Configuration



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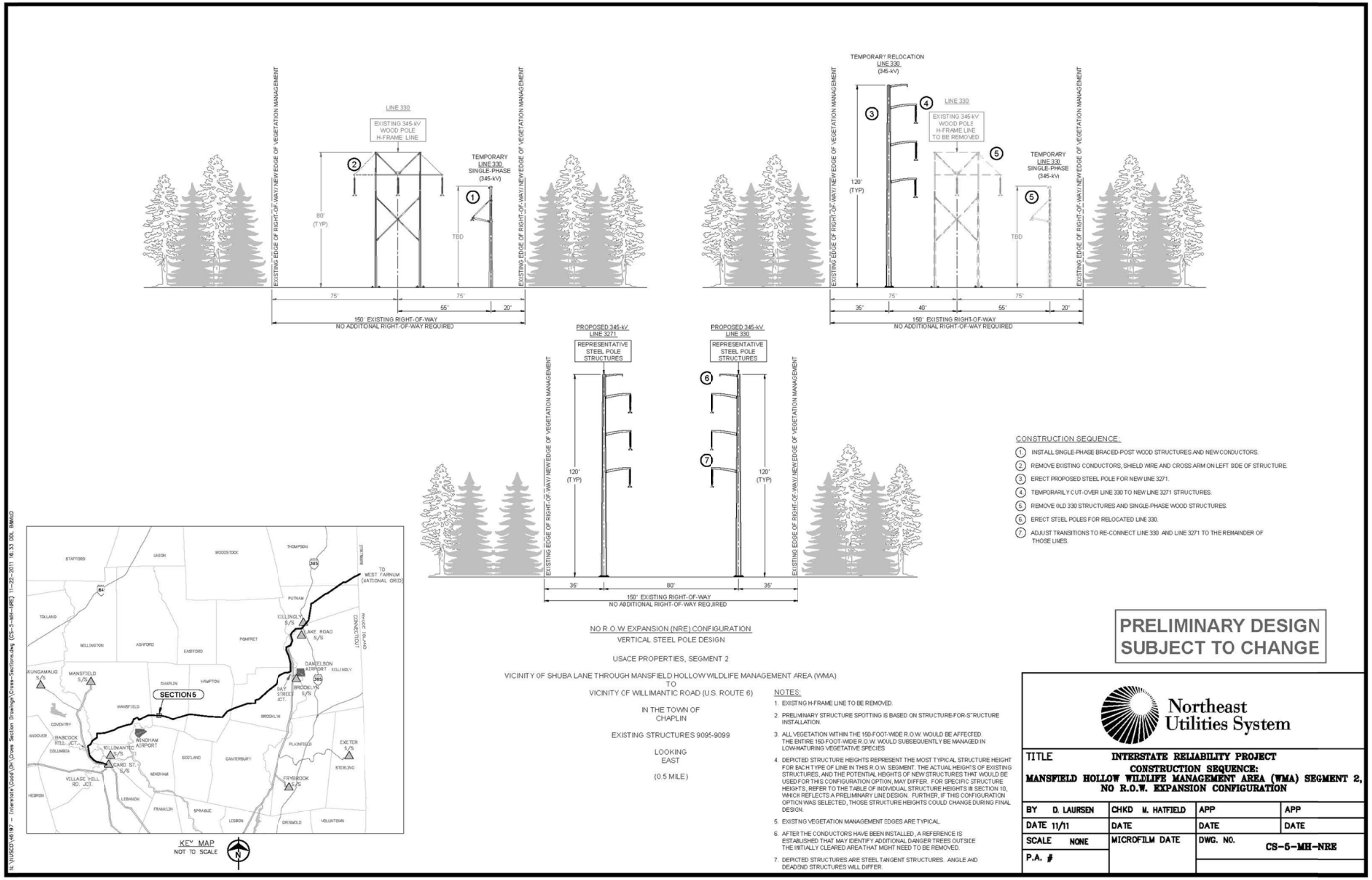
CS-5-MH-NRE: No ROW Expansion Configuration



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Appendix 10B – Minimal ROW Expansion Option Cross-Sections

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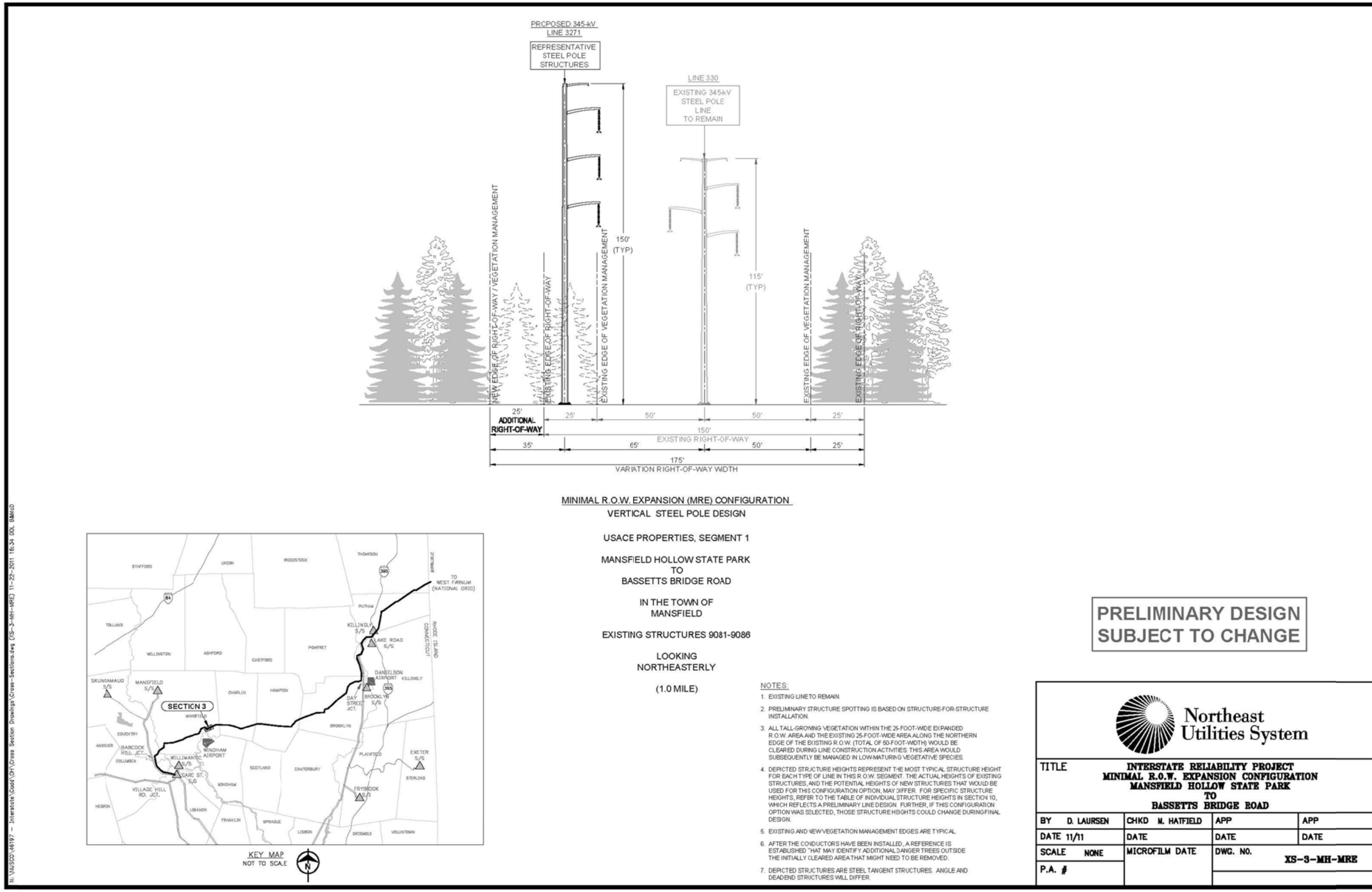
XS-3-MH-MRE: Minimal ROW Expansion Configuration



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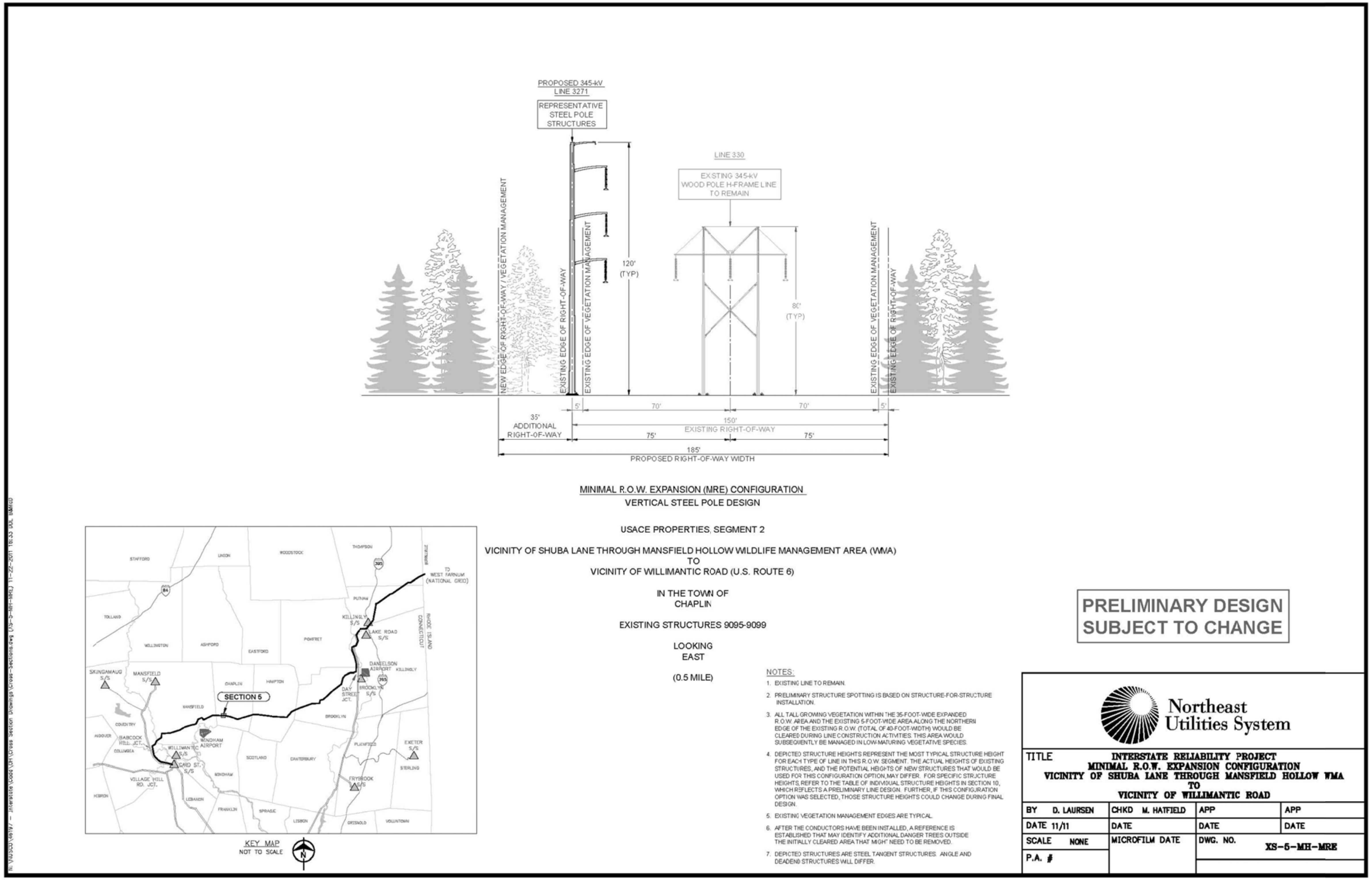
XS-5-MH-MRE: Minimal ROW Expansion Configuration



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Appendix 10C – Photo-Simulations

Interstate Reliability Project
Mansfield Hollow State Park – Town of Mansfield
Transmission Rights-of-Way
Typical Cross Section XS-3
Proposed Configuration

The existing 345-kV line will remain and a new delta-configured 345-kV line will be installed, proposed ROW expansion (Segment 1: 55 feet).

(Existing View – Leaf-off Condition)

(Simulation of Post Project View – Leaf-off Condition)

Existing electric transmission line structures looking east in Mansfield Hollow State Park, located south of Bassetts Bridge Road.

Preliminary design of electric transmission line structures looking east in Mansfield Hollow State Park, located south of Bassetts Bridge Road.

NOTE: See Drawing XS-3 for a representation of the typical transmission structures, typical heights of the structures, and ROW width for this cross section.

Interstate Reliability Project
Mansfield Hollow State Park – Town of Mansfield
Transmission Rights-of-Way
Typical Cross Section XS-3
Proposed Configuration

The existing 345-kV line will remain and a new delta-configured 345-kV line will be installed, proposed ROW expansion (Segment 1: 55 feet).

(Existing View – Leaf-on Condition)

Existing electric transmission line structures looking east in Mansfield Hollow State Park, located south of Bassetts Bridge Road.

(Simulation of Post Project View – Leaf-on Condition)

Preliminary design electric transmission line structures looking east in Mansfield Hollow State Park, located south of Bassetts Bridge Road.

NOTE: See Drawing XS-3 for a representation of the typical transmission structures, typical heights of the structures, and ROW width for this cross section.

Interstate Reliability Project
Mansfield Hollow State Park – Town of Mansfield
Transmission Rights-of-Way
Typical Cross Section XS-3-MH-MRE
Minimal ROW Expansion Option

The existing 345-kV line will remain and a new vertical-configured 345-kV line will be installed, minimal ROW expansion option (Segment 1: 25 feet).

(Existing View – Leaf-off Condition)

Existing electric transmission line structures looking east in Mansfield Hollow State Park, located south of Bassetts Bridge Road.

(Simulation of Post Project View – Leaf-off Condition)

Preliminary design of electric transmission line structures looking east in Mansfield Hollow State Park, located south of Bassetts Bridge Road.

NOTE: See Drawing XS-3-MH-MRE for a representation of the typical transmission structures, typical heights of the structures, and ROW width for this cross section.

Interstate Reliability Project
Mansfield Hollow State Park – Town of Mansfield
Transmission Rights-of-Way
Typical Cross Section XS-3-MH-MRE
Minimal ROW Expansion Option

The existing 345-kV line will remain and a new vertical-configured 345-kV line will be installed, minimal ROW expansion option (Segment 1: 25 feet).

(Existing View – Leaf-on Condition)

Existing electric transmission line structures looking east in Mansfield Hollow State Park, located south of Bassetts Bridge Road.

(Simulation of Post Project View – Leaf-on Condition)

Preliminary design electric transmission line structures looking east in Mansfield Hollow State Park, located south of Bassetts Bridge Road.

NOTE: See Drawing XS-3-MH-ME for a representation of the typical transmission structures, typical heights of the structures, and ROW width for this cross section.

Interstate Reliability Project
Mansfield Hollow State Park – Town of Mansfield
Transmission Rights-of-Way
Typical Cross Section XS-3-MH-NRE
No ROW Expansion Option

The existing 345-kV line will be removed and two new vertical-configured 345-kV lines will be installed, no ROW expansion option (Segment 1: 0 feet).

(Existing View – Leaf-off Condition)

Existing electric transmission line structures looking east in Mansfield Hollow State Park, located south of Bassetts Bridge Road.

(Simulation of Post Project View – Leaf-off Condition)

Preliminary design of electric transmission line structures looking east in Mansfield Hollow State Park, located south of Bassetts Bridge Road.

NOTE: See Drawing XS-3-MH-MRE for a representation of the typical transmission structures, typical heights of the structures, and ROW width for this cross section.

Interstate Reliability Project
Mansfield Hollow State Park – Town of Mansfield
Transmission Rights-of-Way
Typical Cross Section XS-3-MH-NRE
No ROW Expansion Option

The existing 345-kV line will be removed and two new vertical-configured 345-kV lines will be installed, no ROW expansion option (Segment 1: 0 feet).

(Existing View – Leaf-on Condition)

Existing electric transmission line structures looking east in Mansfield Hollow State Park, located south of Bassetts Bridge Road.

(Simulation of Post Project View – Leaf-on Condition)

Preliminary design electric transmission line structures looking east in Mansfield Hollow State Park, located south of Bassetts Bridge Road.

NOTE: See Drawing XS-3-MH-ME for a representation of the typical transmission structures, typical heights of the structures, and ROW width for this cross section.

Interstate Reliability Project
Mansfield Hollow Wildlife Management Area / Nipmuck Trail (East Branch) – Town of Mansfield
Transmission Rights-of-Way
Typical Cross Section XS-3
Proposed Configuration

The existing 345-kV line will remain and a new delta-configured 345-kV line will be installed, proposed ROW expansion (Segment 1: 55 feet).

(Existing View – Leaf-off Condition)

Existing electric transmission line structures looking southwest from the Nipmuck Trail - East Branch and toward Mansfield Hollow Wildlife Management Area, located west of Bassetts Bridge Road.

(Simulation of Post Project View – Leaf-off Condition)

Preliminary design of electric transmission line structures looking southwest from the Nipmuck Trail - East Branch and toward Mansfield Hollow Wildlife Management Area, located west of Bassetts Bridge Road.

NOTE: See Drawing XS-3 for a representation of the typical transmission structures, typical heights of the structures, and ROW width for this cross section.

Interstate Reliability Project
Mansfield Hollow Wildlife Management Area / Nipmuck Trail (East Branch) – Town of Mansfield
Transmission Rights-of-Way
Typical Cross Section XS-3
Proposed Configuration

The existing 345-kV line will remain and a new delta-configured 345-kV line will be installed, proposed ROW expansion (Segment 1: 55 feet).

(Existing View – Leaf-on Condition)

Existing electric transmission line structures looking southwest from the Nipmuck Trail - East Branch and toward Mansfield Hollow Wildlife Management Area, located west of Bassetts Bridge Road.

(Simulation of Post Project View – Leaf-on Condition)

Preliminary design of electric transmission line structures looking southwest from the Nipmuck Trail - East Branch and toward Mansfield Hollow Wildlife Management Area, located west of Bassetts Bridge Road.

NOTE: See Drawing XS-3 for a representation of the typical transmission structures, typical heights of the structures, and ROW width for this cross section.

Interstate Reliability Project
Mansfield Hollow Wildlife Management Area / Nipmuck Trail (East Branch) – Town of Mansfield
Transmission Rights-of-Way
Typical Cross Section XS-3-MH-MRE
Minimal ROW Expansion Option

The existing 345-kV line will remain and a new vertical-configured 345-kV line will be installed, minimal ROW expansion option (Segment 1: 25 feet).

(Existing View – Leaf-off Condition)

Existing electric transmission line structures looking southwest from the Nipmuck Trail - East Branch and toward Mansfield Hollow Wildlife Management Area, located west of Bassetts Bridge Road.

(Simulation of Post Project View – Leaf-off Condition)

Preliminary design of electric transmission line structures looking southwest from the Nipmuck Trail - East Branch and toward Mansfield Hollow Wildlife Management Area, located west of Bassetts Bridge Road.

NOTE: See Drawing XS-3-MH-MRE for a representation of the typical transmission structures, typical heights of the structures, and ROW width for this cross section.

Interstate Reliability Project
Mansfield Hollow Wildlife Management Area / Nipmuck Trail (East Branch) – Town of Mansfield
Transmission Rights-of-Way
Typical Cross Section XS-3-MH-MRE
Minimal ROW Expansion Option

The existing 345-kV line will remain and a new vertical-configured 345-kV line will be installed, minimal ROW expansion option (Segment 1: 25 feet).

(Existing View – Leaf-on Condition)

Existing electric transmission line structures looking southwest from the Nipmuck Trail - East Branch and toward Mansfield Hollow Wildlife Management Area, located west of Bassetts Bridge Road.

(Simulation of Post Project View – Leaf-on Condition)

Preliminary design of electric transmission line structures looking southwest from the Nipmuck Trail - East Branch and toward Mansfield Hollow Wildlife Management Area, located west of Bassetts Bridge Road.

NOTE: See Drawing XS-3-MH-MRE for a representation of the typical transmission structures, typical heights of the structures, and ROW width for this cross section.

Interstate Reliability Project
Mansfield Hollow Wildlife Management Area / Nipmuck Trail (East Branch) – Town of Mansfield
Transmission Rights-of-Way
Typical Cross Section XS-3-MH-NRE
No ROW Expansion Option

The existing 345-kV line will be removed and two new vertical-configured 345-kV lines will be installed, no ROW expansion option (Segment 1: 0 feet).

(Existing View – Leaf-off Condition)

Existing electric transmission line structures looking southwest from the Nipmuck Trail - East Branch and toward Mansfield Hollow Wildlife Management Area, located west of Bassetts Bridge Road.

(Simulation of Post Project View – Leaf-off Condition)

Preliminary design of electric transmission line structures looking southwest from the Nipmuck Trail - East Branch and toward Mansfield Hollow Wildlife Management Area, located west of Bassetts Bridge Road.

NOTE: See Drawing XS-3-MH-NRE for a representation of the typical transmission structures, typical heights of the structures, and ROW width for this cross section.

Interstate Reliability Project
Mansfield Hollow Wildlife Management Area / Nipmuck Trail (East Branch) – Town of Mansfield
Transmission Rights-of-Way
Typical Cross Section XS-3-MH-NRE
No ROW Expansion Option

The existing 345-kV line will be removed and two new vertical-configured 345-kV lines will be installed, no ROW expansion option (Segment 1: 0 feet).

(Existing View – Leaf-on Condition)

Existing electric transmission line structures looking southwest from the Nipmuck Trail - East Branch and toward Mansfield Hollow Wildlife Management Area, located west of Bassetts Bridge Road.

(Simulation of Post Project View – Leaf-on Condition)

Preliminary design of electric transmission line structures looking southwest from the Nipmuck Trail - East Branch and toward Mansfield Hollow Wildlife Management Area, located west of Bassetts Bridge Road.

NOTE: See Drawing XS-3-MH-NRE for a representation of the typical transmission structures, typical heights of the structures, and ROW width for this cross section.

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