SECTION 14

TRANSMISSION LINE ROUTE / CONFIGURATION ALTERNATIVES
14. TRANSMISSION LINE ROUTE / CONFIGURATION ALTERNATIVES

14.1 ROUTING OBJECTIVES AND ALTERNATIVE ROUTE ANALYSIS PROCESS

After the Interstate Reliability Project (designed as new 345-kV transmission lines to 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) was selected as the preferred transmission system solution, both CL&P and National Grid identified and evaluated alternative routes and configurations for the new transmission lines. All of the potential alternative routes for the new 345-kV transmission lines necessarily had to interconnect the two substations and two switching stations that are the backbone of the Interstate Reliability Project. This section describes the approach that CL&P used to identify and evaluate route alternatives for the proposed 345-kV transmission lines in Connecticut.

14.1.1 Routing Objectives

As part of the alternatives analysis process for the Connecticut portion of the Interstate Reliability Project, CL&P applied an established set of route selection objectives in order to identify and compare potential routes for the new 345-kV transmission lines between the Card Street Substation and the Lake Road Switching Station, and from Lake Road Switching Station to National Grid’s new 345-kV transmission line at the Connecticut / Rhode Island border. CL&P’s defined line routing objectives, which are listed in Table 14-1, include the following overarching goals:

- The selection of cost-effective and technically feasible solutions to achieve the required transmission system reliability improvements and to interconnect the specified substations and switching stations; and
- The avoidance, minimization, or mitigation of adverse environmental, cultural, and economic effects.
Table 14-1: CL&P Transmission Line Route Selection Objectives

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

CL&P applied the transmission line route selection objectives to identify potential 345-kV transmission line route alternatives involving both overhead and underground configurations. These potential route alternatives were then examined, using CL&P’s route evaluation criteria for overhead transmission lines (as discussed in Section 14.2) and underground transmission cables (as discussed in Section 14.3), to assess the viability of each option based on operability and reliability, technical feasibility, potential effects on property, potential effects on environmental and cultural resources, and cost. Because overhead and underground transmission line construction and operation are inherently different, the emphasis placed on some of the route evaluation criteria in the analysis of potential route options varied for these two line configuration types.

As the first step in the alternative route analyses, CL&P identified major, geographically distinct, route alternatives (both within or adjacent to existing ROWs and along potential new ROWs) for the proposed 345-kV transmission lines between Card Street Substation, Lake Road Switching Station, and the

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1 The alternative routes were identified and evaluated by a team consisting of CL&P staff, as well as specialized engineering and environmental consultants. This team conducted field reconnaissance, performed baseline data collection, and reviewed aerial photography to determine the characteristics of each route alternative and to assess each in terms of CL&P’s objectives and route evaluation criteria.
National Grid ROW at the Connecticut / Rhode Island border. The initial investigation of potential alternative line routes involved the review of CL&P records, road atlases, and USGS topographic maps to identify existing linear corridors (e.g., highways, pipelines, transmission lines, and railroads) in the Project region. Aerial photographs of the Project region also were reviewed for potential new transmission line routes (e.g., not along existing utility or road corridors), as well as to identify general land uses and environmental features (e.g., vegetative communities, water resources, major designated recreational areas, and developed residential, commercial, and industrial areas) along the alternative routes under consideration.

As a result of these initial investigations, the following potential route/configuration alternatives were identified and then evaluated for the proposed 345-kV facilities:

- Alignment of the proposed 345-kV transmission lines in an overhead configuration along CL&P’s existing ROWs between Card Street Substation, Lake Road Switching Station, and the Connecticut / Rhode Island border.

- Alignment of an underground 345-kV cable system within CL&P’s existing ROWs between Card Street Substation, Lake Road Switching Station, and the Connecticut / Rhode Island border.

- Development of the 345-kV facilities, in either overhead or underground configurations, along new ROWs, which would require the acquisition of utility easements from numerous landowners.

- Collocation of the proposed 345-kV transmission facilities, using either overhead lines or underground cables, adjacent to or within other existing linear corridors in the Project area, including railroads, pipelines, and public roads.

- Development of the proposed 345-kV transmission lines predominantly overhead along CL&P’s existing transmission line ROWs, except for certain segments of the lines where underground cable or overhead line-route variations were identified to minimize potential adverse effects on environmental resources, residential areas, community facilities, or other land uses.

CL&P evaluated each of these potential route alternatives, using the criteria identified in Sections 14.2.1 (for overhead transmission lines) and 14.3.1 (for underground transmission cable systems). Some of the route alternatives were quickly found to be impractical because of overriding environmental issues,
engineering constraints, or cost factors. Other alternatives were determined to be infeasible after field
reconnaissance and closer investigation of potential environmental, social, and cultural effects,
engineering concerns, or costs. (Refer to Sections 14.2.2 and 14.3.3 for discussions of alternative
overhead and underground line routes that were eliminated from consideration.)

Based on this evaluation process, CL&P identified the preferred alternative as all-overhead 345-kV
transmission lines, aligned along CL&P’s existing transmission line ROWs, between Card Street
Substation and Lake Road Switching Station, and from there to the Connecticut / Rhode Island border
(i.e., the “Proposed Project”). Subsequently, CL&P performed more detailed engineering and
environmental investigations to assess and refine the location of the proposed transmission line structures
within these ROWs.

In addition, CL&P examined locations along the ROWs where different transmission line configurations
(i.e., different overhead line structure types or underground cable systems) or different routes (i.e.,
alignments outside of the existing CL&P ROWs) merited consideration. These studies led to the
identification and comparative assessment of six transmission line-route variations, consisting of both
underground and overhead line configurations along certain segments of the Proposed Project ROWs.
These route variations, which are discussed in Section 15, were identified as potentially feasible
alternatives to avoid or mitigate potential effects to environmental resources or to existing developments
near the ROWs.

During the alternatives analysis process, CL&P also identified design options for the location of the new
345-kV transmission line across the 1.4-mile segment of federally-owned property in the Mansfield
Hollow area. These options, which involve different transmission line structure and ROW width
configurations, all represent feasible approaches for installing the new 345-kV line across the federally-
owned properties. Depending on approvals from the Council and the USACE, CL&P would be prepared to use any one of these options. Accordingly, the design options are discussed in Volume 1, Section 10.

In addition, overhead transmission line design alternatives involving the use of steel-monopole structures instead of H-frame structures were identified in five specific locations (referred to as EMF BMP “focus areas”) along the Proposed Route. These areas are identified and discussed in Volume 1, Section 7. After evaluation of these five focus areas, CL&P incorporated steel monopoles into the proposed 345-kV line configuration in three of the focus areas. In the remaining two focus areas, H-frames were determined to represent the BMP overhead line structure designs.

14.2 OVERHEAD TRANSMISSION LINE ROUTES: ALTERNATIVE ANALYSIS

14.2.1 Route Evaluation Criteria
Along with the route selection objectives listed in Table 14-1, CL&P applied an established set of route evaluation criteria to identify and compare potential overhead transmission line routes. These standard route evaluation criteria, as described below, were used to locate and assess alternative overhead transmission line routes for this Proposed Project.

Overhead transmission lines allow some design flexibility, provided that a continuous ROW of adequate width is available. Individual transmission line structures often can be located to avoid, or to allow the conductors to span over, sensitive environmental areas (e.g., wetlands, watercourses and lakes, steep slopes, important wildlife habitat). Overhead lines require ROWs within which certain land uses (such as building a new permanent structure) are precluded and along which vegetation must be managed to prevent tall-growing trees within conductor zones. (Refer to Volume 1, Section 4 for information regarding overhead transmission line construction and ROW vegetation management procedures.)
Taking these issues into account, CL&P gives primary consideration to the criteria listed in Table 14-2 when evaluating potential routes for a new overhead 345-kV transmission line. These overhead line routing criteria were applied to examine and compare alternative overhead line routes for this Project.

14.2.2 Alternative Line Routes Considered but Eliminated
CL&P identified and reviewed numerous overhead transmission line-route options, ranging from the development of the proposed 345-kV lines on new ROWs to the use of various existing linear corridors, to interconnect Card Street Substation and Lake Road Switching Station with National Grid’s facilities in Rhode Island. However, most of these alternative routes were eliminated from detailed consideration because they were found to be unsuitable for the development of the new transmission lines due to factors such as engineering constraints, geographic location, or potential for significant environmental, social, or economic effects.

The following subsections identify the major route alternatives that were initially identified, and then subsequently eliminated from consideration as viable options for the alignment of the proposed 345-kV transmission lines. Figure 14-1 illustrates the general location of these alternative routes. (Note: Figure 14-1 generally identifies the locations of both overhead and underground line-route alternatives that were initially identified.)

14.2.2.1 New Right-of-Way Alternative
This alternative would involve the development of the overhead 345-kV transmission lines between Card Street Substation, Lake Road Switching Station, and the Connecticut / Rhode Island border along an entirely new ROW (referred to as a “greenfield” corridor) not adjacent to any other existing linear corridors. In the absence of any environmental, social, or engineering constraints, such a “greenfield” corridor could provide the shortest, straight-line alignment between the required interconnection points.
### Table 14-2: Route Evaluation Criteria for Overhead Transmission Line Siting

<table>
<thead>
<tr>
<th>ROUTING CRITERIA</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>Availability of Existing ROWs for the New Lines to Follow</td>
<td>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.²</td>
</tr>
<tr>
<td>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.</td>
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<td>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.</td>
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<tr>
<td>Engineering Considerations</td>
<td>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.</td>
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<tr>
<td>Avoidance or Minimization of Conflicts with Developed Areas</td>
<td>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&amp;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 provisions³ 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.</td>
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<tr>
<td>Consideration of Visual Effects</td>
<td>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).</td>
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<tr>
<td>Avoidance or Minimization of Environmental Resource Effects</td>
<td>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.</td>
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<tr>
<td>Accessibility</td>
<td>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.</td>
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² Connecticut General Statutes § 16-50p(a)(2)(D)
³ Connecticut General Statutes § 16-50p(i)
Figure 14-1: Transmission Line Route Alternatives Initially Identified
However, an entirely new corridor for a horizontally configured (H-frame structures) 345-kV overhead transmission line would require a minimum 150-foot-wide ROW. Even (unrealistically) assuming a minimum straight-line 28-mile distance between Card Street Substation, Lake Road Switching Station, and the interconnection with National Grid’s facilities at the Connecticut / Rhode Island border, this alternative route would require the acquisition of more than 500 acres of property for new utility easements.4

In addition to these easement acquisition issues, the development of the 345-kV transmission lines along a “greenfield” corridor was determined to be impractical for environmental reasons. For instance, to construct the proposed 345-kV transmission lines, the majority of the vegetation along the “greenfield” corridor would have to be removed and access roads would have to be created within the new ROW. Compared to the use of existing ROWs, the creation and maintenance of such a “greenfield” corridor can cause long-term environmental effects (e.g., permanent fill in wetlands due to new access roads and structures, development of a new linear corridor through previously undisturbed forested communities, crossings of water resources, and preclusion of certain other land uses within the corridor).

In addition, the creation of a new transmission line corridor, when existing ROWs are available and practical to use, does not conform to federal and state policies regarding the collocation of linear facilities, and likely would not conform to federal criteria (pursuant to the Clean Water Act) for selecting the “least environmentally damaging practical alternative” to avoid or minimize adverse effects to water resources and other environmental and cultural resource features. A new “greenfield” 28-mile transmission line ROW also could be inconsistent with the goals of environmental protection within the Quinebaug and Shetucket Rivers Valley National Heritage Corridor, which encompasses 26 towns in northeastern Connecticut. In general, the installation of new transmission line facilities along existing ROWs (e.g.,

4 Using a vertical (monopole structure) configuration the new 345-kV line would reduce the ROW width, but would require taller structures.
transmission line ROWs, pipeline corridors, highways, railroads) is environmentally preferable to creating entirely new corridors through properties previously unaffected by linear developments.

Operation of the new 345-kV transmission lines requires long-term restrictions on land uses within the new ROW. Uses must be compatible with utility operation, and buildings are precluded. For an overhead transmission line, the ROW would have to be managed in low-growing vegetation, although access would only have to be maintained to the transmission line structures.

Overall, the all-new ROW alternative was determined to be impractical based on land use, and environmental considerations. This alternative would not conform to federal and state policies for the collocation of linear corridors to the extent practical and CL&P’s acquisition of such easements from private property owners would be both costly and time-consuming.

14.2.2.2 Pipeline Right-of-Way Alternatives
The Algonquin Gas Transmission Company (Algonquin), which is owned by Spectra Energy Transmission, operates the only major natural gas transmission pipeline system within the Project region. Algonquin’s natural gas transmission pipelines, which were initially installed more than 30 years ago, extend generally southwest-to-northeast across northeastern Connecticut, traversing the towns of Coventry, Mansfield, Chaplin, Eastford, Pomfret, Putnam, and Thompson (refer to Figure 14-2).
Figure 14-2: Pipeline, Highway, Railroad, and Transmission Line ROWs in the Project Region
After a screening level analysis of this potential route alternative, CL&P determined that the pipeline ROW did not represent a viable option for the location of a new 345-kV transmission line (configured either overhead or as an underground cable system), for the following primary reasons:

- While the pipeline ROW does extend through northeastern Connecticut into Rhode Island, it is not located near the Card Street Substation or Lake Road Switching Station, both of which must be interconnected to National Grid’s transmission facilities.

- Even if the pipeline route were closer to the specified substation and switching station facilities that must be interconnected, the unoccupied portion of the pipeline ROW is too narrow to accommodate a new 345-kV transmission line. Instead, new easements parallel to, but outside of, the pipeline ROW would have to be acquired for the transmission line. Numerous homes are located near the pipeline ROW. In order to accommodate the new transmission line adjacent to the pipeline ROW, CL&P would have to obtain easements from private landowners in order to expand the ROW along its entire length. As a result, the new transmission line would be very close to residences, some of which would likely have to be acquired. In addition, the creation of a new utility ROW for the transmission line would affect a variety of environmental resources.

14.2.2.3 Alternative Routes along Highway Rights-of-Way

Northeastern Connecticut has a well-developed network of federal, state, and local roads. This alternative would involve the development of the proposed 345-kV transmission lines in overhead configurations within or adjacent to highway corridors (refer to Figure 14-2). Key considerations in the review of this alternative were the locations of roads in relation to the existing CL&P substations, switching station, and National Grid transmission lines that must be interconnected to meet Project objectives, as well as construction feasibility and potential environmental resource and social effects.

CL&P focused on state and limited access highways as potential routes for the 345-kV overhead transmission lines. Compared to most local roads, state and federal highways typically have wider ROWs, including undeveloped areas outside of paved travel lanes, where land may be available to accommodate an overhead transmission line. This situation is particularly true of limited-access highways.
In order to construct a new overhead, vertically-configured, 345-kV transmission line, a 100-foot-wide ROW would be required. Along state highways, if an agreement could be reached with ConnDOT to share the outer portion of a highway ROW with an aerial easement, the required new ROW width could be reduced.

However, longitudinal collocation of transmission lines in ConnDOT limited access highways is not permitted except in special circumstances, as provided in ConnDOT’s *Utility Accommodation Manual* (2009). In February 2009, CL&P met with ConnDOT to discuss this policy with respect to the potential for the collocation of the proposed 345-kV transmission lines along state and interstate highways for the Project. ConnDOT representatives affirmed that the agency opposes the collocation of transmission lines in state road ROWs, particularly if other routing alternatives, such as the use of existing utility ROWs, are available.

As illustrated in Figure 14-2, the principal highways in the Project area that are aligned in whole or in part in the general direction required for a transmission line route that would interconnect the CL&P substations, switching station, and the National Grid facilities are:

- U.S. Route 6 – extending from Willimantic east through the towns of Brooklyn and Danielson and into Rhode Island (a portion of which is limited access).

- A portion of Interstate 395 – a limited access highway that generally traverses north-to-south through northeastern Connecticut, paralleling the Connecticut / Rhode Island border.

To evaluate the feasibility of using these highway corridors for the proposed 345-kV transmission lines, CL&P conducted field reconnaissance, reviewed USGS topographic maps, and studied aerial photographs. Because ConnDOT policies discourage the collocation of transmission lines linearly along limited access highways unless no other feasible routes are available, the investigations also involved a

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5 Other common configurations of an overhead 345-kV line use shorter structures, but require up to 150 feet of ROW width. Existing highway easement widths vary. As a result, an overhead transmission line could have to be located either within or adjacent to highway property.
review of the areas immediately adjacent to (but outside of the ConnDOT ROWs) along Interstate 395 and the limited access portion of U.S. Route 6.

Based on these analyses, CL&P determined that only limited and discontinuous segments of the highways would potentially meet the requirements for accommodating a new overhead 345-kV transmission line ROW. In general, because portions of all of the highways traverse suburban or urban areas, the development of the transmission line adjacent to the roads would be constrained by residential, commercial, or industrial land uses. Furthermore, wherever the transmission line ROW could not be located within the existing highway easements, new ROW would have to be acquired from private landowners. As a result, no highway corridors were identified that would provide a continuous linear connection between the existing CL&P substations, switching station, and National Grid’s facilities.

However, CL&P determined that certain portions of Interstate 395 and U.S. Route 6 merited additional study as alternative routes for the potential alignment of segments of the proposed transmission lines.

CL&P’s analyses of these highway segments are summarized as follows:

- **Interstate 395.** Although Interstate 395 was dismissed as a viable alignment for the proposed 345-kV transmission lines as a whole (because the highway does not traverse in the west-to-east direction required for the proposed transmission lines), a 6-mile portion of the highway in the Town of Killingly was reviewed as a possible alternative for a segment of the transmission line. This segment extends from the Killingly / Danielson border to CL&P’s Lake Road Switching Station. However, this portion of Interstate 395 was determined to be infeasible for use as a transmission line route for several reasons, including the ConnDOT policy of not allowing the collocation of transmission lines longitudinally within the ROWs of any limited-access highway. Other primary factors in eliminating this alternative route segment were the lack of adequate space to accommodate a new overhead transmission line ROW within the highway corridor, potential effects on environmental resources adjacent to the highway ROW (e.g., crossing of the Quinebaug River, potential impacts to wooded areas), and potential effects on adjacent land uses (e.g., the possible need to displace homes and businesses).

- **U.S. Route 6.** U.S. Route 6, a primary east-west transportation corridor, is located approximately 2 miles north of the Card Street Substation. The segment of the highway from the Card Street Substation east to Interstate 395 was evaluated as a potential route alternative for the new 345-kV transmission lines. (In the Town of Killingly, U.S. Route 6 is located approximately 7 miles south of the Lake Road Switching Station and thus does not represent a viable option for a transmission line route to connect to this station.) The primary determinant of construction
feasibility was adequate space for a new overhead 345-kV transmission line ROW without having to displace homes or businesses located adjacent to the highway. However, U.S. Route 6 is an important regional transportation corridor and, as a result, a variety of residential, commercial, and industrial uses border the road, with most situated within 200 feet of the edge of the road ROW. Because a new overhead line would require between 100 and 150 feet of ROW width (depending on the line configuration), residential and business properties located near U.S. Route 6 would be directly affected. Although the exact widths of the ConnDOT easements along U.S. Route 6 were not specifically researched as part of this routing study, it is likely that CL&P would have to obtain easements from ConnDOT and private landowners adjacent to U.S. Route 6, which would involve substantial property acquisition costs. In addition, the construction of the transmission line could cause temporary and localized adverse effects on some businesses by interfering with customer access and causing general traffic disruptions (e.g., detours, congestion).

The development and operation of an overhead transmission line adjacent to either of these highway ROWs could also affect the aesthetic environment since the new transmission line would be visible both to travelers on the highways and to local residents and business personnel. Additionally, while overhead electric distribution lines and telephone lines can be configured to follow winding roads, high voltage transmission lines are designed for mostly straight-line, longer-span construction. As a result, the design and construction of a new 345-kV transmission line adjacent to these roads would be difficult. Furthermore, compared to structure heights along a typical transmission line ROW, the transmission line structures along a road ROW would likely have to be taller to maintain conductor clearances over the distribution and telephone lines that are presently aligned along the roadways.

Overall, CL&P dismissed all of the highway route alternatives from further consideration as potential overhead transmission line routes due to the significant construction difficulties and constraints, as well as the unacceptable social effects associated with the need to remove homes and businesses. The complexity of construction, the need to follow road ROWs that do not provide direct routes between the substations and switching station that must be electrically linked, and the amount of land acquisition required also would result in comparatively higher costs than would the development of an overhead line within the unused portions of existing transmission line ROWs that already directly interconnect such stations.
14.2.2.4 Alternative Routes along Railroad Rights-of-Way

Several railroad lines cross northeastern Connecticut (refer to Figure 14-2). These railroad lines are owned and operated by the Providence & Worcester Railroad and New England Central Railroad, and generally traverse in a north-south direction through the Project area. CL&P investigated whether the new 345-kV line could be aligned along these railroad corridors, as well as whether portions of the railroad corridors could be combined with other existing linear ROWs to create a continuous alternative route for the Project.

However, these investigations revealed that it would be impractical to align the new 345-kV line along any of these existing railroad corridors. None of the railroad corridors are located in the immediate vicinity of the Card Street Substation, Lake Road Switching Station, or National Grid’s Rhode Island facilities. As a result, to interconnect the CL&P stations with the National Grid facilities, any transmission line alignment along these existing railroad ROWs would have to be combined with ROW segments along other existing linear corridors or along a “greenfield” ROW. Therefore, any alternative involving alignments along these railroad corridors would be much longer than other routing options and thus would result in higher construction, operation, and maintenance costs.

In addition, the railroad corridors have narrow widths (averaging approximately 50 to 100 feet) and are bordered directly by a variety of land-use developments. In order to construct a new transmission line along these railroad ROWs, CL&P would have to acquire easements on adjacent properties to expand the ROWs. Given the abutting land use development, the acquisition of significant additional property and numerous adjacent homes and businesses would be required. Furthermore, the construction and operation of the 345-kV lines would be complicated by safety concerns associated with work directly adjacent to the active railroad lines, as well as the need for electric transmission line work to avoid conflicts with the railroads’ schedules. Given the significant amount of development near the railroad lines, the narrow
railroad corridors, and the longer route that would be required, this option was determined to be environmentally, socially, and economically impractical.

14.3 UNDERGROUND TRANSMISSION LINE-ROUTE ALTERNATIVES
The vast majority of transmission circuits in Connecticut and in the United States consist of overhead lines. However, underground transmission cable systems, consisting of both buried electric cables and splice chambers (or “splice vaults”, which are required at specified intervals along a cable route), may warrant consideration when overhead lines are impractical due to site-specific environmental, social, construction, or regulatory factors.

Compared to overhead transmission lines, an underground cable system requires a narrower ROW. However, an underground cable system entails a continuous trench and the installation of underground splice vaults, both of which must remain completely accessible by large vehicles for maintenance purposes. Environmentally sensitive areas, such as wetlands and streams, cannot be spanned as with overhead lines. Careful siting is required to avoid or minimize significant effects to environmental resources and other utilities as a result of trenching activities, as well as to ensure that the cable system is immediately accessible in the event that maintenance is required during the operation of the facility.

Within the past eight years, CL&P has sited and installed underground transmission cable systems as part of the Bethel-Norwalk Project (345-kV and 115-kV transmission cables), Middletown-Norwalk Project (345-kV and 115-kV transmission cables), and the Glenbrook Cables Project (115-kV transmission cables). As a result, CL&P has extensive, recent experience in underground transmission cable routing, construction, and cost analysis.

14.3.1 Cable Technology Considerations and Route Evaluation Criteria
Underground cable systems and overhead transmission lines represent different technologies for transporting power. In a given system application, one of these line types may not be practical to use. As
a result, any potential use of a 345-kV underground cable system instead of a 345-kV overhead transmission line must first give consideration to the key differences between overhead line and underground cable technologies.

Consequently, the siting analysis for underground cable systems involves a two-step process:

- Reviewing key engineering considerations for the selection of appropriate underground cable technology (refer to Section 14.3.1.1); and then
- Applying traditional route evaluation criteria to identify and assess siting options for underground cable systems (Section 14.1.3.2).

The cost of installing and maintaining underground transmission cable systems also is a critical consideration in the alternatives evaluation process and is discussed separately in Section 14.3.1.3.

14.3.1.1 Considerations in Selecting Underground Transmission Technology
A tutorial regarding underground electric power transmission cable systems, included in Volume 6, describes underground cable technologies in greater detail. The important differences between underground and overhead 345-kV transmission systems center around the following factors, which are discussed in this section: technical limitations, transmission system operational considerations, power quality concerns, and recovery time from outages (reliability).

Based on its recent experience with transmission cable systems, CL&P identified two cable technologies for consideration for the Project: High Pressure Fluid Filled (HPFF) and Cross-linked Polyethylene (XLPE). The principal characteristics of each of these technologies are:

- **HPFF.** Until recently, HPFF cable was the primary underground technology used for 345-kV underground transmission lines in the United States. This type of cable system involves the use of a dielectric fluid pressurized to a nominal 200 pounds per square inch (psi) within a steel pipe housing the cables, and therefore requires pressurization plants and reservoirs. These reservoirs hold thousands of gallons of dielectric fluid. The fluid system within HPFF cable systems

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6 Volume 6 describes other cable technologies, which were not deemed practical for this Project.
requires more maintenance and planned outages than XLPE cable systems. In addition, HPFF cables have higher electrical losses, lower capacity for equivalent size conductors, and much higher capacitive charging requirements.

- **XLPE.** XLPE cables have a water-impervious sheath to keep moisture from entering the extruded, cross-linked polyethylene insulation, and each cable is installed inside a separate duct within a duct bank. No dielectric fluid is involved. Compared to HPFF cables, the XLPE cables have lower electrical losses and significantly higher ratings. XLPE cables have recently experienced more use at 345 kV and over longer distances. CL&P is successfully operating approximately 25.7 double-circuit miles of 345-kV XLPE cables as part of the Middletown-to-Norwalk and the Bethel-to-Norwalk projects. In addition, CL&P used XLPE cables (at 115 kV) for the Glenbrook Cables Project, two portions of the Bethel-Norwalk Project, and a 1-mile section of the Middletown-to-Norwalk Project.

As explained further below, based on the capacity required and the success of CL&P’s recent underground cable projects, XLPE cable was selected as the preferred cable technology for the Project.

**Technical Limitations**

Underground transmission cables have typically been used for short distances (less than 5 miles) in urban environments, which characteristically have strong electrical sources (e.g., proximity to generation facilities or multiple transmission lines). Consideration of long lengths of underground 345-kV cables in suburban or rural settings (which usually are remote from strong sources) and the large amounts of cable-charging current associated with the long cable lengths, combined with moderate system strength relative to the cable-charging currents, requires care to prevent damage, disruptions to the transmission system, and potential damage to customer equipment. Proposed 345-kV cable installations must be carefully analyzed by power-system engineers, taking into account the different characteristics of the cables and substation equipment at the cable terminations.

Underground 345-kV cables have much lower current-carrying capability compared to overhead 345-kV transmission line conductors. At 345 kV, to achieve the same power-transfer capacity of a single overhead transmission line, multiple underground cables must be installed (three or more sets of three cables). Thus, a 345-kV underground cable system must consist of multiple sets of cables, and therefore multiple splice vaults at each vault location.
Due to the electrical characteristics of the insulation materials used in underground transmission cables and the proximity of the cables to each other when buried, the capacitive charging currents of an underground cable system are significantly higher than those of overhead lines. For most medium- and long-length underground 345-kV transmission systems, special switching devices and large shunt reactors may be required to compensate for the capacitive charging of the underground cables in order to prevent unacceptably high system voltages during normal operating conditions. These devices add operating complexity, decrease system reliability, require additional land at termination points, and add appreciable cost, especially when multiple cable systems are required.

To connect a 345-kV underground cable segment with an overhead transmission line segment, a line transition station on a 2- to 4-acre site must be constructed at the interconnection location. Within the line transition station, switching equipment may be installed to isolate the underground cables from the overhead line conductors and large shunt reactors, depending upon the underground cable segment’s circuit location and its length. (For example, if an underground cable system were used for the Project, a new 345-kV line transition station would have to be constructed near the Connecticut/Rhode Island border at the interconnection with the National Grid overhead 345-kV line.)

When transmission lines or power transformers are switched in a transmission system that has a circuit made up of overhead line and underground cable sections, potential problems can arise because of traveling wave reflections. Switching transient voltages traveling along a line would reflect at points of characteristic impedance change, such as where an overhead line and an underground cable are connected. The voltage reflections can lead to excessive transient voltages, damaging the underground cable itself or other electrical equipment associated with the overhead transmission system.

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7 Site acreage requirements vary based on terrain (e.g., need for grading, site development work). Typically, approximately 1.5 to 2 acres of each 345-kV line transition station site is developed for the above-ground electrical equipment, the overhead and underground lines, and access road. Any remaining land at the site typically would be undeveloped.
Because of these technical considerations and lower electrical impedances of cables, detailed 60-Hertz (Hz) load-flow and harmonic transient voltage studies (refer to the discussion of **Power-Quality Concerns**, below) must be conducted by power-system engineers to determine the maximum length of 345-kV underground cables that could be potentially installed at any location on the transmission grid without adversely affecting the New England transmission system.

**Transmission System Operational Considerations**

The operation of an all-underground 345-kV cable transmission circuit, or an overhead 345-kV transmission circuit with one or more segments of underground cables, introduces additional transmission system complexity. When a long (more than 5 miles in length) underground cable circuit is initially energized, even though it may not be carrying load, all associated shunt reactors need to be energized to maintain voltages within acceptable levels. When the underground cables start to carry load, the voltage on portions of the system would instantaneously drop until a sufficient amount of shunt reactor compensation can be disconnected. If the shunt reactors are improperly sized or designed, unacceptable voltage swings can occur on the system which can lead to brownouts or blackouts when relays operate to protect the system.

At normal loading, typically only one third of the shunt reactors necessary to maintain the voltages within acceptable levels at the terminals of the underground cable circuit may be required to be in service. For some contingencies on the interconnected transmission system, current flow through the underground cables may instantaneously drop to nearly zero. Because only a portion of the shunt reactors are in service and the remaining portion of the shunt reactors cannot be connected instantaneously to increase their compensation for the capacitive charging of the cables, voltages could rise to unacceptably high levels within portions of the transmission system.
Unlike an all-overhead transmission system, the underground cables introduce a higher level of system operational complexity. System operators must carefully follow a defined sequence of steps when placing an underground cable system in service or removing it from service. They must also be fully aware of the effects of their actions on the transmission system to ensure that voltages remain within acceptable ranges. In critical or emergency situations, the time required to perform these crucial operating steps could be detrimental to the integrated transmission system.

**Power-Quality Concerns**

When operating underground cables, system engineers need to be concerned with the magnification of harmonic voltages and currents, which are predominantly generated by customer loads and during the energization of three-phase transformers. System harmonic resonances arise for applications of longer cables where the transmission system’s local strength is weak or moderate relative to the cable-charging requirement. Low-order harmonic resonances can cause system failures, including cascading outages, and damage to equipment, including power transformers.

Day-to-day switching events, like the energizing and de-energizing of transmission circuits occurring in the normal transmission system operation, can cause amplification of harmonic voltages and currents leading to system component failures and severe power-quality problems. The amplified harmonic voltages and currents can have a detrimental effect on customer equipment and processes. A standard developed by the Institute of Electrical and Electronics Engineers (IEEE) establishes the maximum levels of harmonic voltages and currents allowed to exist on a transmission system at different voltage levels to ensure electric utility and customer equipment and processes are not damaged.

**Recovery from Outages**

Most faults occurring on an overhead transmission line trip a circuit out of service for only a few seconds because typical faults are temporary, do not cause line damage, and automatic circuit reclosing systems
successfully restore the circuit to service. In contrast, when a fault occurs on and trips out a transmission circuit that consists entirely or partially of underground cables, automatic circuit reclosing is not used for fear of causing further damage to an already damaged underground cable. Thus, the circuit outage lasts longer until the cause is found.8

Furthermore, compared to an overhead circuit, when a non-temporary fault occurs on a transmission circuit that is entirely or partially comprised of underground cables, significantly more time typically is required to find and then isolate a faulted segment of cable before repairs may commence. Non-temporary fault causes on all-overhead circuits can be found quickly.

Transmission circuits with multiple short underground cable sections further complicate and extend the time it takes to locate precisely where, within the underground cable segments, the problem exists. Once the problem is located, repair times on an underground cable typically take weeks to complete, compared to hours or a few days to repair most overhead transmission line failures.

Historically, most underground cable-system failures are associated with cable-splice failures or with termination equipment. A long outage of a 345-kV transmission circuit negatively affects system operations and reduces the overall reliability of the transmission system.

14.3.1.2 Route Evaluation Criteria

When performing any analyses of potential underground cable-system routes, CL&P applies a set of standard routing criteria reflecting the consideration of environmental, social, construction, engineering, and economic factors. Given typical cable-system design, installation, and maintenance considerations, the criteria summarized in Table 14-3 are factored into the identification and evaluation of potential underground cable system route alternatives. Cost, as described separately in the following section, also is a critical factor in the consideration of underground cable systems.

8 For example, in 2011, an outage occurred on the underground cable portion of the Middletown to Norwalk 345-kV line.
14.3.1.3 Cost

Cost is a key consideration in the evaluation of underground cable technology versus overhead technology. The typical costs for constructing an underground 345-kV transmission cable system are five to ten times greater than those for installing an equivalent length of overhead 345-kV transmission line.

The higher end of this range is reached when line transition stations are required to interconnect overhead and underground cable segments. Each 345-kV line transition station may involve acquisition of land from private property owners (where CL&P fee-owned land is not available) and costs several million dollars to construct.
### Table 14-3: Route Evaluation Criteria for Underground Transmission Cable System Siting

<table>
<thead>
<tr>
<th>ROUTING CRITERIA</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td><strong>Environmental Considerations</strong></td>
<td>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.).</td>
</tr>
<tr>
<td><strong>Engineering Considerations</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Availability of Useable ROW</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Social Considerations</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Availability of Land for Line Transition Stations</strong></td>
<td>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).</td>
</tr>
</tbody>
</table>
In addition, except where underground cable routes can be aligned entirely within highway ROWs or within existing CL&P ROWs where CL&P’s easements include underground cable rights, CL&P would have to acquire new easement rights from private landowners for the installation and operation of the cable system. Along state highway ROWs, ConnDOT policy requires the locations of splice vaults outside of the highway easement; as a result, for any cable systems aligned along state roads, easements from private landowners would be required to accommodate the splice vaults and the interconnecting portions of the duct bank.

As a result, where existing ROWs have sufficient space to accommodate a new overhead transmission line or can be expanded for comparatively low cost, the capital costs associated with developing underground 345-kV cable systems are significantly greater than the costs of building a comparable overhead transmission line. However, for most applications, the percentage difference between overhead and underground system “life cycle” costs (which additionally consider operating and maintenance expenses and electrical losses over the life of the transmission facility) is slightly less than the difference between overhead and underground system capital costs.

The difference in the cost to Connecticut consumers for a 345-kV underground cable system, compared to an overhead line, is even greater because of federal tariff provisions. Because this Project is expected to qualify for inclusion in New England regional transmission rates, the Project costs would be shared by consumers throughout New England, based on each electric transmission company’s share of the regional electric load. Connecticut accounts for approximately 27% of the New England load; therefore, Connecticut consumers would bear approximately 27% of the Project cost included in regional rates.

Recovery of Project costs through regional rates, however, is not automatic. Only costs determined by ISO-NE to be eligible for regionalization according to specific tariff provisions would be included in regional rates. Experience has shown that where a transmission line (or a line segment) that would
normally be constructed overhead, in conformity with good utility practice, is instead constructed underground, ISO-NE does not allow the extra costs of underground line construction to be included in regional rates. Instead, such extra costs are “localized” and must be borne solely by consumers in the area in which the underground system is situated.

In Connecticut, the effect of localizing excess underground cable costs is that in-state consumers would bear 27% of the cost of an overhead line (or segment), plus 100% of the difference between that cost and the cost of an underground cable system. For example, if CL&P were to build an all-underground line that cost 10 times more than a comparable overhead line (constructed in accordance with standard good utility practice), the cost to Connecticut consumers for the underground cable system could be 34 times more than that of the overhead line \[\left(1 \times 27\% \right) + \left(9 \times 100\% \right) = 9.27 ÷ 0.27 = 34.3\]. The cost multiple can be even larger for Connecticut electric consumers if a section of underground 345-kV transmission line with line transition stations is selected as an alternative to a short segment of overhead line because the entire cost to construct the transition stations would be borne solely by CL&P customers.

14.3.2 Construction Considerations and Procedures
Underground cable system construction requires vastly different procedures and considerations than overhead transmission line construction. This section summarizes the typical underground transmission cable construction procedures that would be used to install an XLPE 345-kV transmission cable system. Such procedures would apply for any length of cable system (i.e., for the installation of an “all underground cable route” between Card Street Substation, Lake Road Switching Station, and the Connecticut / Rhode Island border, or for smaller segments of transmission line, as discussed in Section 15 for the underground line-route variations).

Section 14.3.2.1 explains the typical construction activities and sequence for underground cable system installation within or adjacent to road ROWs, whereas Section 14.3.2.2 describes how construction procedures would differ for the development of a cable system outside of road ROWs (e.g., along
transmission line ROWs or along a “greenfield” utility corridor). Sections 14.3.2.3 through 14.3.2.9 provide details regarding specific underground cable construction considerations (e.g., splice vault locations, erosion controls, traffic management, 345-kV line transition stations).

14.3.2.1 General Construction Sequence: Cable Systems in or adjacent to Road ROWs

Underground transmission cable systems are most often situated within or adjacent to public roads. Public roads provide both linear corridors for the cable route and roadway access along the entire cable system for construction and maintenance. This section summarizes the typical construction activities involved in underground cable installation within or adjacent to roads.

The sequence in which some of these activities are performed varies, depending on site-specific factors and construction scheduling. The types of activities generally involved in cable system installation along or adjacent to a road ROW are illustrated on Figure 14-3 and summarized below. Most of these activities also apply to underground cable construction outside of road ROWs. (Refer to Section 14.3.2.2 for additional information regarding the differences in cable system installation and operation in non-road areas).

Cable System Land Requirements and General Sequence

- **Construction Staging, Storage, and Laydown Areas.** Cable system construction requires construction contractor yard(s), as well as a combination of other staging, storage, and laydown support areas. These areas, which typically would range in size from 2 to 5 acres, would optimally be located on previously disturbed sites and would be selected based on availability and proximity to work locations. Construction support sites near the cable system route are preferred to facilitate the construction work and to minimize adverse effects on traffic resulting from the movement of equipment and materials to work sites. Generally, these support sites would be used for construction offices, worker parking, equipment staging, the storage of cable system construction materials (e.g., conduit, trench boxes, backfill), and the temporary storage of excavated materials (e.g., rock, soil, dewatering wastewater).
- **Install Erosion Controls and Pavement Cutting / Removal.** The first step in the construction process would be to deploy appropriate erosion and sedimentation controls (e.g., catch basin protection, silt fence, or straw bales) at locations where pavement or soils would be disturbed. Within roads and other paved areas, the pavement over the cable route and splice vault locations would then be saw-cut and removed.

- **Excavate and Install Splice Vaults.** At approximately 1,600-foot intervals along each circuit cable route, pre-cast concrete splice vaults (one for each circuit) would be installed below ground. Depending on the amount of space, the vaults may be arranged so that vaults are nested together, side-by-side, or staggered linearly along the route. The length of an underground cable section between splice vaults (and therefore the location of the splice vaults) is determined based upon engineering requirements (such as maximum allowable pulling tensions, the cable weight/length that can fit on a reel and be safely shipped, and cross-bonding requirements) and land constraints. The specific locations of splice vaults would be determined during final engineering design, and in some areas, could be significantly closer than the 1,600-foot interval stated above.
For safety purposes, the splice vault excavations would be shored and fenced. Vault sites may also be isolated by concrete (Jersey) barriers or the equivalent. Vault installation within roadways may require the closure of two travel lanes in the immediate vicinity of the vault construction.

Each vault would have two entry points to the surface. Approximately 2.5 feet of fill would be placed as cover on top of each vault. After backfilling, these entry points are identifiable as manhole covers, which are set flush with the ground or road surface.

- **Trench and Install Duct Bank.** To install the duct bank for the XLPE-insulated cables, a trench 7 to 10 feet deep and approximately 5 feet wide would be excavated within a typical linear 40-foot-wide construction area. This trench would typically be stabilized using trench boxes or another type of shoring.

Excavated material (e.g., pavement, subsoil) would be placed directly into dump trucks and hauled away to a suitable disposal site, or hauled to a temporary storage site for screening/testing prior to final disposal or re-use in the excavations for backfill. If groundwater is encountered, dewatering would be performed in accordance with authorizations from applicable regulatory agencies and may involve discharge to catch basins, temporary settling basins, frac tanks, or vacuum trucks.

Because underground cable installation would involve both the excavation of a continuous trench and areas for splice vaults, it is very probable that rock would be encountered. Such rock would have to be removed using mechanical methods, or possibly mechanical methods supplemented by controlled drilling and blasting. Should drilling and controlled blasting be necessary for the underground cable, it would be performed only pursuant to a plan incorporating multiple safeguards that would be subject to specific approval by the Council, and in consultation with local authorities.

The duct bank system would consist of nine 8-inch polyvinyl chloride (PVC) conduits for the XLPE-insulated cables, three 2-inch PVC conduits for the ground-continuity conductors, three 2-inch PVC conduits for the fiber optic relaying cables, and three 2-inch conduits for the temperature-sensing fiber optic cables. Figure 14-4 illustrates a typical 345-kV duct bank cross-section. The conduit would be installed in sections, each about 10 to 20 feet long, and would have a bell and spigot connection. Conduit sections would be joined by swabbing the bell and spigot with glue and then pushing the sections together. After installation in the trench, the conduits would be encased in high-strength concrete. The duct bank would then be backfilled with a low-strength fluidized thermal backfill (FTB) with sufficient thermal characteristics to dissipate the heat generated by the cable system.

Trenching, conduit installation, and backfilling would proceed progressively along the route such that relatively short sections of trench (under favorable conditions, typically 200 feet per crew) would be open at any given time and location. During non-work hours, temporary cover (steel plates) would be installed over the open trench within paved roads to maintain traffic flow over the work area. After backfilling, the trench area would be repaved using a temporary asphalt patch or equivalent. Disturbed areas would be permanently repaved as part of final restoration.
**Duct Swabbing and Testing.** After the vaults and duct bank are in place, the ducts would be swabbed and tested (proofed), using an internal inspection device (mandrel) to check for defects. Mandrelling is a testing procedure in which a ‘pig’ (a painted aluminum or wood cylindrical object slightly smaller in diameter than the conduit) is pulled through the conduit. This is done to ensure the ‘pig’ can pass easily, verifying the conduit has not been crushed, damaged, or installed improperly. After successful proofing, the transmission cables and ground-continuity conductors would be installed and spliced. Cable reels would be delivered by special tractor trailers to the vaults, where the cable would be pulled into the conduit using a truck-mounted winch and cable handling equipment.

**Cable Installation.** To install each transmission cable and ground-continuity conductor within the conduits, a large cable reel would be set up over a splice vault, and a winch would be set up at one of the adjacent splice-vault locations. The cables and ground-continuity conductors (during separate mobilizations) would then be pulled into their conduits by winching a pull rope attached to the ends of each cable. In a separate pulling operation, the splice vaults would also be used as pull points for installing the temperature-sensing fiber optic cables. Additionally, pull boxes would be installed near the splice vaults for the pulling and splicing operations required for the remaining fiber optic cables.

**Cable Splicing.** After the transmission cables and ground-continuity conductors are pulled into their respective conduits, the ends would be spliced together in the vaults. Because of the time-consuming and precise nature of splicing high-voltage transmission cables, the sensitivity of the cables to moisture (moisture is detrimental to the life of the cable), and the need to maintain a clean working environment, splicing XLPE-insulated cables involves a complex procedure and requires a controlled atmosphere. The ‘clean room’ atmosphere would be provided by an enclosure or vehicle that must be located over the manhole access points during the splicing process.

It typically takes 10 to 14 days to complete the splices in each vault (three XLPE 345-kV cable
splices in each splice vault). Each cable and associated splice would then be stacked vertically and supported on the wall of the splice vault.

- **Cable Termination.** At either end of a 345-kV cable system, termination equipment is required. To interconnect a 345-kV cable to overhead transmission facilities, a new 345-kV line transition station is required. Alternatively, if the cable system ends at an existing substation or switching station, the cable terminations can be installed or adjacent to the station site, depending on the amount of space available. (Refer to Section 14.3.2.9 for additional information regarding transition stations.)

- **Restoration.** After the installation of the duct banks and splice vaults, disturbed road ROWs or other paved areas (e.g., parking lots) would be restored to appropriate grade and re-paved. Sidewalks, curbs, and road shoulder or median areas affected by construction also would be restored. Non-paved areas affected by construction (e.g., vegetated road shoulders, lawns, or other previously vegetated areas disturbed by cable system construction) would be seeded, mulched, and allowed to revegetate.

**14.3.2.2 Additional Requirements for Cable System Construction Outside of Road ROWs**

To install and operate a transmission cable system within or adjacent to non-road ROWs (such as CL&P’s existing overhead transmission line ROWs or pipeline ROWs) or along an entirely new cross-country (“greenfield”) ROW, the ROW requirements and typical construction procedures described in Section 14.3.2.1 would be used, with the following exceptions:

- **Construction Workspace.** Because the cable system would not be aligned along existing roads, the workspace required to construct the system could be wider than 40 feet to accommodate construction equipment, trench excavation, splice vaults, and access roads along the entire cable route. Additional ROW width and temporary construction work spaces also could be needed in certain areas to account for topography and subsurface conditions, which may affect the width of the excavations that would be required to achieve the specified cable and splice vault depths. The required width of the construction workspace would depend on site-specific conditions.

- **Easement Requirements.** Generally, CL&P could have to purchase easements from private landowners for an underground cable system, even for transmission cables aligned along its own overhead transmission line ROWs (where the existing easements do not encompass underground transmission systems). Permanent underground easements would have to be acquired.

- **Vegetation Clearing and Grading.** Vegetation would have to be cleared and removed along the entire width of the construction ROW, which would then have to be graded both to create an access road along the length of the cable route and to achieve appropriate elevations for the installation of the duct banks and splice vaults. Additional construction work spaces, such as in areas of side slopes, wetlands, and adjacent to stream crossings, and temporary construction support areas (e.g., crane pads adjacent to splice vaults, temporary material staging sites) also would have to be cleared and graded as appropriate to site-specific conditions.
• **Access Roads.** Because permanent access would be required along the entire route for cable system maintenance purposes (i.e., for immediate access to the duct banks and splice vaults), gravel-type roads, with a 20-foot-wide travel area, would likely be developed during the construction phase. The roads would have to be designed to handle all anticipated construction equipment and material deliveries, including trench boxes, concrete trucks, splice vaults, cranes, and cable reel trucks. Access road construction would involve cutting and filling activities (including permanent fill in wetlands along the cable route), as well as the installation of permanent watercourse crossings (e.g., culverts, bridges) as needed.

• **Erosion and Sedimentation Controls.** Because of the soil disturbance along the length of the cable system route, erosion and sedimentation controls would have to be deployed and maintained both along and across the ROW as necessary to minimize the potential for impacts to adjacent properties and to environmental resources. Soil erosion and sedimentation controls would consist of the measures as summarized in Section 14.3.2.4. Where the ROW intersects public roads, crushed stone anti-tracking pads would have to be installed along the ROW to minimize the amount of soil tracked onto the pavement from construction-related activities.

• **Restoration.** Restoration activities would consist of reseeding and mulching disturbed soil areas. With the exception of the permanent access road, disturbed areas would be allowed to revegetate, but would be managed in low-growth vegetation, consistent with the operation of the underground cable system.

Underground cable system construction outside of roadway ROWs also typically must address site-specific environmental conditions. For example, wetlands are typically characterized by soils that are relatively poor in terms of thermal characteristics for heat dissipation, compared to granular soils typically found beneath roadways. Organic soils require over-excavation, or the use of different phase spacing within the duct bank. In addition, wetlands and watercourses could pose significant obstacles to underground construction, requiring either direct trenching or costly and time-consuming trenchless duct-bank installation methods (such as jack and bore or HDD, both of which would require potentially extensive staging areas on either side of the water crossing).

14.3.2.3 **Splice-Vault Requirements**
Due to current-carrying limitations and the assumed underground duct bank configuration requiring three separate circuits, three separate splice vaults would be required at each cable splice interval along the length of an underground line. The outside dimensions of a splice vault for 345-kV XLPE cables are approximately 10 feet wide by 10 feet deep and up to 32 feet in length (one vault per three XLPE cables).
The installation of each splice vault therefore requires an excavation area approximately 14 feet wide, 13 feet deep, and 36 feet long. At each splice vault location, pre-cast splice vaults would be installed below ground. Each vault location would consist of three splice vaults. Splice vaults located along, but outside of public road ROWs, require a minimum of 12,000 square feet of permanent easement for future access to perform maintenance and repairs. An additional minimum 4,300 square feet of temporary easement would be required for cable system construction. Therefore, the construction of each vault would require approximately 0.4 acre (exclusive of access).

Along a cable route, the actual burial depth of each vault would vary, depending on site-specific topographic conditions and the depth of the interconnecting duct bank. For cable systems aligned along roads, the below grade elevation of the duct banks (and therefore the depth at which vaults must be placed) often depends on the depth required to avoid conflicts with other buried utilities.

Vaults may be installed beneath public road travel lanes or, in order to avoid conflicts with other utilities buried beneath the roads, may be installed in other suitable locations adjacent to roads (e.g., beneath parking lots, sidewalks, road shoulders, road medians). However, in locations where the duct bank extends beneath a road but vaults must be installed off-road, the duct bank may need to cross other parallel buried utilities twice to interconnect each vault, greatly complicating the cable system design and construction process.

For cable systems aligned along linear corridors other than road ROWs (e.g., CL&P’s overhead transmission line ROWs, pipeline ROWs, railroad ROWs), vaults would be installed within or adjacent to the ROWs so as to avoid conflicts with the existing facilities. However, along such ROWs, vault installation may be more difficult due to factors such as unfavorable topographic conditions (e.g., need for grading or filling, presence of rock that must be excavated and removed, dewatering needs, and needs for developing and maintaining suitable access for the heavy construction equipment such as cranes). Extra
work areas adjacent to the vaults also would be required for crane pads, which would be needed to place each vault. The crane-pad area required at each splice vault would be approximately 80 feet wide by 130 feet long.

14.3.2.4 Temporary Erosion and Sedimentation Controls

Temporary erosion and sedimentation controls (e.g., silt fence, hay/straw bales, filter socks, inlet and catch basin protection) would be installed as needed prior to or in conjunction with the commencement of cable system construction activities that would involve soil disturbance. The controls would be installed in compliance with the 2002 Connecticut Guidelines for Soil Erosion and Sedimentation Control. The need for, type, and extent of erosion and sedimentation controls would be a function of considerations such as:

- Whether the underground cable route is within or adjacent to road ROWs or along CL&P transmission line or other utility ROWs (for example, catch basin protection would be required for cable system construction within roads)
- Slope (steepness, potential for erosion) and presence of resources, such as wetlands or streams, at the bottom of the slope
- Type of soil disturbed
- Soil moisture regimes
- Schedule of future construction activities
- Proximity of cleared areas to water resources, roads, or other sensitive environmental resources
- Time of year, as this dictates the types of erosion and sedimentation control methods for a particular area. For example, re-seeding is not typically effective during the winter months. In winter, with frozen ground, controls other than re-seeding (such as wood chips, straw and hay, geotextile fabric, waterbars, or crushed stone) would be used to stabilize disturbed areas until seeding can be performed.
- Extreme weather conditions during or immediately following soil disturbance.
14.3.2.5 Vegetation Clearing (Within / Adjacent to Roads vs. Other Sites)

Only minimum vegetation clearing is typically required for underground cable system construction within or adjacent to road ROWs. Some landscaping or other vegetation bordering the cable route within roads may need to be removed or trimmed to allow the safe operation of construction equipment, and vegetation also would have to be removed at off-road splice vault locations (unless the vaults are located in paved areas). Similarly, vegetation may be affected by temporary staging or material storage sites.

In contrast, underground cable system construction within CL&P’s transmission line ROWs or other non-roadway corridors would involve the removal of all vegetation within a typical minimum 40-foot-wide construction work area. Additional vegetation clearing would also be needed at the locations of line transition stations, splice vaults, splice vault work (crane) pads, and staging areas.

14.3.2.6 Special Procedures: Rock Removal (Blasting), Dewatering, Material Handling

Based on a review of the soil and subsurface characteristics in the Project area (refer to Section 5.1 in Volume 1), it is likely that the excavations for any cable system would encounter rock and groundwater in some locations. Compared to the installation of overhead transmission line structures at defined locations, underground cable construction, which involves both the excavation of a continuous trench and areas for splice vaults, would require substantially more rock digging and removal and would require the management of significantly greater quantities of both dewatering wastewater and excavated soils. All of these excavated materials must be properly disposed.

Generally, rock encountered during underground cable system construction would be removed using mechanical methods, or mechanical methods supplemented by controlled drilling and blasting. If drilling and blasting are necessary, CL&P would adhere to the same standard procedures as described for the overhead transmission line construction in Volume 1, Section 4. Similarly, dewatering wastewaters and excess excavated soils would be managed pursuant to a Materials Handling Plan, as described for overhead transmission line construction in Section 4; however, substantially greater quantities of excess
soil and dewatering wastewater would be involved in the underground cable system installation. Further, dewatering could result in discharges to catch basins, sanitary sewers, temporary settling basins, tanker trucks (for eventual off-site transport), or watercourses.

14.3.2.7 Traffic Management
Traffic issues are often of primary concern with respect to the construction of underground cable systems within or adjacent to public road ROWs. The installation of the duct banks and splice vaults typically requires temporary travel lane closures, which would potentially cause traffic disruption, delays, detours, or congestion.

To minimize traffic-related impacts, CL&P would typically coordinate with municipal and state highway authorities regarding peak and non-peak travel times in order to identify construction schedules that would limit potential interference with traffic flow along public roads, and would prepare a project-specific Traffic Control Plan. CL&P also would employ police personnel to direct traffic at construction sites, and would erect appropriate traffic signs and install work area protection measures and signs to clearly denote the presence of construction work zones.

14.3.2.8 Construction Scheduling and Work Hours
Cable system construction is time-consuming and highly dependent on subsurface conditions. Duct-bank construction could proceed at a rate of only 50 feet / day and the excavation and installation of a splice vault could require a week to complete.

In addition, cable system construction schedules would depend on the location of the underground route (e.g., within public road travel lanes, near developed land uses, timing for crossing of sensitive environmental resources, such as streams that support fisheries). Where underground cables are routed within public road ROWs, construction work may be coordinated with state or local highway authorities to avoid peak travel times and thus may occur at night. In contrast, in areas where the underground cable
system traverses adjacent to residential areas, work would be scheduled during daylight hours, to minimize nighttime noise disturbance to residents.

Cable system installation beneath watercourses that support fishery resources or that are classified as high quality waters would be performed and scheduled in accordance with CT DEEP requirements. Often, cables must be installed beneath larger watercourses using trenchless technologies such as horizontal directional drilling or jack and bore. Using either of these techniques, the installation of the duct bank beneath a watercourse typically requires several weeks or months to complete.

**14.3.2.9 Line Transition Station Construction**

A 345-kV transmission line transition station is required whenever an underground cable segment of the line connects to an overhead section of the line. As discussed previously, each 345-kV line transition station typically requires about 2 to 4 acres of land, approximately 1.5 to 2 acres of which must be developed for the line transition facilities. The amount of land developed at each site would depend on site-specific topographic features, including the need for grading or filling and access.

To develop a new 345-kV line transition station, CL&P would typically have to purchase land from private owners, unless the station could otherwise be sited on fee-owned CL&P property. Where underground cable systems terminate at an existing CL&P substation (e.g., the Card Street Substation), the line transition facilities would be developed on the substation property.

Facilities at a line transition station include a line-terminal structure, cable terminator stands, cable terminators and surge arresters, circuit breakers, station service equipment, and a relay/control enclosure that would house the protective relaying systems, Supervisory Control and Data Acquisition (SCADA) equipment, battery systems, etc. Shunt reactors, which resemble large power transformers, may also be required at some line transition stations. Refer to Appendix 15A, Section 15A.2.9, for additional detail regarding 345-kV line transition stations, including representative photographs.
The primary activities required for the construction of a line transition station would include site preparation (e.g., grading, filling), foundation construction (e.g., excavation, form work, concrete placement), installation of components, wiring systems testing and interconnections, clean up and restoration. Temporary erosion and sedimentation controls would be deployed around the work site during the vegetation clearing phase (or when soils are initially disturbed), and would be maintained after the completion of construction until the site is determined to be stabilized (i.e., revegetated or stabilized with gravel).

14.3.3 Alternative Underground Line Routes Considered but Eliminated

Pursuant to the Council’s requirements, an applicant proposing an overhead 345-kV electric transmission line must establish that it is “…cost effective and the most appropriate variation based on a life-cycle cost analysis of the facility and underground variations to such facility…”9 Accordingly, although overhead circuits are the most efficient and reliable method for delivering power over long distances, CL&P identified and evaluated “all-underground” cable-route alternatives to interconnect Card Street Substation, Lake Road Switching Station, and National Grid’s facilities at the Connecticut / Rhode Island border.

As discussed this section, after considering constructability, cost, and environmental factors, CL&P’s analyses determined that none of the “all-underground” cable system options would be practical for the Project as a whole. However, the use of underground cable systems along select, short segments of the 345-kV transmission line route were considered potentially feasible; these underground line-route variations are described and reviewed in Section 15.

In identifying and evaluating potential “all-underground” routes for the new 345-kV lines between Card Street Substation, Lake Road Switching Station and the Connecticut/Rhode Island border, CL&P applied the routing objectives and technology considerations / evaluation criteria described in Sections 14.1 and 14.3.1, respectively. CL&P also took into consideration the underground cable-system construction

9 Connecticut General Statutes § 16-50p(a)(3)(D)
requirements detailed in Section 14.3.2 and the environmental and land use characteristics of the Project area.

As described in this section, using these criteria, CL&P subsequently reviewed the viability of underground line-route alternatives along new “greenfield” ROWs, within existing transmission line ROWs, and along road, pipeline, and railroad ROWs. In addition, CL&P also identified and examined two “all underground” cable system route alternatives involving a combination of road and CL&P transmission line ROWs to minimize the length of the route between Card Street Substation, Lake Road Switching Station, and the Connecticut / Rhode Island border. The general locations of these “all-underground” route alternatives are depicted on Figure 14-1.

For all of the analyses of underground line-route alternatives, cost and construction schedule would be significant issues. Compared to an overhead 345-kV transmission line configuration, any “all-underground” cable system between Card Street Substation, Lake Road Switching Station, and the Connecticut / Rhode Island border would require an estimated six to 12 months longer to construct, thereby delaying energization of the Project. In addition, both the capital and life-cycle costs of an underground cable system would be significantly more, by an order of magnitude, than a comparable overhead transmission line.

After examination of the various “all-underground” line-route alternatives, CL&P determined that two “combination” routes (one primarily using underground cable, but also involving a short segment of overhead line and one aligned entirely underground along road ROWs and CL&P’s ROWs) represented the best of the underground alignments (refer to Sections 14.3.3.5 and 14.3.3.6). CL&P conducted additional studies of these “combined” underground route alternatives and estimated the life-cycle costs compared to that of the proposed overhead 345-kV transmission lines located within CL&P’s existing ROWs. CL&P determined that the development of the new 345-kV line using either of the combined
underground line configurations and routes would be environmentally and economically impractical, would be less reliable than the proposed overhead 345-kV transmission lines, and would be significantly more costly (with high costs to Connecticut consumers).

14.3.3.1 New Right-of-Way Alternative

Similar to the discussion in Section 14.2.2.1 of a new ROW alternative for an overhead transmission line, this alternative would involve the construction and operation of a new 345-kV underground cable system between Card Street Substation, Lake Road Switching Station, and the Connecticut / Rhode Island border along a “greenfield” corridor, not within or adjacent to any existing roads or other linear corridors. As was the case for the corresponding overhead transmission line “greenfield” ROW alternative, CL&P determined that this line-route option would not conform to regulatory guidelines for the collocation of linear corridors to the extent practical, would result in comparatively significant, unavoidable environmental impacts, and would not be cost-effective.

To develop a “greenfield” corridor for a new cross-country (non-street) underground transmission cable system, CL&P would first have to acquire new easements from private property owners along the length of the route. A minimum easement width of 40 feet would be required. 10 Assuming a minimum straight-line 28-mile distance between Card Street Substation, Lake Road Switching Station, and the interconnection with National Grid’s facilities at the Connecticut / Rhode Island border, this alternative route would involve the acquisition of approximately 136 acres of property for new utility easements. This property acquisition process would be both costly and time-consuming.

In addition, the development of the 345-kV underground cable system along a “greenfield” corridor would have significantly greater environmental effects than other available route alternatives. To install the cable system, all of the vegetation along the “greenfield” corridor would have to be cleared and the

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10 This easement would be required for the construction and subsequent operation and maintenance of the cable system. Additional easements would be required for property on which splice vaults would be located.
The entire corridor would have to be graded (as needed) to create work space for construction equipment, access roads, and for the excavation of the cable duct bank and splice vaults. The continuous trenching required for the duct bank would result in long-term adverse effects to wetlands and watercourses as a direct result of filling (i.e., installing the duct bank and surrounding the conduits with FTB, and creating permanent access roads along the entire ROW). The cable system would have to be installed beneath major rivers (e.g., the Natchaug and Quinebaug rivers) and other watercourses using either conventional trenching (which would result in direct disturbance to the stream beds and water quality impacts) or more costly subsurface installation methods (e.g., jack and bore, horizontal directional drill [HDD]).

The development of the cable system along a “greenfield” corridor also would cause long-term environmental effects due to the conversion of previously undisturbed forested wetland habitats to scrub-shrub communities, development of a new ROW through upland forest, preclusion of certain land uses within the corridor, and potential direct disturbance to archaeological sites. For the operation of the underground cable system, permanent access roads would have to be maintained along the length of the ROW, and other (non-access road) portions of the ROW would have to be maintained in low-growing vegetation.

14.3.3.2 Alternative Routes along Existing Pipeline and Railroad Rights-of-Way
CL&P determined that the alignment of a cable transmission system along either existing pipeline or railroad corridors in the Project region would be impractical for the same general reasons as described for the routing of an overhead 345-kV transmission line (refer to Sections 14.2.2.2 and 14.2.2.4). In particular, because the cable system could not be accommodated within the pipeline and railroad corridors, significant additional easements adjacent to these existing ROWs would have to be acquired.

14.3.3.3 Alternative Routes along Existing Transmission Line Rights-of-Way
At first glance, aligning an underground cable system within CL&P’s existing ROWs appears to offer several advantages, such as collocating the underground and overhead transmission lines within the same
corridor and facilitating the construction process by avoiding both conflicts with other buried utility lines
and the potential for traffic congestion and similar public nuisance issues that are caused by underground
cable-system construction within or adjacent to public roads. Compared to an in-road cable system,
underground cable construction within existing transmission line ROWs is usually less expensive and has
the following advantages:

- Duct banks and splice vaults can typically be installed at uniform depths because buried utilities
  are only encountered at road crossings;

- No special construction design and scheduling is required to maintain traffic flow patterns or to
  avoid construction conflicts with adjacent land uses; and

- Construction does not require road pavement removal or replacement.

In addition, existing transmission line ROWs typically provide the most direct (shortest) route between
terminal points. In contrast, underground cable systems along road ROWs must typically follow more
circuitous, and typically longer, routes between the same terminal points, and therefore are more
expensive to construct and operate.

However, aligning an underground cable system within CL&P’s existing overhead transmission line
ROWs between Card Street Substation, Lake Road Switching Station, and the Connecticut / Rhode Island
border would pose significant construction constraints and, even if feasible, would result in potentially
significant, unavoidable, direct impacts to environmental and cultural resources. The terrain and water
resources that would have to be crossed (e.g., the Willimantic, Natchaug, and Quinebaug rivers and
Mansfield Hollow Lake) would pose difficult, if not insurmountable obstacles in terms of both regulatory
approvals and underground cable system construction.

Environmental impacts would result from the continuous trenching required for the duct banks along the
ROWs, the excavations for splice vaults, and the use of construction support areas along the ROWs, such
as material staging sites and crane pads for the vault installations. Assuming the placement of splice
vaults at intervals of approximately 1,600 feet, an estimated 122 vault locations would be required for the installation of an underground cable system along the 36.8-mile ROWs between Card Street Substation, Lake Road Switching Station, and the border. The construction of the duct bank would involve not only continuous trenching, but also the use of an estimated 40-foot-wide construction work space along the length of the ROWs. Within this construction work space, all vegetation would have to be removed, and a permanent access road must be developed. Overall, based on the minimum use of a 40-foot-wide work space along the 36.8-mile route, cable system construction would directly affect a minimum of approximately 175 acres. Additional land would be affected by splice vaults and the temporary equipment and material staging sites.

In addition, a permanent, 20-foot-wide access road would be required along the entire cable route, involving the permanent conversion of approximately 88 acres of land along the ROWs to road use. The access road would traverse approximately 7 miles of wetlands along the ROWs, where the permanent fill would constitute a long-term loss of wetland habitat.\footnote{Some of CL&P’s existing on-ROW access roads could likely be used. However, all of these roads would likely have to be improved to provide a permanent, contiguous road adjacent to the cable system.}

CL&P’s existing ROWs in the Project area are wide enough to accommodate the construction and operation of an underground cable system. However, CL&P’s easements for overhead transmission lines do not uniformly encompass the use of the ROWs for underground cable installation. As a result, CL&P would have to purchase additional easement rights for the development of an underground cable system from private landowners. Land also would have to be acquired from private landowners for the development of a line transition station at the Connecticut / Rhode Island border, at the interconnection with National Grid’s proposed 345-kV overhead transmission line system.

Further, although CL&P’s existing ROWs in the Project area are wide enough to accommodate the construction and operation of cable systems, the terrain and environmental features that are spanned by
The existing overhead lines pose severe constraints for underground transmission line construction and operation. These constraints include the following:

- Rough terrain, including steep slopes, embankments, rock outcroppings, and wetlands, all of which would make trenching for the cables and excavating for the splice vaults difficult.
- Long and/or steep grades, which could potentially overstress the cable and cable splices.
- Excavation through rock, requiring slow and costly mechanical removal or special provisions for blasting.
- Long waterway (e.g., Mansfield Hollow Lake, Natchaug River, Quinebaug River) and wetlands crossings, which would involve trenching and direct effects to the water resources or (where practical) the use of costly trenchless cable installation technologies, such as horizontal directional drilling or jack and bore.
- Crossings through various state-listed species habitat, as well as areas sensitive for the location of buried archaeological sites.

For these and cost reasons, the development of an underground 345-kV cable system along CL&P’s ROWs was determined to be impractical.

**14.3.3.4 Alternative Routes along Highway Rights-of-Way**

CL&P investigated possible cable-system alignments along various road ROWs in the Project area. In-road alignments for underground cable systems usually offer environmental advantages, particularly if the underground cable construction can be confined principally to paved or previously disturbed portions of the road ROWs. As a result, compared to underground line construction in overhead transmission line ROWs, in-road cable-system construction would typically affect fewer environmental resources (e.g., forested areas, wetlands) and fewer cultural resources.

To install the underground cable system within road ROWs, an approximately 40-foot-wide working area would be required adjacent to or within the existing highway travel lanes. The exact location of the cable system would depend on agreements with ConnDOT (for state highways) or local highway authorities.
limited access state road ROWs. An encroachment agreement must be negotiated between CL&P and ConnDOT for the use of the road ROWs. For the most part, although the cable duct banks may be aligned beneath the highway pavement, ConnDOT does not permit the location of splice vaults within paved road ROWs. As a result, CL&P typically must obtain easements for splice vaults and the associated cable duct bank interconnections from private landowners.

Alternatively, if the underground cable system could not be installed within public road ROWs, the availability of land for a transmission line easement, without having to displace homes or businesses located adjacent to the highways, would be a major concern. Furthermore, the costs and schedule of acquiring easements for the cable system from private landowners would be significant.

Key construction, engineering, safety, and environmental issues related to the identification and evaluation of potentially viable routes for an underground cable system within or adjacent to public road ROWs in the Project region included:

- Presence of road embankments and elevated portions of road ROWs, which would make cable system excavations difficult.
- Presence of areas of rock, where excavation would potentially require highway closures for blasting.
- Location of wetlands and waterways adjacent to or crossed by the road ROWs, beneath which the underground cable system would have to be buried.
- Construction and future maintenance activities causing traffic delays and congestion.
- ConnDOT policy of not allowing collocation of transmission lines within and parallel to the ROWs of limited access highways.

14.3.3.5 Combination Highway and Transmission Line Rights-of-Way Alternative Route

In addition to evaluating separate alternative underground cable system alignments along specific types of existing ROWs, CL&P assessed the combination of both highway and transmission line ROWs to achieve the objectives of minimizing the overall length of the route, avoiding or minimizing adverse
environmental and social effects; and minimizing cable system costs. Accordingly, as the shortest potential alignment for a cable system between Card Street Substation, Lake Road Switching Station, and National Grid’s facilities, CL&P identified a 39.1-mile route that would use a combination of ROWs (road and CL&P transmission line) and would involve a short (1.1-mile) segment of overhead line.

Along this route, the new 345-kV line would consist of approximately 38 miles of underground cable system extending for approximately 36.3 miles along road ROWs and for 1.8 miles along two segments of CL&P’s existing transmission line ROW. Along the remaining 1.1-mile segment of the route (between a new line transition station in the Town of Thompson and the Connecticut / Rhode Island border), the line would be developed in an overhead configuration. (This alternative assumes that National Grid’s new 345-kV line would be overhead and, therefore, the new CL&P 345-kV line would also have to be in an overhead configuration to interconnect with National Grid’s facilities at the state border.)

Figure 14-5 illustrates the location of this approximately 39.1-mile combined road / transmission line route alternative. Table 14-4 identifies the public road ROWs and the portions of the CL&P transmission line ROWs along which the route would be aligned.

For this alternative, a new line transition station would be required on the Connecticut side of the Connecticut / Rhode Island border to interconnect to National Grid’s overhead 345-kV transmission line (assuming the underground cable route did not continue into Rhode Island). A potential site for this line transition station was identified on property owned by CL&P east of Quaddick Town Farm and Elmwood Hill Road in the Town of Thompson. However, to accommodate the line transition station, it is likely that some additional adjacent privately-owned property would have to be purchased.

Note: Any underground 345-kV cable system for the Interstate Reliability Project would be significantly more costly than an overhead 345-kV line. Consequently, the goal in the underground cable-route alternatives evaluation was to identify the most potentially desirable underground cable alignment - that is, the route that would minimize the costs and environmental and social effects compared to other cable routing options.
Figure 14-5: Combined Highway and Transmission Line ROWs Alternative Route
Table 14-4: Summary of ROWs along Combined Highway and Transmission Line ROW

<table>
<thead>
<tr>
<th>Alternative Route</th>
<th></th>
<th></th>
<th>Town</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Existing ROW Following (Public Road, CL&amp;P Transmission Line)</strong></td>
<td><strong>Distance (miles)</strong></td>
<td><strong>Town</strong></td>
<td></td>
</tr>
<tr>
<td>Card Street Substation to Card Street</td>
<td>0.1</td>
<td>Lebanon</td>
<td></td>
</tr>
<tr>
<td>Card Street</td>
<td>1.1</td>
<td>Lebanon, Windham</td>
<td></td>
</tr>
<tr>
<td>Pleasant Street</td>
<td>1.1</td>
<td>Windham</td>
<td></td>
</tr>
<tr>
<td>Windham Road</td>
<td>0.8</td>
<td>Windham</td>
<td></td>
</tr>
<tr>
<td>Plains Road</td>
<td>1.9</td>
<td>Windham</td>
<td></td>
</tr>
<tr>
<td>State Route 203</td>
<td>3.6</td>
<td>Windham</td>
<td></td>
</tr>
<tr>
<td>U.S. Route 6</td>
<td>15.9</td>
<td>Windham, Chaplin, Hampton, Brooklyn, Killingly</td>
<td></td>
</tr>
<tr>
<td>Maple Street</td>
<td>1.2</td>
<td>Killingly</td>
<td></td>
</tr>
<tr>
<td>Upper Maple Street</td>
<td>3.3</td>
<td>Killingly</td>
<td></td>
</tr>
<tr>
<td>Lake Road</td>
<td>0.1</td>
<td>Killingly</td>
<td></td>
</tr>
<tr>
<td>Alexander Park Way</td>
<td>0.4</td>
<td>Killingly</td>
<td></td>
</tr>
<tr>
<td>Alexander Park Way to Lake Road Switching Station</td>
<td>0.2</td>
<td>Killingly</td>
<td></td>
</tr>
<tr>
<td>Lake Road Switching Station to Old Trolley Road</td>
<td>0.2</td>
<td>Killingly</td>
<td></td>
</tr>
<tr>
<td>Old Trolley Road</td>
<td>0.4</td>
<td>Killingly</td>
<td></td>
</tr>
<tr>
<td>Attawaugan Crossing</td>
<td>0.6</td>
<td>Killingly</td>
<td></td>
</tr>
<tr>
<td>Putnam Pike</td>
<td>0.8</td>
<td>Killingly</td>
<td></td>
</tr>
<tr>
<td>State Route 21</td>
<td>2.6</td>
<td>Killingly; Putnam</td>
<td></td>
</tr>
<tr>
<td>Existing CL&amp;P 345-kV ROW</td>
<td>1.5</td>
<td>Putnam</td>
<td></td>
</tr>
<tr>
<td>U.S. Route 44</td>
<td>0.4</td>
<td>Putnam</td>
<td></td>
</tr>
<tr>
<td>Munyan Road</td>
<td>1.1</td>
<td>Putnam</td>
<td></td>
</tr>
<tr>
<td>State Route 438</td>
<td>0.4</td>
<td>Putnam, Thompson</td>
<td></td>
</tr>
<tr>
<td>Existing CL&amp;P 345-kV ROW to Transition Station</td>
<td>0.3</td>
<td>Thompson</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal: Underground Cable System</strong></td>
<td><strong>38.0</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>OVERHEAD TRANSMISSION LINE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Line Transition Station to Connecticut/Rhode Island Border</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing CL&amp;P 345-kV ROW</td>
<td>1.1</td>
<td>Thompson</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>39.1</strong></td>
<td></td>
<td></td>
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</tbody>
</table>

* Mileage estimates rounded to nearest tenth.
Line transition facilities also would have to be developed at CL&P’s Card Street Substation and Lake Road Switching Station. These line transition facilities would likely require the expansion of both stations beyond the existing station fence lines.

At Card Street Substation, the expansion could be accommodated on CL&P fee-owned property, but would require vegetation removal and the conversion of presently undeveloped land to utility use. In contrast, CL&P does not own the Lake Road Switching Station site. Depending on the final design for the new 345-kV line transition facilities, CL&P would potentially need to acquire additional property (easements). As envisioned in preliminary analyses conducted for this underground line alternative, the switching station would be expanded based on a split-level design, which would require development outside the existing station fence line and would involve tree clearing and grading. In addition, the existing transmission lines at the switching station might need to be reconfigured to avoid the proposed expansion area. The proposed expansion area would be approximately 2 acres.

**Routing Considerations**

The combined alternative route was selected to maximize, to the extent possible, conformance to CL&P’s routine objectives and underground cable system routing criteria (as summarized in Sections 14.1 and 14.2.1). For example, as Figure 14-5 illustrates, the combined route alternative would follow U.S. Route 6 through the Town of Windham, avoiding Mansfield Hollow Lake, as well as Mansfield Hollow State Park and WMA. However, portions of the underground cable route would be aligned within CL&P’s existing ROW in the towns of Putnam and Thompson, thereby decreasing the length of the route compared to using road ROWs in this area. Underground easement rights would need to be acquired along CL&P’s existing transmission line ROW along these segments.

Using a combination of road and overhead transmission ROWs for the underground cable system would also avoid areas of potentially difficult construction to the extent possible. For example, use of road
ROWs would avoid long HDDs or direct trenching to install the cable ducts beneath Mansfield Hollow Lake and large wetlands. The use of road ROWs also would avoid potential visual effects associated with the addition of a second overhead 345-kV transmission line to CL&P’s existing ROWs.

A preliminary review of existing easements along the approximately 1.8 miles in the towns of Putnam and Thompson where the underground line-route alternative would be aligned within CL&P’s existing transmission line ROW indicates that the majority of the easements do not include underground line rights. As a result, to develop the underground cable system along the 345-kV transmission line ROW along these segments, CL&P would have to acquire additional easement rights from property owners.

The development of the cable system along the highway ROWs and within CL&P’s transmission line ROWs would involve the land requirements and construction procedures detailed in Section 14.3.2. If the underground transmission line could not be installed within the road ROWs (due to conflicts with ConnDOT policies, etc.), the availability of adjacent land for the installation and operation of the cable system, without having to displace homes or businesses located adjacent to the highways, would be a major concern. Furthermore, the costs and schedule of acquiring easements from private landowners would be significant. Table 14-5 summarizes the key characteristics of the combined underground line-route.

Although this alternative represents CL&P’s best-identified combined use of road and transmission line ROWs for the alignment of the all-underground line route (assuming an overhead line connection with National Grid at the state border), cable-system construction in the Project area nonetheless poses constructability issues, and would face environmental and land-use constraints. For example, the underground line route would traverse 15 watercourses, including several large rivers.
Table 14-5: Summary of Key Features: Combined Highway and Transmission Line ROW Underground Alternative

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ROW / Land</strong></td>
<td><em>(Miles / Acres)</em></td>
</tr>
<tr>
<td>Underground Within or Adjacent to Road ROWs</td>
<td>36.3 miles</td>
</tr>
<tr>
<td>Underground Within Transmission Line ROW</td>
<td>1.7 miles</td>
</tr>
<tr>
<td>Overhead within Transmission Line ROW</td>
<td>1.1 miles</td>
</tr>
<tr>
<td>Transition Station (Town of Thompson)</td>
<td>4 acres</td>
</tr>
<tr>
<td>Lake Road Switching Station Expansion</td>
<td>2 acres</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>39.1 miles / 6 acres of land for stations</td>
</tr>
<tr>
<td><strong>Towns Traversed by Route</strong></td>
<td><em>(Miles)</em></td>
</tr>
<tr>
<td>Lebanon</td>
<td>0.8</td>
</tr>
<tr>
<td>Windham</td>
<td>8.2</td>
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<td>Chaplin</td>
<td>3.6</td>
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<td>Hampton</td>
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<tr>
<td>Thompson</td>
<td>1.6</td>
</tr>
<tr>
<td><strong>Highway Characteristics</strong></td>
<td>% along each lane type</td>
</tr>
<tr>
<td>Four-lane Roads (U.S. Route 6)</td>
<td>4%</td>
</tr>
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<td>Two-lane Roads (State Route 203, Pleasant Street, Maple Street, Upper Maple Street, Hartford Road, Putnam Pike, Thompson Pike)</td>
<td>96%</td>
</tr>
<tr>
<td><strong>Adjacent Land Use</strong></td>
<td><em>(Percent of Total Route)</em></td>
</tr>
<tr>
<td>Residential</td>
<td>43%</td>
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<tr>
<td>Commercial</td>
<td>5%</td>
</tr>
<tr>
<td>Public</td>
<td>5%</td>
</tr>
<tr>
<td>Forested</td>
<td>37%</td>
</tr>
<tr>
<td>Undeveloped (Open Land)</td>
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<td>1%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Watercourse Crossings</strong></td>
<td><em>(Number)</em></td>
</tr>
<tr>
<td>Major crossings (Shetucket River, Merrick Brook, Quinebaug River, Five Mile River)</td>
<td>15</td>
</tr>
<tr>
<td><strong>Wetlands Adjacent to or Crossed</strong></td>
<td><em>(Number)</em></td>
</tr>
<tr>
<td>Underground Portion along Road ROWs</td>
<td>16</td>
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<tr>
<td>Underground Portion along Transmission line ROW</td>
<td>6</td>
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<tr>
<td>Overhead Portion along Transmission line ROW</td>
<td>4</td>
</tr>
<tr>
<td><strong>Railroad Crossings (No.)</strong></td>
<td><em>(Name / Number)</em></td>
</tr>
<tr>
<td>Two</td>
<td>One double track- New England Central One single track – Providence and Worcester</td>
</tr>
</tbody>
</table>
The cable system would have to be installed across all of these locations using methods such as a bridge attachment (if the bridges have the design capacity to handle the weight of the cable system and if ConnDOT permits the attachment) or a subsurface crossing method (jack and bore, HDD). In addition, the cable system would have to be installed beneath Interstate 395 and railroads using HDD or jack and bores. The installation of the cable system beneath watercourses, roads, and railroads would require substantial staging areas, typically on private property, on either side of the crossing in order to position construction equipment and materials.

Except for the isolated crossings where trenchless technologies (such as HDD or jack and bore) could be used, the cable-system installation would require continuous excavations for the duct banks, as well as excavations for the splice vaults. As described previously, ConnDOT would likely require that splice vaults be located outside of state road ROWs, which would require the acquisition of easements from private property owners and land disturbance on such private property. Furthermore, where the cable system could be installed within the paved portions of the road ROWs, lane closures (resulting in traffic delays), trench dewatering (where groundwater is encountered), and trimming of trees overhanging or adjacent to the ROWs, would be required.

Where the underground cable system would be aligned within CL&P’s transmission line ROW in Putnam and Thompson, its installation would directly affect wetlands (Wetland Nos. 20-190 through 20-196, as shown on Mapsheets 35 through 37 in Volume 9 and Mapsheets 97 through 101 of Volume 11), habitat for state-listed species, and various confirmed vernal pools and amphibian breeding habitats (refer to the Volumes 9 and 11 maps for further information regarding the environmental and land-use characteristics along this segment of ROW between State Route 21 and the potential line transition station east of Elmwood Hill Road).
The majority of the road ROWs along which the route would be located were selected because they are generally wide enough to accommodate the construction of a cable system, using lane closures, rather than full road closures. However, these roads also represent important components of the regional highway system. As a result, they generally traverse more developed areas and, in some locations, residential, commercial, and industrial uses abut the road ROWs. Such land uses would be affected in areas where the construction or alignment of the cable system would have to occur on private property (e.g., at splice-vault locations, or areas where in-street buried utilities leave no space for the cable system).

Although the combined highway and transmission line ROW route reflects the optimal “all underground” cable system between Card Street Substation, Lake Road Switching Station and the National Grid facilities, this alternative is not a practical, cost-effective, or environmentally-sound solution for meeting the Project objectives. Compared to an overhead transmission line configuration using existing CL&P ROWs, the use of the cable system along the combined alternative route would be significantly more expensive and would require substantially more time to construct, delaying the Project’s scheduled energization by at least one year.

As explained in Section 14.3.1.3, the costs of constructing an overhead transmission line are expected to be shared with the rest of New England. However, the significantly higher costs of building the same line underground would be expected to be borne by Connecticut consumers alone and that incremental increased cost would be dramatically higher than that of an overhead line. As previously stated, the estimated cost for the construction of the new 345-kV transmission line overhead is $215.5 million.13 In

13 The project cost estimates in the Supplemental MCF reflect capitalized Allowance for Fund Used During Construction (AFUDC) accrual for the duration of the project. On May 27, 2011, the FERC issued an Order authorizing recovery in rate base of 100% of transmission construction work in progress (CWIP) costs for the NEEWS projects, including the Interstate Reliability Project. Under this Order, CL&P, the Western Massachusetts Electric Company, and the New England Power Company (collectively “the Companies”) ceased their accrual of AFUDC associated with expenditures on the NEEWS projects on June 1, 2011. The Companies are in the process of reducing their NEEWS project cost estimates accordingly and will complete this process before filing the Application to the Council.
comparison, the estimated cost for the combined underground alternative is $1.3 billion. Using these
estimates, the probable cost to Connecticut consumers for the development of the all-overhead line (as
proposed) in Connecticut would be approximately $58.2 million (27% of the total overhead line cost).
However, after localization of the extra costs for undergrounding, the development of an all-underground
cable system would cost Connecticut consumers approximately $1.2 billion.

Similarly, the life-cycle cost, which reflects the estimated capital cost and the anticipated maintenance
costs of a project over its anticipated useful life, also would be substantially greater for the underground
cable system along the combined route alternative than for an all-overhead 345-kV transmission line,
installed along CL&P’s ROWs. Specifically, the life-cycle costs will be estimated in the Application.

In sum, although identified to minimize, to the extent possible, the effects typically associated with cable-
construction and operation, the combined road and transmission line ROW route alternative
between the Card Street Substation and a line transition station in the Town of Thompson nonetheless
does not represent a practical, cost-effective, or environmentally-sound solution for meeting the Project
objectives. Construction of the alternative would be prohibitively costly, would require more time to
construct, would disrupt local traffic patterns, would result in potential environmental impacts associated
with major watercourse crossings and land use/soil disturbance adjacent to roads, and would be more
difficult to operate within the system than a comparable overhead line. For these reasons, the installation
of the 38.6-mile underground cable system along the combined alternative route was eliminated from
consideration as a viable option.

14.3.3.6 U.S. Route 44 Underground Variation to Portion of Combination Highway and
Transmission Line Rights-of-Way Underground Alternative Route

To accommodate the possibility that National Grid could be required to develop its new 345-kV
transmission line in an underground configuration in Rhode Island, CL&P identified and evaluated a
route variation to the Combination Highway and Transmission Line ROWs Underground Alternative that
would involve the extension of the underground cable system in Connecticut to interconnect with the National Grid facilities at the border. This 2.3-mile route variation would replace the easternmost 2.9 miles of the Combined Highway and Transmission Line ROWs Underground Alternative, and would eliminate an overhead line alignment in the Town of Thompson. This variation is therefore an all-underground line.

As illustrated in Figure 14-6, the route variation would diverge from the route of the Combined Highway and Transmission Line ROWs Underground Alternative at the intersection of U.S. Route 44 and Munyan Road in the Town of Putnam, and would continue underground due east along U.S. Route 44 to interconnect with the National Grid underground cable system at the Connecticut / Rhode Island border. Thus, the route variation would be located entirely in the Town of Putnam, and would replace the following segments of the Combined Highway and Transmission Line ROWs Underground Alternative:

- Underground cable system along Munyan Road (1.1 miles), State Route 438 (0.4 mile), and CL&P’s existing ROW (0.3 mile).
- The 345-kV line transition station in the Town of Thompson.
- The alignment of the 345-kV line in an overhead configuration along 1.1 miles of CL&P’s existing ROW in Thompson.

Table 14-6 summarizes and compares the key features of the Combined Highway and Transmission Line ROWs Underground Alternative with and without this U.S. Route 44 underground route variation.

The incorporation of this route variation into the Combined Highway and Transmission Line ROWs Underground Alternative would increase the length of the underground cable system route by 0.5 mile, but would eliminate the costs and environmental effects associated with developing a 345-kV line transition station in Thompson. However, this all-underground route would have the same issues as described in Section 14.3.3.5 and would be significantly more costly than an overhead line built along CL&P’s existing ROWs. Specifically, the life cycle cost will be estimated for the Application.
Figure 14-6: Combined Highway and Transmission Line ROWs Underground Alternative Route: U.S. Route 44 Variation
Table 14-6: Summary of Key Features: Combined Highway and Transmission Line ROW Underground Alternative with U.S. Route 44 Underground Variation

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
<th>Combined Route</th>
<th>Combined Route with U.S. Route 44 Variation</th>
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</thead>
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<tr>
<td>ROW / Land</td>
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<td>(Miles / Acres)</td>
<td>(Miles / Acres)</td>
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<tr>
<td>Underground Within or Adjacent to Road ROWs</td>
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<td>36.3 miles</td>
<td>37.1 miles</td>
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<tr>
<td>Underground Within Transmission Line ROW</td>
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<td>1.7 miles</td>
<td>1.4 miles</td>
</tr>
<tr>
<td>Overhead within Transmission Line ROW</td>
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<tr>
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<tr>
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<td>2 acres</td>
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<td>38.5 miles</td>
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<tr>
<td></td>
<td>(land for line transition station)</td>
<td>6 acres of</td>
<td>2 acres for</td>
</tr>
<tr>
<td></td>
<td></td>
<td>land</td>
<td>line transition station</td>
</tr>
<tr>
<td>Towns Traversed by Route</td>
<td>(Miles)</td>
<td>(Miles)</td>
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</tr>
<tr>
<td>Lebanon</td>
<td></td>
<td>0.8</td>
<td>0.8</td>
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<tr>
<td>Windham</td>
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<td>96%</td>
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</tr>
<tr>
<td>Adjacent Land Use</td>
<td>(Percent of Total Route)</td>
<td>(Percent of Total Route)</td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td></td>
<td>43%</td>
<td>45%</td>
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<tr>
<td>Commercial</td>
<td></td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Public</td>
<td></td>
<td>5%</td>
<td>4%</td>
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<tr>
<td>Forested</td>
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<td>37%</td>
<td>36%</td>
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<tr>
<td>Undeveloped (Open Land)</td>
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<td>9%</td>
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<tr>
<td>Industrial</td>
<td></td>
<td>1%</td>
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<tr>
<td>Total</td>
<td></td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Watercourse Crossings</td>
<td>(Number)</td>
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<td></td>
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<td>(Number)</td>
<td></td>
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<tr>
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<td>16</td>
<td>18</td>
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<td>Underground Portion along Transmission line ROW</td>
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<tr>
<td>Overhead Portion along Transmission line ROW</td>
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<tr>
<td>Railroad Crossings (No.)</td>
<td>(Name / Number)</td>
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<td></td>
</tr>
<tr>
<td>Two</td>
<td></td>
<td>One double track- New England Central</td>
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<tr>
<td></td>
<td></td>
<td>One single track – Providence and Worcester</td>
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14.4 JUSTIFICATION FOR THE SELECTION OF THE PROPOSED TRANSMISSION LINE ROUTE AND CONFIGURATION

After considering various alternative technologies and routes for the Project, CL&P identified overhead line designs as the preferred configuration for the new 345-kV line and the use the existing transmission line ROWs as the preferred alignment for the new 345-kV lines between Card Street Substation, Lake Road Switching Station, and the Connecticut/Rhode Island border. CL&P determined that the Proposed Route for the installation of the new overhead 345-kV transmission lines meets all Project objectives and represents the most cost-effective, least environmentally damaging practical alternative.

The Proposed Route and proposed overhead line design represents the optimal Project configuration for the following reasons:

- **Availability of Existing ROW.** Along approximately 96% of the Proposed Route, the new overhead 345-kV lines would be located within CL&P’s existing ROWs, which have sufficient un-utilized space to accommodate the new lines without requiring relocation of the existing lines or the acquisition of additional easements. Along the remaining 4% (approximately 1.4 miles) of the Proposed Route, CL&P’s existing ROW (through the federally-owned Mansfield Hollow properties) is only 150 feet wide. However, if required, CL&P has identified alternative configurations for aligning the new 345-kV line across the 1.4 miles that would involve minimal or no additional ROW acquisition from the federal government. (These design options for the Mansfield Hollow area are discussed in Volume 1, Section 10.)

- **Environmental Effects.** With the exception of the additional ROW easement that could be associated with the 1.4 miles of federally-owned property in the Mansfield Hollow area, the proposed lines would be aligned entirely within CL&P’s existing ROWs, which are already devoted to utility use. Although incremental effects to site-specific environmental resources would occur as a result of the construction and operation of the proposed 345-kV transmission lines within these ROWs, the development of the new 345-kV transmission lines along this existing corridor would be consistent with federal, state, and local land use policies and would minimize long-term adverse environmental impacts.

- **EMF BMPs.** The proposed overhead transmission line design incorporates BMPs, as described in Volume 1, Section 7.

- **Cost.** The Proposed Route and overhead line design represent the most cost-effective alternative to Connecticut consumers.
Therefore, the Council should certify the Project along the Proposed Route, specifically the construction and operation of the new 345-kV overhead transmission lines, configured as proposed by CL&P. In the case of the 1.4 miles across the federally-owned properties in Mansfield Hollow, CL&P is prepared to develop the new 345-kV line using any of the design configurations (expanded easement or no easement expansion), in accordance with approvals by the Council and the USACE.