



**Connecticut
Light & Power**

The Northeast Utilities System

Bethel to Norwalk Project Schedule 12C Application

January 12, 2005



**Northeast
Utilities System**

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VIA ELECTRONIC MAIL

January 12, 2005

Mr. Stephen J. Rourke
Chairman, NEPOOL Reliability Committee
ISO New England Inc.
One Sullivan Road
Holyoke, MA 01040-2841

RE: NU-04-TCA-O4, CL&P 12C Application for the Bethel-Norwalk Project

Dear Steve,

Pursuant to Schedule 12C of the NEPOOL Open Access Transmission Tariff and NEPOOL/ISO-NE Planning Procedure No. 4, The Connecticut Light and Power Company ("CL&P") hereby submits an electronic copy of the Transmission Cost Allocation ("TCA") Application for the work associated with the construction of a new 345-kV transmission line between Plumtree Substation in Bethel, Connecticut and Norwalk Substation in Norwalk, Connecticut. In addition to the construction of the new 20.4-mile 345-kV transmission line, certain sections of the existing 115-kV transmission lines between the Plumtree, Peaceable and Norwalk substations will be reconfigured and certain ancillary facility work will be performed. The attached TCA Application form is required in accordance with section 2.0 of Planning Procedure No. 4. Also attached is a report that provides a detailed discussion of the project components, the need for the project, the alternatives considered, and cost.

Fifteen hard copies of the TCA Application will be delivered to you. If you have any questions or would like additional hard copies, please contact me at (860) 665-2519 or scarfaw@nu.com.

Sincerely,

Allen Scarfone

TCA Application Form

Project Name:

1.	Applicant: The Connecticut Light and Power Company	Date: December 17, 2004
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2.	<p><u>Project Description:</u></p> <p>a. Summary of PTF-related Work for Project:</p> <p>b. Summary of Non-PTF-related work for Project:</p>	<p>CL&P will construct a new 345-kV transmission circuit from Plumtree Substation in Bethel to Norwalk Substation in Norwalk, as well as reconstructing certain sections of the existing overhead 115-kV transmission circuits between these two substations and performing ancillary facility work. The new 345-kV line will include 8.6 miles of new overhead construction and 11.8 miles of 345-kV underground cables. CL&P will utilize 345-kV HPFF cable systems for the majority (approximately 9.7 miles of the 11.8 miles) of the underground portion of the route of the new 345-kV line, and 2.1 miles of 345-kV XLPE cables for the portion of the route south of Plumtree Substation. The modifications to existing 115-kV lines include overhead reconstruction of 1.8 miles of these lines on an expanded right-of-way to accommodate the new overhead 345-kV facilities, as well as relocation of approximately 7.8 miles of existing 115-kV line segments underground, primarily in public roads.</p> <p>At Plumtree Substation, the Company will construct a 345-kV outdoor gas-insulated substation (“GIS”), including switchgear and equipment that allows for the transition from SF₆ bus to existing open-air 345-kV lines and bus.</p> <p>At Norwalk Substation, the Company will install an indoor 345-kV GIS system, autotransformers, a relay/control enclosure, battery enclosures, three underground 115-kV line sections, a fourth 115-kV switchyard bay, and a 345-kV line terminal structure.</p> <p>In addition, 345-kV line transition stations will be constructed in Bethel, Redding, and Wilton at points where the 345-kV line transitions from overhead to underground construction.</p> <p>None</p>	<p><u>In Service Date:</u></p> <p>4th quarter of 2006</p>
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3.	Was a transmission 18.4 Application required for this work?	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>	
4.	Has a transmission 18.4 Application been approved? If yes, attach a copy and reference Section 18.4 Application # and approval date.	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>	N/A <input type="checkbox"/>
				Approval Date: February 2004

Need For Project:

5.	Need Based On:	Yes	No
	a. Reliability	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	b. Economic	<input type="checkbox"/>	<input type="checkbox"/>
	c. Service to new load	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	d. New generator interconnection	<input type="checkbox"/>	<input type="checkbox"/>
	If yes, Category of Generator (See NEPOOL Tariff Schedule 11):	‘A’ <input type="checkbox"/>	‘B’ <input type="checkbox"/> ‘C’ <input type="checkbox"/>
	18.4 Generator Application Number	_____	
	18.4 Generator Application Date	_____	
	(Attach copy of cover letter & 18.4 Generator Application)		
	e. Other (specify in line 6)	<input type="checkbox"/>	<input type="checkbox"/>

6.	<p>Provide a narrative description of the need for this Project.</p> <p>See sections 2 and 3 of the Application.</p>
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Cost of Project:

7.	Total Proposed PTF Cost of this Project:	\$ 357 million
	a. PTF Costs associated with this Project:	\$ 357 million
	b. Generator Supported PTF Costs**:	
	If the costs in 7.a. plus 7.b do not equal the total PTF cost, please explain and indicate who is responsible for the remaining costs.	
8.	Costs introduced as a result of local, state or other regulatory/legislative requirements, including costs identified pursuant to Section 1.6.3 of this PP-4.	\$ 0

9.	Total Non-PTF Cost associated with this Project (if any)	\$ 0
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10.	Total PTF Cost based on: (check one)	
	Actual Costs	<input type="checkbox"/> OR
	Estimated Costs*	<input checked="" type="checkbox"/>

11.	Provide a breakdown of the total costs consistent with Table 1. If applicable, explain how the cost of common facilities was allocated between PTF and non-PTF.
	See Cost Tables in Appendix A of Application. All costs are PTF costs.

12.	Does this Project result in a change of existing non-PTF facilities to PTF?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>
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13.	Describe the major transmission alternatives that were considered and why the preferred alternative was selected.
	See sections 4, 5, and 6 of the Application.

* If the actual PTF cost exceeds the estimated PTF cost by more than 10%, a revised filing is required.

** Pool-Supported PTF costs were determined purs



**Connecticut
Light & Power**

The Northeast Utilities System

**Bethel to Norwalk Project
Schedule 12C Application
Report**

January 12, 2005

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1. Overview of Application

The Connecticut Light and Power Company (“CL&P” or the “Company”) submits this Schedule 12C Application to the Independent System Operator of New England (“ISO-NE”) in accordance with the NEPOOL Open Access Transmission Service Tariff (“NEPOOL Tariff”) for cost recovery of the Bethel to Norwalk Project (the “Project”). In February 2004, the Project received Section 18.4 approval from ISO-NE in accordance with the Restated NEPOOL Agreement (NU-04-T01 through T09). The Project includes construction of a new 20.4-mile 345-kV transmission line between Plumtree Substation in Bethel and Norwalk Substation in Norwalk. In addition, certain sections of the existing 115-kV transmission lines between the Plumtree, Peaceable and Norwalk substations and two other 115-kV lines in the vicinity of Norwalk Substation will be reconfigured, and certain ancillary work will be performed. The Project will address reliability issues of the regional electric transmission system serving southwest Connecticut and will extend the 345-kV transmission system into this major load pocket. The total cost of the Project, including the ancillary work, is estimated to be \$357 million. CL&P seeks regional cost support for the entire cost of this urgently needed transmission upgrade.

1.1 Background and Purpose

Over the past several decades, electricity usage in Connecticut has increased significantly as a result of population increases, economic growth and the expanded use of air conditioners and electronic devices such as computers. This growth in electricity usage is particularly evident in Southwest Connecticut (“SWCT”)¹, which encompasses 54 municipalities, including the metropolitan centers of New Haven, Waterbury, Danbury, Bridgeport, Norwalk, Stamford, and all of lower Fairfield County.

¹ For electrical system purposes, ISO-NE has defined “Southwest Connecticut” to consist of the following municipalities: Bridgeport, Darien, Easton, Fairfield, Greenwich, New Canaan, Norwalk, Redding, Ridgefield, Stamford, Weston, Westport, Wilton, Ansonia, Branford, Beacon Falls, Bethany, Bethel, Bridgewater, Brookfield, Cheshire, Danbury, Derby, East Haven, Hamden, Meriden, Middlebury, Milford, Monroe, Naugatuck, New Fairfield, New Milford, New Haven, Newtown, North Branford, North Haven, Orange, Oxford, Prospect, Roxbury, Seymour, Shelton, Sherman, Southbury, Southington, Stratford, Trumbull, Wallingford, Waterbury, Watertown, West Haven, Wolcott, Woodbridge, and Woodbury. Because the boundaries of the SWCT electrical system are defined by electrical interfaces with other portions of the transmission system (as opposed to municipal boundaries), portions of some of these municipalities are outside of the “Southwest Connecticut” electrical system.

SWCT is currently served by an electric transmission system of 115-kV lines and substations. It is the only major load pocket in New England that is not connected to the 345-kV backbone transmission system. Many of the lines in this region were installed more than 40 years ago and were never intended to support the present level of electric demand. Despite numerous upgrades and reinforcements that the Company has implemented over the last few decades, the 115-kV transmission system is no longer adequate to supply the area's continuing growth in electricity usage without extensive modification. The Company can no longer defer its plan to construct a 345-kV loop in SWCT to ensure reliable operation of the region's transmission grid.

The urgency of this need has been highlighted by a series of recent events:

- In June 2000 the local area 115-kV system experienced a prolonged voltage depression following a contingency event that disconnected local customer loads. Fortunately, this event did not lead to cascading losses of transmission system elements or to a wide-area blackout, but it forewarned of this danger.
- As reflected by ISO-NE's issuance of "gap RFPs" for temporary emergency generation in SWCT during the summers of 2002, 2003, and 2004, ISO-NE has determined that SWCT has inadequate transmission and generation resources. It is expected that ISO-NE will continue to rely on "gap RFPs" until the construction of needed transmission upgrades is completed.
- On August 14, 2003, nine states and one Canadian province suffered a "blackout" originating from severe line and generator contingencies in Ohio. This blackout caused customer loads to be disconnected in SWCT. Portions of the region were without power for more than 24 hours. If the 345-kV loop had been in place at the time of the blackout, the additional supply paths in SWCT would likely have enabled a faster restoration.
- During the five-year period preceding the Company's application for siting approval of the Project, the peak load in the Norwalk-Stamford Sub-area increased by approximately 27%. The load growth in the Norwalk-Stamford Sub-area is driven by the commercial and

residential customer classes and consistently exceeds the overall load growth rate for the state of Connecticut.

In short, the combined capabilities of generation and transmission resources in the SWCT area are insufficient to serve the region's peak electric loads. Many of the generating facilities that are located in the region are older fossil fuel plants. There is substantial uncertainty about the continued short-term and long-term availability of these older units.

The transmission system in SWCT is presently exposed to line overloads, voltage degradations and high short-circuit currents under various operating conditions. As a result, there is an increasing risk of customer outages in the SWCT region, particularly in the Norwalk-Stamford Sub-area². The Norwalk-Stamford Sub-area, which encompasses 14 towns and cities, is the portion of SWCT that is farthest away from the existing bulk 345-kV transmission grid. (See Figure 1-1 at the back of this section for a map of the SWCT and Norwalk-Stamford Sub-areas.). Moreover, given the integrated nature of the transmission network in New England, the reliability issues in SWCT affect the system outside the SWCT interfaces. The SWCT reliability issues therefore pose the risk of cascading outages that could impact the entire grid.

The electric reliability problems in SWCT are well documented and have been recognized by a number of recent reports and statements, most notably:

- In the 2001 Regional Transmission Expansion Plan Report (RTEP01 Report), ISO-NE concluded that, within the SWCT area during peak loading periods in the summer of 2001, when all generating units were on-line, load shedding would have been required had there been an outage of a single generating unit or the loss of a single transmission line.
- ISO-NE has designated SWCT as a deficient load pocket due to transmission constraints. Deficient load pockets require the operation of more expensive "out-of-merit" local

² The Norwalk-Stamford Sub-area, like the SWCT region, is defined by electrical interfaces, and includes all or part of the municipalities of Bridgeport, Darien, Easton, Fairfield, Greenwich, New Canaan, Norwalk, Redding, Ridgefield, Stamford, Trumbull, Weston, Westport, and Wilton.

generation to meet moderate and peak load requirements because less expensive electric generation outside of the load pocket cannot be transported to serve local loads.

- In the 2003 summer power assessment issued in May 2003 by the North American Electric Reliability Council (“NERC”), SWCT was identified as an area of concern. NERC specifically noted that limited generation resources, compounded by transmission limitations into and within SWCT, make the region particularly susceptible to reliability problems (e.g., rolling blackouts) if there is lower than expected generating unit availability or extreme weather. (NERC Press Release May 15, 2003).
- On April 16, 2004, ISO-NE issued a press release stating:

Southwest Connecticut is the most critical area of concern for New England’s bulk power system. This area lacks the required transmission infrastructure needed to ensure a reliable system for its electric customers. The existing transmission system in that region can neither accommodate significant generation expansion nor fully utilize the area’s generating resources during times of need. During high use periods in the summer, the situation is so acute that the loss of a single major transmission line or power plant in Southwest Connecticut could lead to the disruption of electricity supply.
- In his November 17, 2004 remarks to the Connecticut Power and Energy Society, ISO-NE President and CEO Gordon van Welie stated:

Southwest Connecticut does not have enough generation, or ways to import it, to serve customers reliably. Existing generators have attempted to put up the “going out of business sign” – but the ISO won’t allow them to. There isn’t any replacement for the energy needed to serve large businesses and growing consumer demands – nor is there any on the horizon. The transmission system that carries the needed energy is already loaded to its limits – there is simply no more room on the lines to support these needs.

As recognized most recently in the 2004 Regional Transmission Expansion Plan (“RTEP04”), the most reliable long term solution to these problems is the construction of a 345-kV transmission “loop” that would fully integrate SWCT and the Norwalk–Stamford Sub-area into the New England 345-kV network. The first leg of the 345-kV loop is a 345-kV line between Plumtree Substation and Norwalk Substation. The Company initially concentrated on obtaining siting approval, section 18.4

approval, and related approvals for the Bethel-Norwalk segment of the loop for the following reasons:

- the need for additional power transmission transfer capacity across the SWCT and Norwalk-Stamford interfaces is acute;
- the Project's relatively short length of 20.4 miles and predetermined terminal point locations based on existing substations (Plumtree Substation and Norwalk Substation) were advantages for siting and construction;
- the Plumtree-Peaceable-Norwalk 115-kV line, which would need to be interrupted for construction activities for the Project, is the most lightly loaded of the five 115-kV lines that presently supply the Norwalk-Stamford Sub-area; and,
- the construction of a new 345-kV line to Norwalk will provide a platform for completing the 345-kV loop because it will provide a stronger source into the SWCT and Norwalk-Stamford Sub-areas, and will allow for outages on 115-kV lines that will have to be removed from service during the construction of the next leg of the loop. The completed 345-kV loop would allow electricity to flow more freely into and out of SWCT from other areas of the New England and New York electric grids.

1.2 Brief Description of the Project

In order to address SWCT's critical reliability issues, CL&P will construct a new 345-kV transmission circuit with at least 1,200 MW of emergency capability from Plumtree Substation to Norwalk Substation. In addition, sections of the existing overhead 115-kV transmission circuits between these two substations will be reconstructed as necessary to construct the 345-kV line, without reducing the capability of those 115-kV circuits.

The proposed route traverses developed areas of SWCT through the towns of Bethel (the location of Plumtree Substation), Redding, Wilton and Norwalk. In order to minimize impacts to historic districts and schools, to avoid condemnation of homes and other property, and to construct the Project as soon as possible, the Project uses a combination of overhead and underground technologies in constructing the new 345-kV line and modifying portions of the existing 115-kV lines. The schematic diagram and geographic map in Figures 1-2 and 1-3 at the end of this section

provide an outline of the proposed route and the 345-kV and 115-kV overhead and underground line work to be completed within each segment of the route. The new 345-kV line will include 8.6 miles of new overhead construction and 11.8 miles of 345-kV underground cables. The Company will utilize 345-kV high-pressure fluid-filled (“HPFF”) cable systems for the majority (approximately 9.7 miles of the 11.8 miles) of the underground portion of the route of the new 345-kV line, and 2.1 miles of 345-kV XLPE cables for the first portion of the route south of Plumtree Substation. The modifications to existing 115-kV lines include overhead reconstruction of 1.8 miles of these lines on an expanded right-of-way (“ROW”) to accommodate the new overhead 345-kV facilities, as well as relocation of approximately 7.8 miles of existing 115-kV line segments underground, primarily in public roads.

At Plumtree Substation, the Company will construct a 345-kV outdoor gas-insulated substation (“GIS”), including switchgear and equipment that allows for the transition from SF₆ bus to existing open-air 345-kV lines and bus. A GIS design was required because the space for expansion is severely constrained by adjacent wetlands. At Norwalk Substation, the Company will install an indoor 345-kV GIS system, autotransformers, a relay/control enclosure, battery enclosures, three underground 115-kV line sections, a fourth 115-kV switchyard bay, and a 345-kV line terminal structure. It is also necessary to replace a 115-kV line series reactor and 115-kV capacitors. The limited property available to support new facilities at Norwalk Substation, which is bounded by the Norwalk River and Route 7, dictated the selection of the GIS design. In addition, 345-kV line transition stations will be constructed in Bethel, Redding, and Wilton at points where the 345-kV line transitions from overhead to underground construction. A detailed description of the substation and transition station work is provided in section 5.4 below.

1.3 Project Schedule

The current goal for the in-service (“ISD”) date of the Project is the 4th quarter of 2006. This ISD is based upon the following projected timeline for Project activities.

- Norwalk Substation construction started in late December 2003. By the end of 2004, all site work will be complete. Construction of the GIS began in the 4th quarter of 2004. The complete cut-over will take place in the 2nd half of 2006.

- Plumtree Substation construction began in mid 2004. The GIS is under construction and will be completed by July of 2005. The 345-kV XLPE cables and 345-kV shunt reactor will be installed at Plumtree Substation in the 3rd quarter of 2006.
- Installation of 115-kV XLPE cable will be conducted from mid - March 2005 to February 2006 with all construction in roadways from March to December 2005.
- Installation of the 345-kV HPFF cable must begin in March of 2005 in order to be completed by the summer of 2006.
- The 345-kV XLPE cable segment in Bethel will have to be installed in the spring and summer 2006 to avoid conflicts with activities at the Bethel Educational Park.
- Construction of the three transition stations (Hoyts Hill Road in Bethel; Archers Lane in Redding; and Norwalk Junction in Wilton) will begin in the summer of 2005. Work on the Norwalk Junction transition station cannot commence until the Company receives a stream channel encroachment permit from the Connecticut Department of Environmental Protection. An application for this permit has been filed, and the permit is expected to be issued by summer 2005.
- The three segments of new overhead 345-kV lines will be built as soon as the 115-kV underground cable segments are energized. Once the underground cables are installed and the combined 115-kV underground–overhead circuit is placed in-service, the de-energized 115-kV overhead lines can be removed to make room for constructing the 345-kV overhead line on the existing ROW. This removal work will start in the spring of 2006.

1.4 Project Cost

The total estimated cost for the Project and ancillary work is \$357 million, comprised of \$350 million for the proposed Project facilities between Bethel and Norwalk and \$7 million for ancillary work at other locations. The Project has been divided into the following eight components for purposes of subcontracting and cost estimates:

- Norwalk Substation
- Plumtree Substation
- 115/345-kV overhead lines
- 115-kV XLPE cable

- 345-kV XLPE cable
- 345-kV HPFF cable
- Transition Stations (Hoyts Hill, Archers Lane, Norwalk Junction)
- Ancillary facilities

Cost estimates are provided in Appendix A.

1.5 FERC Orders Concerning Regional Cost Support for the Bethel-Norwalk Project.

The Bethel-Norwalk Project is one of the SWCT reliability upgrades included in RTEP02. Under a series of orders beginning with FERC’s December 20, 2002 order in *New England Power Pool et al*, 101 FERC ¶61,344 (2002), FERC has confirmed that the RTEP02 upgrades, including the Bethel-Norwalk Project, are eligible for regional cost support. The Company is submitting this application for regional cost recovery in order to provide detailed information regarding the Project and its underlying costs for purposes of review by ISO-NE under the 12C Transmission Cost Allocation ("TCA") Process.

On December 2, 2004, FERC confirmed that it had determined that the Bethel-Norwalk Project is eligible for regional cost support under the Schedule 12C process. Specifically, FERC stated in its order that:

43. In filing the TCA Amendments, NEPOOL and ISO-NE state, with regard to "upgrades located in Southwest Connecticut as identified by ISO-NE in RTEP02," that "[t]he principles and recommended methodology [of this filing] would provide regional cost support to needed transmission upgrades that are 115 kV and above and that meet certain functional criteria. The upgrades for Southwest Connecticut meet these criteria." Thus, ISO-NE proposed to provide regional cost support for 100 percent of the costs of the SWCT upgrades.
44. Because the Commission has approved the TCA proposal, including accepting ISO-NE's and NEPOOL's proposal to provide regional support for the costs of the SWCT upgrades, we find that the appropriate allocation formula for upgrades for SWCT is, as NEPOOL and ISO-NE have stated, 100 percent regional cost support.

New England Power Pool et al, 109 FERC ¶61,252 (2004), Para. 43, 44 (Footnotes omitted).

Most recently, in its Order Granting Clarification issued January 5, 2005, FERC confirmed that the “schedule 12C procedures on file in the NEPOOL OATT apply to the planned Southwest

Connecticut upgrades.” Under the relevant FERC precedent, the Company submits that this Project is eligible for full regional cost recovery both as an RTEP02 designated project and as a regional benefit upgrade, subject to ISO-NE’s review of the information provided regarding the Project and in accordance with the requirements of the Schedule 12 C process.

1.6 The Project Qualifies for Full Regional Cost Support Pursuant to Schedule 12C and ISO-NE Planning Procedure No. 4.

In accordance with the Company’s understanding of the guidelines set forth in Schedule 12C of the NEPOOL Tariff and NEPOOL/ISO-NE Planning Procedure No. 4, the Company believes the socialization of the entire cost of the Project to be appropriate.

This Application provides detailed information regarding the following matters in support of the Company's position that the Project is eligible for full cost recovery on a regional basis:

- the development of the system solution for the SWCT reliability issues, namely, the 345-kV loop;
- the need for the Bethel-Norwalk Project and the reliability benefits it will provide;
- a review of system alternatives and 115-kV transmission alternatives that were considered and rejected because they were not feasible and practical alternatives;
- a detailed description of the Project and ancillary facilities;
- a comparison of the Project with an overhead 345-kV transmission alternative, including a discussion of why the Project is the only feasible and practical transmission alternative; and,
- cost tables for the Project, the overhead transmission alternative, and the ancillary facilities.

2. Development of the System Solution to SWCT's Reliability Needs: The 345-kV Loop

2.1 Introduction

The existing electric power system in SWCT does not meet national and regional reliability performance standards. The transmission system studies performed in accordance with the section 18.4 of the Restated NEPOOL Agreement (RNA) identified system contingencies that could result in thermal overloads and the propagation of voltage collapse outside of SWCT and into the New England region. The system deficiencies arise from the following factors.

- Lack of adequate transmission: The region is not served by an interregional 345-kV transmission grid.
- The development of new generating plants is restricted by transmission constraints.
- The 54-town SWCT area continues to experience peak customer demands for electricity that exceed existing transmission service capabilities and peak demands are forecasted to grow.
- There are existing generation and transmission system interdependencies that restrict the full dispatch of generation resources to serve the customer demand for electricity.
- Legislative and regulatory requirements are imposing higher environmental standards on existing fossil fuel (oil and coal) generating plants, and these standards may have an adverse impact on the long-term operation and viability of these plants.
- Deregulation of generation and the implementation of a competitive generation marketplace, without adequate transmission infrastructure, is fueling a significant number of reliability must-run contract (RMR) proposals between existing generators and ISO-NE. These RMR contracts reduce competition and result in additional costs to transmission load.
- There is uncertainty surrounding the long-term operation of existing generation due to economic concerns.
- Dense development in SWCT makes it difficult to site large new generating plants in close proximity to populated load centers.

2.2 History of the Development of the 345-kV Bulk Power Grid in New England

In the 1960's, New England's electric utilities envisioned a transmission grid that could serve New England well into the next century designed initially around eleven large and strategically located generating stations. These stations would be interconnected via a 345-kV transmission grid that could deliver large amounts of power within and between the New England states. It was called the "BIG 11 POWERLOOP".

The "BIG 11 POWERLOOP" was based on a concept of large central generating stations dispersed throughout New England and interconnected by a series of major transmission lines. These lines allow for the back and forth transmission of power if one or more of the large generating units are out-of-service. Based on forecasted loads at the time, the distances involved and the relatively large sizes of the generating units, the system voltage chosen to perform this function in New England was 345 kV. This voltage was selected because it provided the capability to reliably move significantly larger amounts of electric power over greater distances than the existing 115-kV system, and could perform this function more efficiently. With the establishment of this plan, 345 kV was designated as the extra high voltage (EHV) transmission system of the future for New England.

The subsequent completion of the "BIG 11 POWERLOOP" connecting new, large generation plants throughout New England fulfilled the need originally envisioned, enabling utilities in the region to participate in remote generation projects and to move large amounts of power more efficiently across greater distances. Underneath this 345-kV system, which utilities consider to be the true regional bulk power transmission grid, lies a 115-kV transmission network moving power from take-off points for delivery to cities and towns and interconnecting smaller power generating stations. Older interstate 115-kV transmission interconnections still exist, but they play only a limited role in regional transfers.

CL&P's proposed system plan is to extend the 345-kV transmission grid into SWCT by constructing a 345-kV loop. A loop enhances the reliability of the transmission system. The integrated 345-kV bulk power system in New England is primarily constructed in a series of "loops" so that 345-kV transmission service can be maintained to an area following an interruption of one "leg" of the loop.

CL&P's existing 345-kV transmission systems include several interconnected loops within Connecticut, and portions of loops that extend beyond Connecticut as interstate ties with 345-kV transmission systems in Massachusetts, New York, and Rhode Island. Virtually all of the load centers in central and eastern Connecticut are connected to one of these 345-kV loops.

The Project is a continuation of the overall "BIG 11 POWERLOOP" plan that was envisioned to establish a comprehensive 345-kV transmission grid. In the late 1960s and early 1970s, transmission planners determined that a 345-kV loop would be needed to serve the long-term electric needs of SWCT. The implementation of this plan began in 1975 when the Connecticut Siting Council approved the construction of a 345-kV line between Long Mountain Substation in New Milford and Plumtree Substation in Bethel.

From the mid 1970s until the late 1990s, load growth rates fluctuated in SWCT and local area generation control was maintained and operated by CL&P. Utility-owned generation was scheduled to be available during high and peak load periods as well as during high maintenance periods; this allowed CL&P to plan and rely on certain amounts of this generation and on the capabilities of the existing 115-kV system together to meet customer demands for electric power. The 1998 Electrical Restructuring Act required CL&P to divest its generation units, which reduced CL&P's ability to rely on generation. During the 1980s and early 1990s, the Company pursued a program to meet incremental capacity and reliability needs in SWCT through more than 30 projects to reinforce the 115-kV system while relying on local generation for support. CL&P's long range plans, however, were never abandoned and consistently projected the need for 345-kV expansion in SWCT.

2.3 Current and Projected Conditions in SWCT

New England Load:

The NEPOOL 2003 Capacity, Energy, Load and Transmission (CELT) Report, issued in April 2003, predicted a New England summer peak load (adjusted reference load) of 25,690 MW in 2004 and 27,820 MW in the year 2010. The adjusted New England load forecast contained in the CELT report is based on normal weather and a 50% probability of being exceeded. If the probability of exceeding the forecast peak demand is reduced to 10%, the CELT report forecasted a peak 2004

New England summer demand of 26,300 MW. Power flow analyses in support of the 18.4 application for the Project utilized the 2003 CELT forecast.

It is good utility practice to consider a range of forecasted peak demands in selecting a design basis load level. The design basis peak New England demand level used in the study is 27,700 MW. This is based on the 2003 CELT report that predicts a 2010 peak demand of 27,820 MW with a 50% probability of being exceeded. However, considering a 10% probability of exceeding the forecasted peak demand, this load level would be reached as early as 2006. Therefore, studying a peak load level of 27,700 MW is reasonable by covering a range of possible weather variations that can influence peak demand levels.

The power flow analyses include testing at a light load level of 11,400 MW to ensure that the adequacy and security of the transmission grid are maintained under a wide-range of operating conditions.

Load distribution modeling at individual substations is based on local metering data. Load power factor levels for all forecasts are modeled at values consistent with local standard design practices.

Connecticut/Southwest Connecticut/Norwalk-Stamford Load:

CL&P annually prepares a forecast of the loads and resources in Connecticut. In 2004, the Company filed with the Connecticut Siting Council the most recent annual report on loads and resources: *The Connecticut Light & Power Company's "2004 Forecast of Loads and Resources for 2004-2013"*. Forecasts attempt to predict peak load levels that system planners must anticipate. Since the load can vary dramatically with weather conditions, and precise long term weather forecasts are not possible, the Company considers both historical average and extreme weather conditions in its forecasts, and predicts probable peaks based on a range of possible future loads. The system must operate reliably not just in average weather conditions, but in extreme weather as well.

History demonstrates that peak loads are very sensitive to weather conditions, so that in any given year, the peak may vary considerably. For instance, in March of 2002, the Company's forecast based on average weather predicted that its system peak load would not reach 5,169 MW until 2011; but that load was actually exceeded during the summer of 2002 - almost as soon as the forecast was

made, and nine years ahead of the predicted date. That was principally because of the extremely hot weather during the summer of 2002. (The Company's 2002 summer peak load was 5,183 MW.)

The Company's energy growth is forecast at 1.9% per year for the 2003 - 2013 periods. This energy forecast reflects moderate economic growth in Connecticut, moderate gains from economic development and significant savings from demand side management programs (i.e., energy conservation). The weather-normalized summer peak is forecast to grow at 2.2% annually for the 2003 – 2013 periods. The forecasted peak growth rates are significantly affected by the weather impact such as in 2002, so the growth rate of energy output requirements more accurately describes the growth of electric usage in CL&P's service area.

SWCT can be roughly described as the area south of Route I-84 and west of Route I-91 between Meriden and New Haven. The peak demand in this area accounts for almost half of the peak load in the state of Connecticut. This densely populated load pocket is one of the fastest growing and economically vital regions in the state. SWCT is the largest load pocket in New England without 345-kV interregional transmission service capability. The Norwalk-Stamford Sub-area is contained within SWCT and is electrically remote from the integrated bulk 345-kV transmission grid. The power flow analyses modeled SWCT peak demand in excess of 3,900 MW. Correspondingly, the Norwalk-Stamford Sub-area peak demand was modeled in excess of 1,300 MW. These peak demand levels assume continuation of the Conservation and Load Management programs by CL&P and The United Illuminating Company ("UI") and the impact of these programs on customer energy demands.

Figure 1-1 identifies the fifty-four towns in SWCT including the Norwalk-Stamford sub-area, as defined in RTEP04.

2.4 Existing Transmission System

Electric transmission service in Connecticut is primarily provided by CL&P and UI. The Connecticut transmission network consists of approximately 398 miles of 345-kV, 5.8 miles of 138-kV, 1,300 miles of 115-kV, and 104 miles of 69-kV transmission lines. Eight existing bulk power substations (Montville, Card, Manchester, Southington, Frost Bridge, North Bloomfield, Plumtree

and East Shore) are equipped with autotransformers that convert electric energy from 345 kV to 115 kV. These bulk power substations deliver energy into the 115-kV transmission system that is distributed to numerous local area load serving distribution substations.

Connecticut's existing 345-kV transmission facilities are vital links to the region's interconnected bulk power electric transmission grid. The Connecticut 345-kV transmission system ties bulk power substations to large generating stations and to three transmission tie lines that connect to the 345-kV systems of other utilities serving New England and New York State; including National Grid, the Western Massachusetts Electric Company (WMECO), and Consolidated Edison of New York (Con Ed). In addition, a high voltage direct current line connects the New England 345-kV system to the Long Island Power Authority.

Connecticut's transmission network also has five lower voltage tie line connections with neighboring utilities. These tie lines operate at voltages from 69 kV to 138 kV and link the Company's facilities to the facilities of National Grid, Long Island Power Authority, Central Hudson Gas & Electric Corporation, and WMECO. Connecticut's tie lines to neighboring electric systems provide customers with improved reliability benefits under both all-lines-in and contingency conditions. Figure 2-1 is a geographical map showing the main electric systems of Connecticut.

The SWCT load area is supplied via a 115-kV transmission system that ties to the 345-kV Connecticut transmission grid primarily via existing autotransformers at the Plumtree, Frost Bridge, Southington and East Shore substations. Multiple overhead 115-kV lines exit these substations and transmit power into the SWCT load pocket. The Connecticut 345-kV transmission grid does not penetrate the high load density area between New Haven and Greenwich. The 115-kV transmission system integrates local generating resources and brings power into the SWCT area.

Three corridors within the SWCT area serve the Norwalk-Stamford Sub-area, one originating from the Plumtree Substation, one from Devon Substation, and one from Pequonnock Substation. These corridors are the major transmission paths and the primary links to this sub-area. Figure 2-2 shows the major SWCT Connecticut right-of-way corridors.

Transmission lines into this area have been reconducted to increase their current carrying capability. These transmission lines have conductors ranging from 4/0 copper to 1590-kcmil Aluminum Conductor Steel Reinforced (ACSR). ACSR became the conductor of choice in the 1950's due to its strength, durability and lower cost, as well as the higher current carrying capacities of sizes larger than were available in copper.

Some of the transmission lines into the area have larger conductors than others, some structures support one line, others support multiple lines, and some lines are tapped at intermediate locations to serve distribution substations. These existing transmission corridors are a primary asset for reinforcement plans to address power system needs.

2.5 Existing Generation Facilities

Connecticut's large generating units are connected to the network at two transmission voltage levels.³ The Middletown 4 (located along the Connecticut River), Millstone 2 & 3 (located on Long Island Sound), and Lake Road generating plants are directly connected to the existing Connecticut 345-kV transmission grid. All other major generating stations are directly connected to the 115-kV transmission system throughout the state. Major generating stations (> 20 MW) located within the Norwalk-Stamford Sub-area are Cos Cob, Norwalk Harbor and Bridgeport RESCO. Major generating stations operating within the SWCT area include those in the Norwalk-Stamford sub-area, plus Bridgeport Energy, Bridgeport Harbor, Devon, Milford, Wallingford, Rocky River, Shepaug and Stevenson. In the study, the proposed power plant at Meriden is also assumed available for dispatch. However, financial conditions have prevented the developers/owners from constructing or operating this plant.

Figure 2-3 summarizes the dispatch scenario used for major generating units and corresponding New England interface transfers modeled in the analyses. The “Base” dispatch scenario was used for the analysis in support of the 18.4 application for the Project (proof of no adverse impact).

The reports titled: “Southwest Connecticut Electric Reliability Study, Volume I, 345-kV Plumtree – Norwalk Project Final Power-Flow, Voltage and Short-Circuit Report”, dated November 11, 2003

³ CL&P divested its generation units pursuant to the Electrical Restructuring Act passed in 1998 by the Connecticut Legislature. It no longer owns any generation units.

and “Southwestern Connecticut Electric Reliability Study”, dated December 2002 contains various dispatch scenarios that represent a wide range of potential unit commitments under NEPOOL’s standard market design. The generation dispatch levels represent stressed conditions as required by reliability standards. The intent of maximizing power transfers across key transmission lines in SWCT is to examine the ability of the area to reliably serve customer peak demands under widely varying operating conditions.

Dispatches 2 through 5 were used to evaluate the need for further improvements in SWCT following the construction of the Project by stressing the Norwalk-Stamford and SWCT interfaces from different directions. Dispatch 2 stresses the SWCT interface and Norwalk-Stamford interface by transporting most of the power from generation outside of SWCT. Dispatch 3 stresses the Norwalk-Stamford interface from the east by running heavy generation at Devon and Pequonnock. Dispatch 4 unloads the Norwalk-Stamford and SWCT interfaces by running most generation in these areas. Dispatch 5 evaluates the condition where there is heavy generation at Norwalk, and lighter generation at Devon and Pequonnock. Results of contingencies tested against dispatches 2-5 can be found in the subject reports.

Since these transmission reliability reports were finalized, Devon 7 and 8 have been placed on deactivated reserve under NEPOOL rules and procedures at the request of the unit owner. At the Devon Substation, offsetting generation dispatch capacities can be assumed using the recently added local generation at Milford.

Figure 2-4 is a one-line diagram of the existing SWCT transmission system.

2.6 Designing the Solution to SWCT’s Reliability Needs: The 345-kV Loop

The Project is the first phase of an overall plan to build a 345-kV loop across the SWCT interface into the Norwalk-Stamford Sub-area to improve the reliability and efficiencies of the transmission grid. The 345-kV loop will provide high capacity 345-kV lines that reduce overloads on existing over-stressed 115-kV transmission lines. In effect, the 345-kV lines become the critical main highways to transfer power into and around the area. The 115-kV lines become the true secondary routes, transferring power to the local distribution substations.

The 345-kV loop as contemplated in the early 1970's remains the preferred system solution today to adequately address the reliability problems in SWCT. In 2003, the Connecticut Siting Council issued a certificate of environmental compatibility and public need in Docket 217, approving the construction of a new 345-kV transmission line that will provide bulk power transmission from Plumtree Substation in Bethel south to Norwalk Substation in Norwalk. The Middletown-Norwalk Project, which is pending before the Connecticut Siting Council, would complete the loop by providing 345-kV service to Norwalk from central Connecticut and from intermediate points in Milford and Bridgeport.

The 345-kV loop is designed to accomplish the following goals:

- eliminate line overloads in SWCT;
- eliminate the possibility of a system voltage collapse following cascading outages;
- limit any increases in short-circuit levels to avoid short-circuit duty problems;
- be capable of maintaining system stability following contingencies;
- minimize right-of-way expansion and land acquisition;
- allow the economic dispatch of generation within SWCT over a wide range of customer energy demands;
- permit the interconnection of new efficient generation in SWCT;
- allow the building of needed facilities without undue risk of interrupting customer service;
- be feasible to site and construct on reasonable timetables;
- minimize system losses;
- minimize congestion costs while constructing new, or modifying existing, substation and transmission line facilities;
- provide a safe work environment;
- minimize adverse environmental effects across SWCT; and,
- provide needed system improvements at a reasonable cost.

Identifying the Best Strong Source

In the design of the system solution, the Company identified the strongest sources of power available for transmission into SWCT, and considered potential terminal points (i.e., junction points, substations, and switching stations) that could be connected to form a loop in order to address the reliability problems in SWCT. The Norwalk Substation located in the heart of the Norwalk-Stamford and SWCT areas, is the obvious terminal point for any new transmission line designed to provide additional supplies into SWCT. The originating 345-kV terminal points to serve the Norwalk Substation need to consider a wide-range of reliability benefits.

Initially, the consideration of alternative transmission plans included the determination of a best strong source. A strong source for electric energy can be defined as a location where significant generation supply is available via multiple and independent transmission interconnections. Transmission supply options were evaluated from several source locations inside and outside the SWCT area, including the following:

- Frost Bridge Substation;
- Southington Substation;
- Plumtree Substation
- Devon Substation;
- Pequonnock Substation;
- East Shore Substation; and,
- Middletown Area (Beseck).

A substation or switching station is a strong source if it is electrically close to multiple large central generating stations and transmission interconnections, each of which is in turn served by separate transmission lines or loops. A weak source, by contrast, is electrically further from significant generation resources and has fewer or restricted transmission interconnections. If that same substation were served from two different directions by two separate 345-kV lines that did not have a common source, the substation could be considered a stronger source. If the substation was electrically close to several major generating stations and was also served by multiple looped 345-kV lines from different directions and on separate rights-of-way, it would be considered a very strong source.

All transmission facilities must be designed with the capability to operate effectively under a wide range of system conditions. Small and moderate changes in system conditions will have a negligible impact on the performance of a strong source. The electric system will continue to reliably transmit electricity because strong sources can be highly integrated into the transmission network and close to multiple generation resources. Strong sources provide the capability for high power transfers and stabilization of potential line overloads and low voltages, thereby significantly reducing the risk of customer outages. On the other hand, small changes in system conditions can have significant impacts on performance if an area is served by a weak source. These impacts can include line overloads, voltage violations, and the risk of blackouts. Strong sources have the ability to transfer larger amounts of power, and to provide voltage control and system stability during normal conditions with various generation dispatches, as well as during emergencies.

From a transmission system planning standpoint, a critical goal of power system design is to access multiple generation resources and to reliably transmit that generation to the load. To accomplish that goal:

- *Build transmission loops.* A looped system is better than a radial line because it is more reliable and can withstand system contingencies without system interruptions.
- *Diversify transmission sources.* No large load center should rely on a single source of power. Access to multiple transmission interties is important, both for maintaining system operations and for future expansion opportunities.
- *Diversify generation sources.* Generation sources change over time. A transmission system should not depend on a single generating station. This is particularly important in a restructured competitive generation marketplace.
- *Utilize Regional Interconnections for Enhanced Reliability.* Transmission connections to other Control Areas or states improve the reliability and robustness of the transmission system. Connecticut's 345-kV system interconnects with three other states (Massachusetts, Rhode Island and New York).

- *Use High Voltage Lines.* High voltage transmission lines can serve more customers more efficiently.
- *“Don’t put all your eggs in one basket.”* A power system should be designed so that the loss of one substation or transmission line does not result in the catastrophic loss of other substations or lines.

Frost Bridge

The Frost Bridge Substation is a relatively weak source. It is remote from large generating plants both inside and outside of Connecticut. This substation also has inadequate voltage regulation to handle the demands of the SWCT load and is prone to be isolated as a radial supply from New York under contingency conditions and during maintenance. This means that the transmission of power into SWCT would be put into jeopardy under a number of operating conditions if Frost Bridge were used as the primary source for a new 345-kV transmission line into SWCT. For example, the loss of the 345-kV line (the 329 line) from Southington Substation to Frost Bridge Substation would result in both Plumtree Substation and Frost Bridge Substation being fed by a single radial line from New York through the Long Mountain Switching Station in New Milford. Should the transmission line between the Long Mountain Switching Station and New York be lost during this period, both Plumtree and Frost Bridge Substations would lose their only 345-kV source from the bulk power system.

Southington

The Southington Substation is a 345-kV source that is more integrated into the bulk power system than Frost Bridge. It is directly connected to the Millstone Generating Station by the 345-kV Millstone – Southington line (348 line) and to the two generating units at Montville Generating Station and the AES Thames Generating Station by the Montville – Haddam Neck and the Haddam Neck - Southington 345-kV transmission lines (364 and 362 lines, respectively). Upon the loss of the 348 line, Southington would continue to be connected to the Millstone Generating Station through the Millstone – Montville 371 line and the 364 / 362 lines. The 348 line is a direct connection and the 364 / 362 lines connect indirectly through the Haddam Neck Substation. Both Millstone and Haddam Neck substations also interconnect with 345-kV lines extending into Massachusetts and Rhode Island.

However, the transmission sources into Southington Substation are not as robust as for other locations on the Company's system. The two 345-kV lines connecting Southington to Millstone and to Haddam Neck are on a common right-of-way. If both of these lines were out of service together due to a common cause or overlapping outage, then the Southington Substation would be served by a single radial 345-kV line from New York. Under such conditions, Southington Substation would also have inadequate voltage regulation to handle the demands of the SWCT load.

In general, outages in Connecticut that result in CL&P substations being fed solely from the New York transmission system are subject to voltage depressions and reliability concerns. The transmission corridor that connects Connecticut to the New York transmission grid is one of the primary corridors that bring electric energy from upstate New York to the load center in the New York City metropolitan area.

Plumtree

The Plumtree Substation in the Bethel area is a 345-kV source that is in close proximity to the electrical "hub" at Norwalk. This substation is fed by a single 345-kV line from the Long Mountain Switching Station. An outage of one of the east-west transmission lines connected to the Long Mountain Switching Station results in the Plumtree Substation being tied to either the New York system or to the Frost Bridge Substation. This configuration can result in low voltages caused by long radial transmission service with little or no voltage regulation. However, a major advantage of this substation for transmission upgrade plans is the relatively short and direct 20-mile existing transmission corridor leading to Norwalk Substation. The Plumtree Substation can potentially play a bigger role in an overall system plan that could integrate multiple strong sources of electric energy.

Devon & Pequonnock

The Devon and Pequonnock substations have generation resources in close proximity and are electrically close to the Norwalk Substation. These substations do not have 345-kV facilities. However, expanding the transmission facilities from these substations alone does not relieve the thermal overloads and voltage degradations in transmitting power further into SWCT. In addition, new 115-kV transmission facilities will aggravate the short-circuit problems at these locations. A

major reconfiguration of the network would be required to reduce fault-current levels such as isolation of substations from multiple sources of electric energy. Such reconfigurations would most likely result in lower reliability and an overall decrease in system performance.

East Shore

The East Shore Substation is fed by a single 345-kV line from the Scovill Rock Switching Station in the Middletown area. Expanding transmission facilities emanating from this substation would not alone relieve the line overload and voltage problems following the loss of the 387 line. In order to meet national and regional reliability standards, a second 345-kV line would have to be constructed on separate structures within the same ROW occupied by the existing 387 line in order to fully utilize new transmission facilities that could be constructed from East Shore into the Norwalk - Stamford sub-area.

Middletown Area (Beseck)

The Middletown area is at the crossroads of several electric energy resources. The construction of a switching station in nearby Wallingford (Beseck, the Middletown area) would be an electrical hub that would draw upon the strength of a multitude of looped 345-kV lines located on different transmission ROWs fed from large 345-kV connected generation resources. The Middletown area meets all criteria for a strong source: electrical proximity and access to Connecticut generation resources, access to neighboring states' generation resources through multiple tie lines and the availability of multiple and independent transmission interconnections.

A new Beseck Switching Station would be directly connected to Millstone, Southington, and Haddam Neck substations. In those instances when maintenance is being performed on one of the transmission lines to the east (either the Beseck – Millstone or Beseck – Haddam Neck lines) and a fault occurs on the other 345-kV line, Beseck Switching Station would continue to be served from Southington Substation, which will directly interconnect with Haddam Neck Substation and to New York, by way of the Frost Bridge and Long Mountain substations. In addition, Beseck would remain interconnected to the 345-kV bulk power system in Massachusetts and Rhode Island. The location at Beseck offers the opportunity to maximize power transfers and increase voltage control into SWCT. A Beseck Switching Station would best meet the NERC/NPCC/NEPOOL criteria.

In summary, a new Beseck Switching Station in Wallingford would provide the strongest source. Eastern Connecticut is rich in generation resources, and supply from these sources, in Middletown and New London, can be consolidated by reconfiguring the existing 345-kV lines in the Meriden-Middletown area at Beseck. Moreover, this reconfiguration would connect Beseck to all the existing 345-kV tie lines to the neighboring states. Specifically, a Beseck Switching Station would be connected to the tie line from Massachusetts (395 line) through the Scovill Rock Switching Station and Manchester Substation; to the tie line from Rhode Island (347/330 line) through the Millstone, Card and Lake Road Substations; and to the tie line from New York through the existing Frost Bridge, Southington and Long Mountain stations. Thus, a Beseck Switching Station would provide a robust and strong 345-kV source to support a loop into SWCT. In contrast, the Frost Bridge and Southington alternatives would be more vulnerable to contingencies.

2.7 Conclusion

The construction of the 345-kV loop in SWCT will create an integrated transmission grid that can withstand a reasonable level of facility outages and still reliably and economically serve the electrical demands of customers. The need to extend 345-kV facilities into SWCT is supported by the “Southwestern Connecticut Reliability Study Interim Report”, dated January 2002 and the “Southwestern Connecticut Electric Reliability Study”, Volume I, Final Power-Flow, Voltage and Short-Circuit Report, dated December 2002. This design must respect established thermal, voltage, stability and short circuit criteria. The construction of both legs of the 345-kV loop could not be accomplished concurrently. As a result, CL&P separated the system plan into individual segments based on consideration of outage planning for construction and timeliness for need. The Bethel to Norwalk Project is the first step in the construction of the 345-kV loop. Extending the 345-kV system from the Plumtree Substation to the Norwalk Substation will improve reliability, will provide a higher capacity line to this region, and will reduce the high loadings on the critical 115-kV circuits. Beginning the Project in Bethel has the major advantage of a relatively short (20.4 miles) connection into SWCT.

In effect, the 345-kV line will become the main route to transfer power into and around the area, unloading the 115-kV lines. The 115-kV lines will become the secondary routes, transferring power to the local substations. In addition, the Bethel to Norwalk Project will provide the platform needed

for the construction of the second leg of the 345-kV loop. (See Figure 2-5 for schematic diagrams of the Connecticut 345-kV transmission system following construction of the Bethel to Norwalk Project and following construction of the 345-kV loop.) The subsequent addition of the Middletown to Norwalk Project then adds the strong source at Beseck and completes the much needed 345-kV loop.

3. Studies Regarding the Need for and Reliability Benefits of the Bethel–Norwalk Project

3.1 Reliability Issues Over the Planning Horizon

The Company conducted studies to test the system before and after construction of the Project. These studies, which formed the basis for the 18.4 approval granted by ISO-NE, demonstrate that the Project is a first step in addressing the SWCT reliability issues and will provide critically needed relief of power flows on 115-kV transmission paths into and within the SWCT and Norwalk-Stamford areas.

3.1.1 Overview of Contingency Analysis

Consistent with the reliability criteria established by NPCC and NEPOOL/ISO-NE, CL&P assessed the ability of the local area transmission system to withstand contingency outages given projections of peak-load, generator availability and dispatch conditions. The studies show that there are a significant number of transmission elements that would experience overloads under these contingency conditions. The tables set forth below list by sub-area the specific transmission elements affected and the magnitude of the associated overloads at that point.

The Project was tested in accordance with the NEPOOL planning procedures⁴. Power flow analyses were conducted at load levels representing peak and light load periods. Testing also included New England to New York transfers and short circuit analyses were conducted with all facilities in service. These analyses are required to show that the proposed Project will operate reliably in the future under reasonable system conditions.

3.1.2 Contingency Analysis Results

3.1.2.1 Thermal Analysis – Peak (100%) Load

This analysis identifies power flow deficiencies on the SWCT transmission system. The base case generation dispatch scenario includes both Norwalk Harbor units on-line. This dispatch assumption

⁴ See Appendix B for a general discussion of the reliability planning process and reliability criteria

pre-positions the electric system in an operating condition where pre-contingency 115-kV transmission line loadings are below normal ratings. This dispatch was considered to be the optimal dispatch for the pre-Project conditions, where interfaces were stressed to the extent possible and shutting off more units would create additional overloads. This same dispatch was used to analyze the post-Project condition so that a comparison of the impact of the Project could be drawn.

Figure 3-1 contains the results of power-flow analyses performed on the existing transmission system in SWCT. Both 345-kV and 115-kV outages caused post-contingency thermal overload conditions throughout SWCT. The most problematic transmission line corridors are the 115-kV Frost Bridge to Stevenson, Stevenson to Plumtree, and Grand Ave to West River (UI) corridors. These transmission line corridors experience thermal overload conditions up to 140% above emergency ratings.

3.1.2.2 Voltage Analysis

Reliability standards limit voltage depressions on the 115-kV system to 95% of nominal voltage. The report titled “Southwest Connecticut Electric Reliability Study, Volume I, 345-kV Plumtree – Norwalk Project Final Power-Flow, Voltage and Short-Circuit Report”, dated November 11, 2003 identified post-contingency voltage violations in the SWCT area that are unacceptable and may cause widespread outages that could cascade into neighboring areas. The addition of the Project reduced the number of low voltage violations when compared to the pre-Project system.

3.1.3 Transfer Analysis Results

Power Technologies’ Managing and Utilizing System Transmission (MUST) program was used for this analysis and results were confirmed using AC analysis in PSS/E. A variety of generation patterns and system transfers were simulated with its linear FCITC (First Contingency Incremental Transfer Capability) calculation feature, which uses DC analysis. The transfer capability of the pre-Project system was compared to that of the post Project system. Double circuit and 115 kV stuck breaker contingencies were excluded from this analysis and LTE ratings were respected.

Eight (8) power flow cases were set up for pre- and post-Project simulations (utilizing the same case, “Base”, as was used for the thermal / voltage analysis). Each case was a dispatch sensitivity based on various combinations of the Milford, Bridgeport Energy, and Wallingford plants. System performance based upon generation dispatched at Devon and Bridgeport Harbor is equivalent to generation dispatched at Milford and Bridgeport Energy, respectively.

Units in Maine were chosen as source generators for both the SWCT and the Norwalk-Stamford transfer analyses since these were outside the area of interest and would not affect the results. For the SWCT transfer analysis, Bridgeport Harbor units 2 and 3 were chosen as sink generators (units where the output was reduced); for the Norwalk-Stamford transfer analysis, Norwalk Harbor units 1 and 2 were used.

Figure 3-2 contains a summary chart and graphical representation of the transfer analysis. The results show that the Project provides an increase of up to 200 MW of thermal transfer capability into the Norwalk-Stamford Sub-area independent of the status of the Norwalk Harbor generation. This increase is based on an average transfer capability of 1,100 MW pre-Project and 1,300 MW post-Project.

The Project also provides an increase of up to 175 MW of thermal transfer capability into SWCT at a constant Norwalk Harbor generation level (142 MW). This increase is based on an average transfer capability of 2,400 MW pre-Project and 2,575 MW post-Project. In addition, with the Project in service, today’s SWCT transfer limit of 2,400 MW can be maintained even when the Norwalk Harbor units are out of service.

This transfer analysis demonstrates that the Project provides a significant increase in transfer capability across the SWCT and Norwalk-Stamford interfaces.

New York – New England Transfer Sensitivity

Parallel transfer analysis was run using MUST to determine the relationship between SWCT import and NY-NE transfer for pre- and post-Project systems. The baseline system included 2% reactors at Todd and Canal and an upgraded 318/362 345-kV line terminal at Southington (upgrades associated with the Meriden Project).

The SWCT transfer analysis used Bridgeport Harbor units 2 and 3 as sink generators with source generators located in Maine. The NY-NE transfer analysis used generation in northwestern New York against generation in Southeast Massachusetts and Rhode Island (SEMA/RI).

In the New England to New York cases, it was determined that the Project creates a minor limitation between the 600 and 1000 MW export level. Increasing the Canal and Todd reactors from 2% to 3% and upgrading the terminals of the Southington-Millstone 348 line removes this limitation. With these upgrades, the Project improves the New England to New York transfer capability.

In the New York to New England cases, there is a decrease in transfer capability by up to 1000 MW. The reduced impedance from the Long Mountain area down to Norwalk (due to the Project) tends to increase the pre-contingency loading on this 345-kV corridor as opposed to the 115-kV lines coming from the east and northeast into SWCT. The Long Mountain 5T stuck breaker contingency, which removes the 321 and 398 lines from service, causes overloads on the Norwalk Harbor to Rowayton Junction lines and the Norwalk Harbor autotransformer. Installing a 345-kV breaker between the 4T and 8T and re-terminating the 398 line at Long Mountain Substation eliminates the possibility of this contingency occurring. With these upgrades, the Project improves the New York to New England transfer capability.

3.1.4 Summary of Reliability Issues Identified by Contingency Analysis

Power flow analyses indicate both 345-kV and 115-kV outages cause unacceptable post-contingency operating conditions. All the major transmission corridors in SWCT (Plumtree to Norwalk, Norwalk - Norwalk Harbor – Glenbrook, Devon to Norwalk, Pequonnock to Norwalk, Frost Bridge to Devon, East Shore to Pequonnock, and Southington to Devon) experience transmission line power flows above emergency ratings and voltages that fall below acceptable limits. In addition, there are numerous contingencies where a mathematical solution was not obtained. The computer models predict the potential for a SWCT voltage collapse and widespread customer outages (i.e., blackout). The propagation of a voltage collapse cannot be assured to stay within SWCT and could impact neighboring areas and external systems.

The most critical and problematic contingencies are those that involve the loss of two transmission lines sharing common structures. More than 70% of the CL&P 115-kV circuits in SWCT are supported by multi-circuit structures. Unplanned outages of two of these lines can occur due to a shield wire failure, insulator/hardware failures, tower failure, lightning, severe weather, or transportation accident.

The need to significantly reinforce the SWCT transmission system is clear. The correction of only voltage performance cannot diminish the need to provide a transmission system that can carry the expected power flows. The number and magnitude of post-contingency conditions where power flows on 115-kV transmission lines are above emergency ratings, voltage profiles are below limits, contingency cases are not solved (voltage collapse), and short circuit currents are close to circuit breaker interrupting capabilities, illustrate an inadequate electric power system under the forecasted load and system conditions tested.

3.2 Post-Construction System Performance

Figure 3-1 also contains the results of power-flow analyses performed for SWCT following the completion of the Bethel – Norwalk Project, including ancillary facilities. Most post-Project analyses show a decrease or an insignificant increase (< 1%) in post-contingency power flows. A 15% reduction in post-contingency power flow occurs on the 115-kV transmission path from the Frost Bridge Substation to the Stevenson Substation. A 20% reduction occurs on the transmission path from Stevenson to Plumtree. This is indicative of the power injection by the 345-kV system into the Norwalk - Stamford sub-area. The project relieves power transfers on 115-kV transmission lines feeding into the load pocket from the Frost Bridge, Southington and East Shore substations.

Two contingencies showed post-Project increases in power flow on existing 115-kV facilities relative to pre-Project conditions. The 1867 and 1880 double circuit tower contingency resulted in a 4.5% increase in the thermal overload on the Glenbrook to Ely Avenue 1890 line. The 1880 and 1890 double circuit tower contingency resulted in a 20% increase in the thermal overload on the Glenbrook to Rowayton Junction 1867 line. Mitigation of these overloads is required in accordance with Section 18.4 of the RNA. A Special Protection System (SPS) is proposed for the Glenbrook

Substation. The proposed SPS would be armed 100% of the time and triggered by power flows on the 115-kV Glenbrook – Ely Avenue 1890 line and the 115-kV Glenbrook – Rowayton Junction 1867 line. The SPS will trigger on local sensing of power flows above LTE ratings and the outage of the 1867/1880 lines or the 1880/1890 lines, respectively. Operation of the SPS will result in tripping the 1753 – 1K and 1792 – 1K circuit breakers that isolate the Cedar Heights substation load. An additional 25 MW of load isolation at Glenbrook is required to reduce power flows below emergency ratings. Designated distribution feeders associated with the under-frequency load shedding program will also be under SPS control.

The short circuit currents at certain substations in SWCT are very close to existing 115-kV circuit breaker and other equipment capabilities. In general a balance must be maintained between generators connected to the 115-kV system and those on the 345-kV system. Short circuit duties at the 115-kV Pequonnock Substation are critically close to the existing equipment ratings. Due to physical site limitations, replacement of the existing 63 kA breakers at this location is problematic.

The report titled “Southwest Connecticut Electric Reliability Study, Volume I, 345-kV Plumtree – Norwalk Project Final Power-Flow, Voltage and Short-Circuit Report”, dated November 11, 2003 contains the results of single-phase and three-phase short circuit analyses performed on the pre and post-Project transmission system. Due to the lower impedance path of the 345-kV system additions, the short circuit levels at Pequonnock exceed the existing 115-kV circuit breaker and station equipment capabilities. Installing a 115-kV 3% series reactor in the Bridgeport Harbor 2 generator lead reduces short circuit currents into the Pequonnock 115-kV Substation to below circuit breaker and station equipment capabilities. In addition, the 3T, 5T, and 6T circuit breakers at Norwalk Harbor were identified as needing to be replaced with new circuit breakers with an interrupting capability of 63 kA.

3.3 Conclusion

The proposed Project and ancillary facilities achieves the following regional system benefits:

- Injects high voltage power regulation into the center of a critical load pocket relieving power flows on 115-kV transmission paths into and within SWCT and Norwalk-Stamford areas.

- Improves area voltage profiles in the vicinity of Plumtree and Norwalk for post-contingency system conditions.
- Decreases short circuit currents in the vicinity of the 115-kV Pequonnock Substation.
- Increases the SWCT and Norwalk–Stamford transfer limits.

Based on these study results, this Project will not have a significant adverse impact on the reliability or operability of the New England electric power system. The Project is a first step in addressing the SWCT reliability problems identified by ISO-NE in the RTEP process.

4. Alternatives Considered and Rejected as Neither Feasible Nor Practical

Transmission planning is a dynamic process, which must take into account load growth and grid reliability, while also remaining flexible to allow market solutions (e.g., generation, demand response programs) to meet demands for power. In assessing the need for new transmission to serve SWCT, including the Norwalk–Stamford Sub-area, the Company considered the following alternatives, each of which is discussed further below:

- No Build;
- Generation;
- Distributed Generation;
- Demand Side Management, including Conservation and Load Management; and,
- 115-kV Alternatives.

4.1 No Build

Under the “no build” alternative, no new transmission facilities would be constructed. This alternative would not resolve the present and projected criteria violations of national (NERC) and regional (NPCC and NEPOOL) reliability standards on the existing transmission lines in the Project area and would not provide for reliable power transmission to meet existing and projected demands in SWCT, including the Norwalk–Stamford Sub-area.

4.2 Generation

The construction of new generation alone is not a practical and feasible alternative. All existing generation in SWCT, including the Norwalk-Stamford Sub-area, is needed to reliably serve the load in this region. Although generation theoretically could assist in meeting SWCT’s reliability needs, constraints on the existing 115-kV transmission system prohibit the connection of new large generating stations. The ability to connect new generation is severely limited by a combination of thermal, voltage, stability and short-circuit constraints. Moreover, these same limitations prohibit the concurrent operation of all existing generation units in SWCT. There would have to be significant modifications and upgrades to the transmission infrastructure to add additional

generation. Even if new generation plants were to be built, the construction of new generation, without transmission upgrades, is not a complete alternative to the proposed line.

4.3 *Distributed Generation*

Distributed Generation (DG) is broadly defined as modular electric generation or storage, located near the point of electric use, and generally involves the use of small generators to lower end-users' electric purchases and reduce the need for electricity generated by large, centrally located power plants and transported via transmission lines. DG systems are not limited to a particular type of technology or fuel and may include combustion turbines, biomass-based generators, fuel cells, wind turbines, solar power and photovoltaic systems. Further, DG systems may operate independently or be connected to the electric grid (usually at the distribution system level).

In Connecticut, DG resources typically fall into one of two categories:

- Self-generating Units. These units are usually installed at large commercial or industrial facilities, which directly use the electricity generated. Such units are typically operated on a regular basis to displace some portion of the facility's outside electric purchases.
- Emergency Generators. These generators, which constitute the majority of DG in Connecticut, are installed at a variety of institutional and industrial facilities, and are operated only when outside power is unavailable.

Although DG can be used to support the electric system by allowing consumers to produce limited power locally, DG alone cannot provide a practical and feasible solution to the reliability problems in SWCT. The barriers to DG installation and penetration into the marketplace include impacts to air quality from oil-fired generators, coordination with grid operations, constraints on the existing natural gas infrastructure, cost of backup service and rate structure, lack of technology maturation and manufacturing economies of scale for emerging technologies, interconnection standards, and financial barriers. In addition, there are physical limits on distribution interconnection capacity. It is recognized within the industry that DG connected to the distribution system should not exceed 15% of each distribution feeder's capacity.

The Xenergy study of DG in SWCT, commissioned by the Institute for Sustainable Energy and published in January 2003 and subsequently updated in March 2004, concluded that only 51 MW to 260 MW of DG can be expected to be installed in all of SWCT by 2013. The 51 MW was a base case, and the 260 MW assumed technology advances and the adoption of many incentive policies. The Xenergy study concluded that, although DG should be part of the response to SWCT's reliability needs, DG cannot be the exclusive solution and new transmission is necessary to insure reliable electric service in SWCT.

The following table summarizes information from the Xenergy study regarding operating characteristics and costs of various DG technologies:

Type of DG	Size Range (MW)		Electric Efficiency	Installed Cost (\$/kW)	
	Low	High		Low	High
Diesel Engine	0.05	5.0	30-50%	800	1,500
Natural Gas Engine	0.05	5.0	25-45%	800	1,500
Steam Turbine	Any		15-35%	800	1,000
Combustion Gas Turbine	0.5	200.0	25-60%	700	900
Micro Turbine	0.025	0.25	20-30%	500	1,300
Fuel Cell	0.2	2.0	40-70%	>3,000	

4.4 Demand-Side Management

Demand-side energy management alternatives include options for reducing customer demand for electricity through the use of conservation and load management measures (“C&LM”) or demand response programs (“DRP”). C&LM technologies may range from relatively simple residential programs (e.g., Energy Star appliances, high efficiency florescent bulbs, improved heating and cooling systems) to complex manufacturing processes at industrial facilities (e.g., high efficiency cooling/refrigeration or variable speed motors). Under DRP, certain industrial and commercial facilities implement measures, on a voluntary basis, to reduce the load on the electric grid during peak periods.

As recognized by ISO-NE in RTEP02, demand-side management programs can play an important role in reducing load and meeting reliability goals on a short-term basis, but they are not sufficient to replace the transmission solution required in SWCT. Demand-side management programs simply cannot meet the large scale reinforcement needed in SWCT to reliably serve current peak load projections. It would be difficult to compensate for the magnitudes of load growth coupled with potential generation retirements, and would pose substantial implementation difficulties.

C&LM estimated performance for the year 2002 in SWCT produced savings of about 15 MW at a cost of 4.5 million dollars (approximately \$300,000/MW). Most of the savings in peak demand were done through ISO-NE and commercial and industrial customer load reduction programs. As part of its energy efficiency program RFP, CL&P was only able to secure 2 MW of reduction at \$750,000/MW. Despite aggressive efforts, CL&P would only have been able to implement an additional 0.7 MW of load reduction at a cost of \$2 million/MW. In summary, while demand-side management programs are important in reducing energy usage and peak demands on a system-wide basis, they cannot serve to provide the focused load reduction that are required in SWCT.

4.5 115-kV Transmission Alternative

ISO-NE conducted an extensive evaluation of a 115-kV alternative to the Bethel-Norwalk Project involving the construction of two new underground 115-kV lines between Plumtree and Norwalk Substations. (*See* ISO-NE SWCT Comparative Study dated December 2002) ISO-NE compared this “two 115-kV lines” alternative to the Company’s proposal of constructing a new 345-kV line between Plumtree and Norwalk. In this same study, ISO-NE also evaluated a hypothetical transmission expansion plan that would begin with the construction of two underground 115-kV lines between Plumtree and Norwalk substations, and then continue with the construction of a 345-kV line from Norwalk to Beseck, thus reproducing the 345-kV loop, but with the Plumtree to Norwalk segment at 115 kV.

In this study, ISO-NE found that the proposed Project was superior to a two 115-kV line option in that it increased transfer limits to a greater degree and reduced a high number of criteria violations with respect to thermal overloads and voltage depressions. (*See* ISO-NE SWCT Comparative

Study) ISO-NE concluded that: (1) the construction of two new 115-kV lines did not provide a feasible and practical alternative to the proposed Plumtree-Norwalk 345-kV line; and (2) a 345-kV loop, rather than a hybrid “115-kV/345-kV loop” provided the best long term solution to SWCT’s reliability needs.

5. Development and Detailed Description of the Project

Once it identified the need for the Project as the first step in the construction of the 345-kV loop, the Company set to the task of designing the new 345-kV line. In planning the Bethel-Norwalk Project, the Company initially identified three potential construction designs for meeting the reliability needs of the region: (1) an overhead 345-kV line design on an expanded ROW; (2) an underground 345-kV line design in public streets; and (3) an overhead 345-kV line design combined with an underground replacement of an existing overhead 115-kV line⁵. These three designs are discussed in Section 5.2 below. In addition, this section describes why an all overhead alternative was neither feasible nor practical. The proposed Project employs a combination of each of these three basic designs.

As described below, the existing ROW is constrained and poses limitations to the expansion and use of this ROW to build a new 345-kV line between the Plumtree and Norwalk Substations. These constraints and limitations played a significant role in the decision to select a combination of these three basic designs for the Project.

5.1 *Description of Existing ROW*

The existing CL&P ROW between the Plumtree and Norwalk Substations is predominantly 80 feet wide for the 16.9 miles between Plumtree Substation in Bethel and Norwalk Junction in Wilton. Most of CL&P's easements for this ROW were obtained in the 1930s and 1940s. Over this 16.9-mile length, the ROW is presently occupied by a single row of transmission structures supporting one 115-kV line (a section of the Plumtree-Peaceable-Ridgefield 1565 circuit north of Peaceable Substation and a section of the Peaceable-Norwalk-Ridgefield 1470 circuit south of Peaceable Substation). For about 25% of this 16.9-mile distance at its south end, the structures of the 1470 circuit are lattice steel towers and also support the conductors of a local distribution circuit.

⁵ The existing 115-kV line between Plumtree and Norwalk actually consists of two lines (or circuits): the 1470 and 1565 lines. These lines serve the distribution load in Redding and Ridgefield and must stay in place to supply these substations. In addition, the 1470 line must be retained because the planned Wilton Substation will interconnect to this line.

Between Norwalk Junction in Wilton and Norwalk Substation in Norwalk, a 3.7-mile distance, the 1470 circuit and the local distribution circuit are supported on common lattice steel towers, sharing a ROW with a parallel row of lattice steel towers supporting two other 115-kV transmission lines (1637 and 1720 circuits). Over these 3.7 miles, the ROW width varies between 80 and 150 feet. It is 150-feet wide over a 1.6-mile section that was rebuilt with steel-pole support structures during the 1980s when construction of Route 7 forced a relocation of these lines. On the final half mile of the ROW north of Norwalk Substation, all four of the above-named circuits are supported together on common lattice steel structures.

The existing ROW is unsuited for underground line construction because of rough terrain, steep and rocky slopes, and wetlands and watercourses. In places, the ROW cannot be expanded (as required to satisfy National Electric Safety Code clearance requirements) without displacing homes and businesses, and fair market property values in the area are high. The ROW traverses approximately 185 parcels of land, 26 of which are public and private open space land, and 112 of which are residential parcels. In the Town of Wilton, the ROW also passes over or close to three historic districts and abuts a narrow railroad corridor.

The following text describes land uses adjacent to specific segments of the existing ROW, moving north to south.

Segment 1 in Bethel: Plumtree Substation to CT Route 58

This segment is approximately 2 miles long. For about two-thirds of this distance, the ROW is adjacent to residential development and crosses residentially zoned land. This section of the ROW is also within or adjacent to wetlands and watercourses. A few homes are close to the ROW, including one which would require removal for a ROW expansion. (See photograph in Figure 5-1.) Over the remainder of this distance, the ROW traverses the David W. Deakin Educational Park where it crosses two school parking lots, a skateboard park, and is in close proximity to an elementary school and a middle school and their sports fields. (See photographs of school complex in Figures 5-2, 5-3, and 5-4) Portions of the Deakin Educational Park property are limited to open space recreational uses under a state land grant and would require state approval for use as part of an expanded ROW.

Segment 2 in Bethel and Redding: CT Route 58 to Crossing of Gallows Hill Road

This segment is approximately 3.6 miles long (2.1 miles in Bethel and 1.5 miles in Redding). In Bethel, the ROW passes through private and town-owned forest land and over a horse farm pasture. The ROW is immediately proximate to residential development at two road crossings that are close together, and ROW expansion is limited to 135 feet in this area. In Redding, the ROW traverses two open space land areas and rural forested land on a ridge. Several residences are adjacent to the ROW at three local road crossings. Large homes abut and surround the ROW on John Todd Way and Costa Lane. Archaeological resources from a Revolutionary War encampment are found in this segment of the ROW near Gallows Hill Road.

Segment 3 in Redding: Crossing of Gallows Hill Road to Vicinity of Archers Lane

This segment is approximately 1.3 miles long. The ROW traverses three large parcels of land owned by CL&P, a water company, and the Town of Redding, respectively. The Town's parcel is designated as the Saugatuck Falls Natural Area. A small number of residences abut the ROW at each end of this segment. The route also crosses CT Route 53 and the Saugatuck River where the existing line descends from the ridge to land at a lower elevation. The adjacent land is largely forested.

Segment 4 in Redding: Vicinity of Archers Lane to Peaceable Street Substation

This segment is approximately 2.4 miles long. For about 75% of this distance, the ROW traverses areas of residential development on both sides. These residences are found on Granite Ridge Road, Umpawaug Road, Windy Hill Road, Quarry Rock Road, Seventy Acre Road, Indian Hill Road, and Peaceable Street. Over the remaining 25% of this segment, adjacent land is undeveloped, forested and owned by the Redding Land Trust.

Segment 5 in Redding, Weston and Wilton: Peaceable Street Substation to Mather Street/Honey Hill Road

This segment is approximately 2.7 miles long. The ROW crosses within the boundary of the Georgetown Historic District for ¼ mile, and the adjacent land over this entire distance is forested, hilly and sparsely populated. Houses are located close to the ROW at the crossings of CT Route 107 and old CT Route 57, and also along Upper Parish Drive in Weston and Mather Street at Honey Hill Road. Two houses on Upper Parish Road would have to be acquired and removed if there were

any westerly ROW expansion. A few other residences and two complexes for senior housing are all more than 200 feet from the ROW. On Honey Hill, the ROW traverses Wilton's recycling and refuse transfer station.

Segment 6 in Wilton: Mather Street/Honey Hill Road to Norwalk Junction

This segment of the existing ROW is approximately 4.2 miles long. Over this distance the ROW parallels the Metro-North Danbury Branch railroad corridor and abuts this 33-foot wide corridor for most of this section. Near the north end of this segment, the ROW traverses the Cannondale National Register Historic District for about 1 mile. Within this district, the existing line passes directly over two historic buildings. (See photograph in Figure 5-5.) Thirty-eight of the hundreds of historic properties in this and other historic districts along the route are within 500 feet of the existing ROW. (See photographs in Figures 5-6 and 5-7 for examples.) This historic district is over 1/3 mile wide at its widest point. In addition, the historic district is bounded by conservation land, aquifer along the Norwalk River floodplain, intensive development in the valley area, and moderate residential development along the steep terrain that borders the valley.

If the existing ROW within the Cannondale Historic District were expanded to accommodate construction of an overhead 345-kV line, the ROW would encompass as many as seven buildings and several outbuildings in this area.

Just south of the Historic District is a 0.8-mile stretch of ROW where Pimpewaug Road runs parallel to the railroad corridor. Over this stretch, the ROW moves away from the railroad corridor to the opposite side of Pimpewaug Road in two locations. The ROW closely abuts several houses in this area, one or two of which would have to be removed for a ROW expansion to accommodate an overhead 345-kV line. (See photographs in Figures 5-8 and 5-9.) The ROW also crosses a sawmill property at Pimpewaug Road and CT Route 7. Moving south from this intersection, the ROW passes just east of the boundary of the Wilton Historic District, and over a distance of approximately 0.8 miles it squeezes between heavily traveled CT Route 7, the railroad corridor, and the Norwalk River. (See photographs in Figures 5-10, 5-11, and 5-12.) A ROW expansion to 125 feet in this segment would encompass a railroad station building, and up to 10 residential and commercial buildings. Two commercial buildings are crossed by the existing 115-kV line. For the

remainder of the distance south to Norwalk Junction, the ROW passes over parking areas located behind commercial buildings.

Segment 7 in Wilton and Norwalk: Norwalk Junction to Norwalk Substation

This segment is approximately 3.6 miles long. For the first 0.8 miles from Norwalk Junction south to Kent Road in Wilton, the existing ROW is 80 feet wide, has two parallel 115-kV lines on lattice towers, and abuts the narrow Metro-North Danbury Branch railroad corridor. Expanding the ROW away from the railroad corridor for a 345-kV overhead line would require the taking of some homes. The Connecticut Department of Transportation (“CDOT”) has agreed to sell the Company a strip of land on the west side of the tracks, which will avoid these takings. The new overhead 345-kV line will be built in this new corridor.

Moving south from the Kent Road crossing, the existing ROW crosses over to the west side of the railroad tracks, and it is expandable on its west side. Shortly after the ROW crosses into Norwalk and crosses Grist Mill Road, it makes a zigzag turn to the west, crossing over Glover Avenue and CT State Highway 7. For 1.5 miles, the ROW then parallels CT State Highway 7 and is 150 feet wide, with room for a small expansion on its west side. A golf course and some residential development on North Seir Hill Road and Perry Avenue are located to the west of the ROW in this area. Over the final 0.5 miles to Norwalk Substation, the ROW narrows to 80 feet, closely abuts CT State Highway 7, and crosses or closely abuts two ponds and wetlands associated with the Norwalk River. Across the river and just north of Norwalk Substation is a well-field site operated by a municipal water company.

5.2 Transmission Line Designs Considered

Design 1...Expand the Existing ROW and Use it to Build a Vertically-configured Overhead 345-kV Line While Removing the Structures Supporting the 115-kV Line (Circuits 1565 and 1470) and Replacing This Line with New Conductors Supported in a Vertical Configuration on the New 345-kV Line Structures

The Company determined that constructing a new 345-kV line adjacent to the existing line on separate structures would require the expansion of the existing ROW by up to 120 feet. This was not feasible over substantial portions of the route because of the extent of closely adjacent

residential and commercial development. Therefore, the Company developed Design 1 as a single-steel-pole tangent structure design to support the 345-kV line on common new structures with the 115-kV line (1565 and 1470 circuits), so as to minimize the ROW expansion requirement. At significant angles along the route, these circuits would be supported on separate steel poles. A standard ROW width for this design is 125 feet. (See Figure 5-13.)

To build this design, the Company determined that the distribution circuit along 8.2 miles of this ROW would have to be removed and replaced with a line along public roads. Then, by removing from the ROW the towers left supporting just the 115-kV 1470 and 1565 circuits, a row of steel pole structures supporting the 115- and 345-kV lines in vertical conductor configurations could be built in its place. However, this change requires the ROW to be expanded by 45 feet over most of the route. Over the final half mile of the route into Norwalk Substation, the removal of existing structures would also displace the 1637 and 1720 circuits, so in this area a separate row of new double circuit 115-kV steel-pole structures would be required. Approximately 160 acres of new ROW, 90 acres of vegetation clearing, and the removal of a number of residences and commercial buildings would be required to implement Design 1 over the entire route.

Under Design 1, the new steel-pole structures would average 130 feet in height. These structures would replace existing wood-pole structures that average less than 70 feet in height, lattice steel towers that average 71 feet in height, and 115-kV steel-pole structures that average 95 feet in height. For corona-effects control, the 345-kV line conductors would each consist of bundles of two 1590-kcmil ACSR conductors. The 115-kV line conductors would be constructed using the Company's current standard 115-kV line conductor size of 1272-kcmil ACSR, matching the existing conductors on the 1565 line. One of two overhead lightning shield wires needed to protect these lines would contain optical glass fibers for communication purposes. (See Figures 5-14 and 5-15 for two representative configurations before and after cross-sections of Design 1.)

Were Design 1 implemented over the entire 20.6-mile route, the necessary ROW expansion would require the displacement of up to eight residences and commercial buildings in the Town of Wilton and one residence in Bethel. The impacts of the ROW expansion and construction of 345-kV transmission structures posed obstacles to the implementation of Design 1, particularly in sections of Wilton and Bethel, as discussed in detail in section 6.3 below. Also, with this pole-sharing design,

the 345-kV and 115-kV lines would be more susceptible to forced outages by a common cause. Finally, construction of this line design would require extensive and extended outages of the 1565 and 1470 circuits.

Design 2...Expand the ROW and Use It To Build a 345-kV Line, While Removing the Structures Supporting The 115-kV Line (Circuits 1565 and 1470) And Replacing This Line With Underground Cables Buried Along State and Town Roads.

Design 2 was developed to overcome three of the disadvantages of the Design 1 design: (1) the tall height of its supporting structures; (2) the susceptibility to forced outages by a common cause; and (3) the need for extensive and extended outages of the 1565 and 1470 circuits during construction.

The 345-kV line design in Design 2 could employ either of two standard 345-kV tangent structure types: (1) wood-pole H-frame structures which would support the phase conductors in a horizontal arrangement and average about 90 feet in height (see Figure 5-16), or (2) single steel-pole structures which would support the phase conductors in a triangular “delta” configuration (i.e., two phases on one side of the pole with the third on the opposite side and vertically centered between them) and average 108 feet tall. (See Figure 5-17). The same conductor and shield wire sizes and types would be used for this 345-kV line design as in Design 1, and additional poles would be needed at large angles along the route. Similar to Design 1, the distribution line now on the ROW would need to be removed and replaced along local public roads.

The ROW expansion required for a 345-kV line design with H-frame and steel-pole delta structures would be greater than for the Design 1 design: 10 feet more for the delta design and 25 feet more for the H-Frame design. Over the final half mile of the route into Norwalk Substation, the removal of existing structures would also displace the 1637 and 1720 circuits, so a separate row of new double circuit 115-kV steel-pole structures would be required in this area, as in Design 1. Between 190 and 220 acres of new ROW would have to be acquired for Design 2 were it implemented over the entire route, and this amount of new ROW expansion would displace at least as many residential and commercial buildings as Design 1 unless a vertical 345-kV conductor configuration was used in bottleneck areas.

Were Design 2 implemented over the entire route, underground 115-kV XLPE cables would be installed between Plumtree and Peaceable Substations and then between Peaceable and Norwalk Substations, replacing the existing overhead line. (See Figure 5-18.) The route for these cables would be along public roads and would cover a total distance of 22.6 miles. Implementing Design 2 over the entire route would involve more than double the amount of new line construction involved in Design 1, and greater real estate acquisition and vegetation clearing requirements.

Design 3...Construct Underground 345-kV Cables Within Public Road ROWs, And Make No Changes to Existing 115-kV Lines

Underground cable designs are typically considered where the costs or complications of ROW acquisition for an overhead line are significant, or where overhead lines may have unacceptable impacts. In order to achieve the minimum required emergency capacity of 1,200 MW for the 345-kV line, an underground 345-kV line must consist of at least two parallel sets of 345-kV cables. A design with two independent sets of cables would also enable a half-capacity circuit operation in the event of a failure of a cable. If Design 3 were constructed for the entire 345-kV line between Plumtree and Norwalk Substations, it would be 21.6 miles long and would go through terrain with significant elevation changes. One of the major concerns with building long lengths of parallel 345-kV cables over the entire route would be high cable charging power requirements. (See Figures 5-19 and 5-20 for typical cross-sections for 345-kV HPFF and XLPE cables, respectively.)

5.3 Proposed Design and Route of the Project

As shown in the schematic diagram in Figure 1-3, the Project employs a combination of line Designs 1, 2 and 3, broken down as follows.

- From Plumtree Substation to a location 2.1 miles distant (Hoyts Hill Road) via local and state roads, the Design 3 design is proposed with 345-kV XLPE cables. Over this distance there is one crossing of a brook where bridge and roadway reconstruction is planned, and here horizontal directional drilling will be employed for installing the cable conduits. The existing 115-kV line between these two points will be left unchanged, except for replacing a 0.5-mile section in front of two schools with underground 115-kV XLPE cables. (See Figures 5-18 and 5-20.)

- Build a 345-kV line transition station on a parcel of land on the west side of CT Route 58 at Hoyts Hill Road, a land parcel currently crossed by the existing overhead 115-kV line. At this Hoyts Hill Transition Station, terminate and connect the 345-kV XLPE cables via disconnect switches to a common bus which can then be connected to an overhead 345-kV line.
- On the east side of CT Route 58 opposite this transition station, dead end the existing 115-kV line on a new steel-pole cable-riser structure (“transition pole”), and remove the existing overhead 115-kV line from this point to Gallows Hill Road, approximately 3.6 miles distant.
- Build the Design 2 design from the 115-kV transition pole and 345-kV line transition station to the south side of Gallows Hill Road in the Town of Redding. The route of the underground 115-kV cables is 5.3 miles long, following CT Routes 58 and 107 and Gallows Hill Road. The ROW route of the overhead 345-kV line is 3.6 miles long in Segment 2. The 345-kV line will be built with H-frame structures on the ROW expanded to 150 feet, except for several structures of delta steel-pole design to squeeze between several residences in Bethel. (See Figures 5-16 and 5-17.) At Gallows Hill Road, erect another 115-kV transition pole and install cable risers.
- Between Gallows Hill Road and Archers Lane in Redding, a distance of approximately 1.3 miles, construct the Design 1 design and widen the ROW to 125 feet. (See Figure 5-14.) At Gallows Hill Road, transition to this vertical conductor design from the 115-kV transition pole and from the overhead 345-kV H-frame construction. Transition the 115-kV line back to the existing overhead 115-kV line at an existing angle-dead end structure near Archers Lane.
- Within the Saugatuck Falls Natural Area, opposite the end of Archers Lane in Redding and to the east of the existing overhead 115-kV line, construct a 345-kV line transition station, and terminate the overhead 345-kV line at this station. Build the transition station at Archers Lane to connect this overhead line to the center of a section of 345-kV bus which is connected at each end, via a 345-kV switching circuit breaker, to a 345-kV HPFF cable

system. The transition station will house an HPFF pressurizing and fluid-storage plant, and a control enclosure.

- Between the Archers Lane Transition Station and a similar station 9.7 miles distant in the Town of Wilton, construct Design 3 using two parallel 345-kV HPFF cables. (See Figure 5-19.) The cables will exit Archers Lane Transition Station to Diamond Hill Road via a town-owned property and a CL&P-owned property, then will follow Diamond Hill Road, Umpawaug Road, CT Route 107, and CT Route 7 to a location in the Town of Wilton just east of the Norwalk 115-kV line junction. Between these same two points, the existing overhead 115-kV line, its connections to Peaceable and Ridgefield substations, and a distribution line sharing tower structures of the 115-kV line will be left unchanged on the existing ROW. Over the 345-kV cable route, either jack and bore or horizontal directional drilling methods must be used to bypass a brook, a river, and a roadway bridge over railroad tracks.
- Build a 345-kV line transition station on a parcel of land on CT Route 7, just east of Norwalk Junction. This Norwalk Junction Transition Station will have the same basic design and function as the Archers Lane Transition Station, except that a variable 75- to 150-MVar, 345-kV shunt reactor will be connected to each 345-kV cable. The 345-kV HPFF cables from Archers Lane will terminate here and connect to an overhead 345-kV line. The existing 115-kV line (1470 circuit) from Peaceable Substation will also be disconnected at Norwalk Junction and connected via a new span of conductors crossing the Norwalk River to a 115-kV transition pole erected in one corner of the Norwalk Junction 345-kV Transition Station.
- From the Norwalk Junction Transition Station to Norwalk Substation, build Design 2. Install 115-kV cables from the transition pole to Norwalk Substation following CT Route 7, Main Avenue and Broad Street. (See Figure 5-18.) For the 115-kV cables, jack and bore or horizontal directional drilling methods are required at a railroad crossing and a crossing beneath the interchange of the Merritt Parkway (a limited access highway with high traffic volume) and Main Avenue in Norwalk. Between Kent Road in Wilton (about 0.8 miles south of Norwalk Junction) and Norwalk Substation, remove the existing row of structures

supporting the 1470 line and the 27.6 line so that a 345-kV line using delta steel poles can be erected on a slightly widened ROW. (See Figure 5-21.) From Norwalk Junction Transition Station to Kent Road, build a 345-kV line using delta steel poles over the Norwalk River and then on a new ROW parallel to and west of the Metro North Danbury Branch railroad line. (See Figure 5-22.)

- Over the final half mile to Norwalk Substation, Segment 7, erect new double-circuit steel poles to support the 115-kV 1637 and 1720 circuits. Terminate the 1637 line on the relocated series reactor structure within Norwalk Substation, which is then connected by underground 115-kV cables to the 115-kV switchyard. Terminate the 1720 line on a transition pole just north of the Norwalk Substation fence, and connect it to the switchyard via underground 115-kV cables. Terminate the overhead 345-kV line on a new structure within Norwalk Substation, and connect it to the GIS switching station via gas-to-air bushings and a short run of gas-insulated transmission line.

5.4 Detailed Description of Proposed Substation Modifications and New Transition Stations

Plumtree Substation

The existing 345-kV equipment at Plumtree Substation consists of a 345-kV bus to which the Long Mountain – Plumtree 345-kV line and two 450-MVA 345/115-kV autotransformers connect. To interconnect the new 345-kV line at Plumtree Substation and allow for future 345-kV line additions, a 345-kV switching station is needed to replace the existing 345-kV bus.

The switching station design is breaker-and-a-half. Three bays with seven breakers are needed to establish five initial bus connection points for lines, autotransformers and one 345-kV, 75- to 150-MVAR variable shunt reactor. (See the attached one-line diagram in Figure 5-23.) This design will ensure that a malfunctioning breaker will not interrupt both 345-kV lines to Plumtree or both Plumtree autotransformers simultaneously.

The Plumtree Substation site is completely surrounded by wetlands, so is not expandable for an air-insulated 345-kV switchyard with three 345-kV bays. (See aerial photograph of site outlining

wetlands in Figure 5-24.) The only available building space within the substation is located on the northern side and is only approximately 80 feet by 180 feet. This expansion constraint dictates that an initial three-bay, 7-breaker, 345-kV breaker-and-a-half switching station be constructed with compact, outdoor gas-insulated substation equipment. (See photographs in Figures 5-25 and 5-26.) An existing control enclosure on the Plumtree Substation site can accommodate the protection and control equipment additions associated with the initial 345-kV equipment.

Norwalk Substation

To interconnect the new 345-kV line with the two main buses of the existing 115-kV transmission switchyard at Norwalk Substation, a 345-kV switching station, 345/115-kV, 600-MVA autotransformer, and two 115-kV circuit breakers are required. CL&P's 14.2-acre property for Norwalk Substation is partially in a 100-year floodplain of the Norwalk River. The existing substation facilities occupy 3.7 acres of this site. (See Figure 5-27 for aerial photograph of site.) The undeveloped portion of this parcel is between an exit ramp from State Highway 7 and the Norwalk River.

Much of this undeveloped land area is within a regulated floodway, and federal, state and local regulations effectively limit full use of this area for substation facilities. As part of the Project, significant site preparation was required as a condition of obtaining permits to elevate grades so as to make 5 acres of the undeveloped area available for the proposed and any future facilities within the fenced-in substation area. The area capable of being developed for installation of substation equipment is approximately 450 feet long and 200 feet wide over much of this length. The site preparation required grading, clearing and dedicating much of the remaining land area to compensate for flood-water changes caused by this site development. This site work included 2,588 feet of concrete retaining walls, 8,500 cubic yards of cut over 3 acres, 51,000 cubic yards of fill over 5 acres, 6,000 cubic yards of contaminated soil disposal, construction of a river overflow channel, replacement in new locations of existing 115-kV capacitor banks and a 115-kV series reactor, construction of several spans of temporary 115-kV overhead lines, a new 115-kV switchyard bay with three circuit breakers, and replacing underground the final 1,200 feet of three existing 115-kV lines that crossed the expansion area. (See Figure 5-28 for diagram of proposed Norwalk Substation arrangement.)

The elevated area which is made available for substation equipment by this site preparation work at the Norwalk Substation is relatively narrow and visible to the public. (See photographs in Figure 5-29, 5-30 and 5-31.) An air-insulated 345-kV station design could not fit on the available land. Even with just two bays of a breaker-and-a-half air-insulated station design, a 345-kV switchyard requires a rectangular space with one side dimension equal to 530 feet, while only approximately 400 feet is available at this site. Therefore, the 345-kV switching station will be constructed with compact, gas-insulated substation equipment installed within a long rectangular-shaped building.

A modified breaker-and-a-half design of the switching station will initially be constructed with four 345-kV circuit breakers to create two bus positions, one for the Plumtree – Norwalk 345-kV line and a second for the autotransformer. (See the attached one-line diagram in Figure 5-32 and 5-33.) The design will support up to six additional bays, with up to 16 additional 345-kV circuit breakers and associated equipment for future 345-kV lines and a second autotransformer. The 345-kV line from Plumtree Substation will enter this switching station at its north end, and the 345/115-kV autotransformer, which consists of three single-phase units, will be placed opposite the south end of the 345-kV switching station. Space to the east side of the gas-insulated substation equipment building is designed for future 345-kV underground cable entries, 345-kV shunt reactors, and a spare single-phase autotransformer.

These additions at Norwalk Substation require a new substation control enclosure and two associated battery enclosures for the new 345- and 115-kV equipment's protection and control systems. The existing protection and control equipment at Norwalk Substation is located on the second floor of an old, congested brick building within the floodway, and it has no expansion room. Therefore, the existing 115-kV protection and control equipment in the existing control building will be replaced and consolidated with needed new protection and control equipment additions in a new control building and new battery buildings. Associated rewiring and cutovers represent a significant complexity and cost to the Norwalk Substation project.

345-kV Line Transition Stations

To interconnect the two overhead and two underground 345-kV line sections of the project, three 345-kV line transition stations will be built. Two of these stations, the Archers Lane Transition Station in Redding and the Norwalk Junction Transition Station in Wilton are required to terminate

and transition the ends of two 345-kV HPFF cables to an overhead line. The third station, Hoyts Hill Transition Station in Bethel, will be constructed to terminate and transition the south end of the 345-kV XLPE cables to the segment of overhead line. The north end of these cables will terminate at Plumtree Substation.

The Archers Lane and Norwalk Junction Transition Stations will each include a section of 345-kV overhead bus to which the overhead 345-kV line directly connects. At each end of the 345-kV bus, each underground cable will be connected via a 345-kV circuit breaker and a disconnect switch. The transition station circuit breakers in this design will serve as switching breakers, not fault-interrupting breakers. They will be remotely and locally controllable in order to individually switch each of the two HPFF cables in or out of service.

At the Norwalk Junction Transition Station only, a 75- to 150-MVAR variable shunt reactor will be connected to a bus section between each cable termination and its associated 345-kV circuit breaker. The shunt reactor can be isolated by a disconnect switch. When a cable is switched in or out of service, the shunt reactor associated with each cable at the Norwalk Junction Transition Station is energized or de-energized.

Relaying and controls at these two facilities will be limited to detection of fault zones (i.e., detecting which cable is faulted and the approximate location of the fault) and to initiate a complete circuit interruption at Plumtree and Norwalk Substations should a fault in a shunt reactor occur. To house this equipment, a control enclosure will be constructed at each station. A fluid pressurizing plant building for the HPFF cables will also be constructed at each of these two transition stations. Because the Norwalk Junction Transition Station is located in the Norwalk River floodway, the equipment and control enclosure will be elevated above ground by a few feet more than is typical. Also, an above-ground oil-spill containment enclosure is required around each of the two shunt reactors. The property for the Norwalk Junction Transition Station is under easement control by CL&P, and the property for the Archers Lane Transition Station will be provided by the Town of Redding at the southerly border of a large open space parcel.

The Hoyts Hill Transition Station will have a smaller footprint than the others because the station will contain less equipment. Each set of three 345-kV XLPE cables will be connected via manually

removable links to each end of a short section of 345-kV overhead bus, to which a 345-kV overhead line will directly connect in the middle. A small control enclosure is required here to house equipment for detecting fault locations and communicating this intelligence to Plumtree Substation. The land for this station, at the intersection of CT Route 58 and Hoyts Hill Road in Bethel, is currently crossed by the existing 115-kV transmission line and will be acquired from the Town of Bethel. The lower portions of the land parcel are wetlands, and retaining walls are required to build a land shelf for the station equipment on the higher portion of the site.

5.5 Description of Ancillary Facilities

The following ancillary facility work will be completed coincident with the Project:

Install 115-kV series reactors at the Southington Substation in the 1910 and 1950 lines.

Install a 115-kV series reactor (3%) in the 115-kV Southington – Todd 1910 line and in the Southington – Canal 1950 line. A parallel 115-kV switching device will be operated normally closed. During times of potential post-contingency overloads on the 1910 and 1950 lines, the 115-kV switching device will be opened pre-contingency to insert the series reactor into the circuit. This action will increase the impedance of the line and re-direct power flows onto other transmission lines.

Install an additional 345-kV circuit breaker at the Long Mountain Switching Station.

Install a 345-kV circuit breaker between the existing 8T and 4T breakers at the Long Mountain Switching Station and re-terminate the 398 line to the 'A' bus. This will eliminate the possibility of a fault on either the 321 or 398 lines causing loss of the other line if the 5T circuit breaker malfunctions.

Install Special Protection System (SPS) at the Glenbrook Substation.

The proposed SPS would be armed 100% of the time, monitoring power flows on the 115-kV Glenbrook – Ely Avenue 1890 line and the 115-kV Glenbrook – Rowayton Junction 1867 line. The SPS will trigger for power flows above LTE ratings and for the coincident outage of the 1867/1880 lines or the 1880/1890 lines. Triggering of the SPS will result in tripping the 1753 – 1K and 1792 – 1K circuit breakers to drop the Cedar Heights substation load. An additional 25 MW of load

dropping at Glenbrook is required to reduce power flows below emergency ratings, so designated distribution feeders will also be tripped when the SPS triggers.

Replace 115-kV Circuit Breakers at the Norwalk Harbor Substation.

Replace the existing 115-kV 3T, 5T and 6T circuit breakers at Norwalk Harbor Substation with new circuit breakers having an interrupting capability of 63 kA.

Replace terminal equipment at the Southington and Millstone 345-kV substations.

Upgrade the limiting line terminal equipment on the Southington to Millstone (348) line so that the full conductor ratings of the line can be realized.

Modify Bridgeport Harbor 2 generator interconnection at the Pequonnock Substation.

Install a 115-kV series reactor (3%) in the Bridgeport Harbor 2 generator lead. A parallel 115-kV switching device will be operated “normally open” during normal operations. This reactor will reduce the fault current contribution from the generator into the 115-kV transmission system. This reactor is connected to the UI transmission system. None of the costs related to this work at Bridgeport Harbor are included in this 12C application.

5.6 Construction Overview

The Project will include the construction of new overhead and underground 345-kV and 115-kV line sections. This discussion provides a brief outline of the construction process for both the overhead and underground sections.

Overhead Transmission Line Construction

The Company will construct the overhead portions of the Project in several stages, some of which will overlap in time. Construction activities will typically consist of: (1) ROW preparation (including vegetation clearing, access road improvement/installation, and site preparation at structure locations); (2) excavation and installation of foundations, erection of wood or steel poles, and installation of ancillary equipment; (3) conductor and wire installation; and (4) clean-up and ROW restoration.

These stages of construction include the following activities:

- Preconstruction activities (e.g., soil borings at proposed structure locations, and reflagging of wetland boundaries where necessary);
- Survey to stake the centerline of existing ROWs and future structure locations;
- Establish field construction areas and prepare staging and lay-down areas;
- Prepare ROWs (including, where necessary, the installation of erosion and sedimentation controls, selective removal of vegetation, access road improvement/installation);
- Prepare work areas at structure sites;
- Excavate and construct foundations (where necessary), erect new structures, and install ancillary equipment;
- Install conductors and wires (if 115-kV XLPE cable bypasses of an overhead line segment are not in service already, outages of the existing overhead 115-kV line will be necessary to erect new 345-kV line structures and to pull wire);
- Remove, where required, existing 115-kV transmission structures and associated conductors and wires; and,
- Perform clean-up and restoration, including revegetation of disturbed areas resulting from the construction process.

Underground 345-kV and 115-kV Cable Installation

HPFF Cables

To construct the new underground 345-kV cables in Redding and Wilton, the Companies propose to use HPFF pipe-type cable technology. HPFF, which is pressurized with a non-toxic and non-hazardous dielectric fluid, is the most common type of extra high voltage transmission cable presently in use in the United States.

The underground 345-kV HPFF cable would be installed principally within or adjacent to public roadways. Within such roadways a trench averaging 4 feet wide and 5 feet deep would be excavated using mechanical methods, supplemented by blasting where necessary.⁶ A bed of thermal sand or

⁶ In certain limited locations, horizontal directional drilling and jack and bore techniques will be employed to address special conditions such as stream, river, and railroad crossings.

fluidized thermal backfill™ would be placed in the bottom of the trench for protection and to improve heat transfer away from the cables. Subsequently, two 8-inch, coated steel pipes would be installed on this sand bed in the bottom of a trench. Each pipe section is approximately 40 feet long; the pipe sections would be welded together to make a continuous pipe between splice vaults. The trench would be backfilled with thermal sand or fluidized thermal backfill.™

The trenching, pipe installation and backfilling work would proceed progressively along the route such that it would only be necessary to keep a short section of trench open at any one time. A temporary cover would be installed over disturbed areas within paved roads and shoulders. At approximately 1,500 - 2,000-foot intervals along the cable route, concrete splice vaults (approximately 8 feet wide, 8 feet high and up to 28 feet long) would be installed below ground for cable pulling and splicing. The length of a section of underground cable between splice vaults is limited both by cable reel diameter and weight size (length of cable on the reel) and by pulling considerations. Each vault would have two entry chimneys to the surface. Several feet of road base fill would be placed on top of each vault. After these vaults and pipes are in place, the cable would be installed and spliced. Within each pipe, the three cables would be pulled into place together.

The splicing of 345-kV HPFF cables within splice vaults requires a complex technical procedure. Splicing is required because cable sections are limited by reel size and weight and are typically between 1800 and 2500 feet in length. Splicing these cables requires a controlled atmosphere, which would be provided by an enclosure or vehicle located over the splice vault's access chimney during the period of splicing. It is expected to take approximately 10-14 days (working 24 hours per day) to complete the splices in each vault (six HPFF 345-kV cable splices in each splice vault).

XLPE Cables

A 2.1-mile portion of the Project between Plumtree Substation and Hoyts Hill Road Transition Station would employ 345-kV XLPE cables. In addition, 10 miles of 115-kV XLPE cable will be installed as part of the Project. The installation procedures for 345-kV and 115-kV XLPE cable types would be substantially similar to HPFF, except that the time and skill requirements associated with 345-kV XLPE cable would be greater than for 345-kV HPFF cable. Splicing XLPE cable requires a controlled atmosphere, which would be provided by an enclosure or vehicle located over

the manhole access chimney during the period of splicing. Other construction differences between HPFF and XLPE cable include:

- conduits for XLPE cable are plastic (rather than the metal pipes in which HPFF cables are installed);
- XLPE cables are pulled individually into their own conduits, while HPFF cables are pulled together into a common metal pipe;
- Six 345-XLPE cables require two splicing vaults at each splicing location, as opposed to one vault for two HPFF cable systems;
- installation of XLPE cables does not require the installation of any pressurization facilities at terminal points because XLPE cables contain no insulating fluid;
- trench dimensions for XLPE cable installations may vary slightly from those for the 345-kV HPFF cables (typical cross-sections for HPFF and XLPE cable installations are found in Figures 5-19 and 5-20); and,
- XLPE cables require cross bonding of their sheaths at link boxes in the splicing vaults. HPFF cables have no similar requirement.

5.7 Consistency with Current Design Practices in the Area

5.7.1 Characteristics of Existing Transmission Line Designs in SWCT

Current design practices in SWCT are of limited utility in evaluating the Project. First, there are no existing 345-kV lines in the SWCT. Moreover, many of the existing 115-kV lines in this region were built decades ago when this region was much less developed and when utilities on the whole faced much less rigorous oversight of transmission siting issues.

The 14-town Norwalk-Stamford sub-area of SWCT is heavily developed. This area includes three densely populated and developed cities (Stamford, Norwalk and Bridgeport) and eleven suburban towns around these cities (Greenwich, Darien, New Canaan, Ridgefield, Wilton, Redding, Trumbull, Weston, Westport, Easton and Fairfield) with high concentrations of residential development. (See Figure 1-1) The existing transmission line designs in these towns are all 115 kV, including both overhead and underground 115-kV sections, and existing transmission ROWs are very limited. Just north of the Norwalk-Stamford Sub-area is the City of Danbury, which is also served by underground 115-kV lines and a very short segment of triple-circuit overhead 115-kV line on a narrow ROW.

The underground 115-kV lines in these municipalities (essentially all in public ROWs and city streets) include:

- two 115-kV lines in Stamford, each 4.9 miles long with HPFF designs, constructed in the 1960s;
- three 115-kV line segments in Norwalk, each 1.5 miles long with HPFF designs, constructed in 1958. These three line segments interconnect with overhead line segments at the Ely Avenue 115-kV Transition Station in Norwalk;
- two short 115-kV line segments in Bridgeport, each with High Pressure Gas Filled designs, constructed by The United Illuminating Company in 1961; and,
- two 115-kV HPFF lines in Danbury constructed in 1975, each of which is 3.6 miles long. One of these lines is in series with a 1.8-mile overhead line segment.

The overhead lines and routes in these municipalities include the following:

- There are ten 115-kV circuits whose overhead construction is completely within or immediately adjacent to the New York – New Haven electric railroad corridor over a distance of 25.5 miles. These circuits are predominantly supported by lattice steel towers or steel poles, including a section of four-circuit lattice towers. Where the circuits are within the railroad corridor, short-span construction exists to minimize the side clearances required by the National Electrical Safety Code. This highly congested transmission and transportation corridor, some of which closely abuts Interstate 95, passes through densely developed areas. The developed areas in close proximity to the overhead 115-kV lines that parallel the electric railroad corridor include industrial, commercial and residential developments.
- There are four overhead 115-kV circuit segments between Old Town Substation in Bridgeport and Norwalk Junction in Wilton. The construction is double circuit on lattice steel towers on a narrow ROW (80 to 110 feet) over a distance of 12.2 miles. Dense residential development abuts much of this ROW.
- There are three 115-kV circuit segments in Norwalk whose overhead construction is double and quadruple circuit on lattice steel towers on an 80-foot-wide ROW over 4.1 miles. Extremely dense residential and commercial development abuts this ROW.
- There are three overhead 115-kV circuit segments between Norwalk Substation and Norwalk Junction in Wilton whose construction is double circuit on lattice steel towers and steel poles (two parallel sets of structures) over 3.6 miles. The ROW, which parallels CT State Highway 7 for approximately 2 miles of this 3.6-mile distance, is 150 feet wide except for a half-mile river/highway bottleneck close to Norwalk Substation. Over the remaining 1.6 miles, the ROW closely abuts the Metro-North Danbury Branch railroad corridor and heavy commercial/residential development along Route 7. The width of the ROW narrows to 80 feet in this area.
- There is one 115-kV circuit segment from Norwalk Junction to Peaceable and Ridgefield Substations in the towns of Redding and Ridgefield. Over 4.2 of these 6.9 miles, the line is supported on lattice steel towers on a ROW with widths of 80 feet or less, closely abutting the Metro-North Danbury Branch railroad corridor, crossing National Register Historic Districts and over historic buildings, traversing developed residential and commercial areas,

and in one area running adjacent to a local street. A ROW spur to Ridgefield Substation is 3.7 miles long, supports two 115-kV circuit segments on steel poles, and occupies an abandoned railroad corridor.

Other than at river and highway crossings, the heights of the structures supporting all of the aforementioned 115-kV overhead lines are typically below 100 feet. Some of the structures were initially installed to support 69-kV lines, and many are a narrow-base design.

Southeast and southwest from Norwalk Substation, the Company has long recognized that there is no practical and feasible way to expand existing overhead ROWs because of dense commercial and residential development and the narrow width of these ROWs. Moreover, creating new ROWs in this area of SWCT is virtually impossible. Whenever system planners have considered needs for additional 115-kV lines to connect with substations southeast and southwest from Norwalk Substation (e.g., Lakeview in New Canaan, Greenwich, and Glenbrook in Stamford), underground 115-kV lines have been identified as the only option. As a result of this dense development, the Company is currently seeking siting approval for a nine-mile underground 115-kV line between Norwalk Substation and Glenbrook Substation. To the north of Norwalk Substation and through the Towns of Wilton and Weston, similarly dense development persists adjacent to narrow 115-kV line ROWs. As a result, expansion of these narrow ROWs is extremely challenging.

5.7.2 Consistency of Proposed Design with Existing Designs in This Area

The proposed designs for the new Plumtree to Norwalk 345-kV line, and designs for associated reconstruction of 115-kV line circuit sections, are consistent with the current designs in the Norwalk – Stamford Sub-area. There are practical limitations to ROW expansion in numerous locations along the route and limitations related to particular uses along the existing ROW, such as the Cannondale Historic District in Wilton. These limitations have been addressed by including underground cable segments in the 345-kV and 115-kV lines while building the 345-kV line overhead where practical and feasible.

The choice of parallel 345-kV HPFF cables, 2500-kcmil copper for a 9.7-mile length is consistent and comparable with similar underground lines constructed in New York City and Boston. (*See, e.g.,*

12C Application of NSTAR Electric for Stoughton-Hyde Park-K Street Station 345 kV Transmission Project in connection with the construction of a new three-circuit underground transmission facility using HPFF cables.) New applications of this technology now typically employ paper polypropylene insulation. As noted above, existing 115-kV line segments in Norwalk and Stamford utilize HPFF technology.

The selection of solid dielectric XLPE cables for the reconstructed underground sections of 115-kV line was made because 115-kV XLPE cable technology has matured, holds environmental and operational advantages over HPFF cables, and is now the cable of choice for most underground 115-kV line applications. In Connecticut, installations of such 115-kV cables exist in New London where they supply a railroad substation, and in East Windsor, Plainfield and Sterling where they are used for generator lead lines.

The choice of parallel solid dielectric 345-kV XLPE cables, 1750-kcmil copper, for a 2.1-mile length in Bethel represents an application in the United States of a technology that has been applied in Europe and Asia. Previously in the U.S., short sections of line (without splices) have employed XLPE cable technology at 345 kV and above, including a generator lead line in Boston. Manufacturing quality of this cable type for 345-kV service has improved significantly over the past decade. In addition, accessories (splices and terminators) have been developed and their design has matured. As a result, there have been a number of 420-kV applications since 1996 in European countries in lengths up to 15 miles and one 25-mile double circuit application at 500 kV in Japan. XLPE cable technology continues to mature and there is more and more use of this technology at voltages over 300 kV throughout the world.

6. Comparison of the Project to an Overhead 345-kV Alternative

6.1 *Overview*

Given the critical need for the Project, as emphasized by ISO-NE in numerous forums, the Connecticut Siting Council asked CL&P to work with the local communities to explore configurations that include both overhead and underground facilities. The Project was the only reliable configuration that could be sited, permitted and constructed in a timely manner. The estimated cost of the combined overhead/underground configuration ultimately approved by the Connecticut Siting Council is \$357 million, including ancillary facilities.

CL&P submits that this cost was an investment in the certainty of getting this line built without undue delay. It was critically important that the Company get this line permitted in a timely manner in order to provide the needed additional transmission into the Norwalk-Stamford Sub-area and to provide the platform needed to complete the 345-kV loop. The Project is, in fact, the only “practical and feasible” 345-kV alternative because it is the lowest cost alternative that CL&P could actually permit and construct in a timely manner without additional regulatory, legislative, or judicial roadblocks.

6.2 *Evolution of the Project*

The Company’s application to the Connecticut Siting Council identified three potential designs, or configurations, for construction of the Project. (Each of these designs is discussed in detail in section 5.2 above.) The impacts of the three configurations identified in the application were not uniform for the entire length of the route. For example, the impact of the increased tower height was greatest in areas of special concern such as designated Historic Districts and through the Bethel School complex, where there would be open views in an intensively frequented park-like setting. The widening of the ROW required for overhead construction was of greatest concern where residences or commercial structures had been constructed close to the existing ROW edge. On the other hand, through the isolated Saugatuck Falls Natural Area, increased tower height of an overhead design was of less concern, and was preferred by the town to widening of the ROW.

The Company's application was the subject of a lengthy, contested proceeding before the Connecticut Siting Council in which numerous parties, including all five affected towns, the Connecticut Attorney General, the Office of Consumer Counsel, environmental groups, and consortiums of residents opposed both the need for the Project and the proposed designs. The towns' expert presented an alternative plan for the construction of two underground 115-kV lines, while the Attorney General's expert supported the towns' plan followed by the construction of a 115-kV loop. Both the Company and ISO-NE presented testimony and studies to demonstrate that the towns' and the Attorney General's 115-kV alternatives did not adequately address the SWCT reliability issues in either the short term or the long term.

During the proceedings, the Connecticut Legislature passed an act delaying the siting proceedings for this Project by extending the one-year decision deadline for the project that would have expired on October 15, 2002.⁷ See P.A. No. 02-95 ("The Act"). The Act also created a "working group" charged with the task of evaluating the "economics and environmental preferences and appropriateness of installing" the Bethel to Norwalk line "underground or overhead." The Act also stated that the Siting Council's decision on the Company's application for the Bethel to Norwalk line would be evaluated to determine "such application's consistency with [the Working Group's] assessment."

During the course of the hearings, Siting Council members identified several configurations that included both overhead and underground elements and asked the Company to evaluate and improve upon them. This began what came to be known as the "mix and match" process, pursuant to which fourteen hybrid configurations (in addition to three configurations, each made up solely of one of the three potential designs described in the application) were identified and evaluated during the hearings and the briefing period.

While the Siting Council was requesting and awaiting Company input on mix and match configurations, the Working Group issued its January 1, 2003 Report, in which it said rather pointedly, "The Working Group endorses the Siting Council's request for CL&P to provide

⁷ This same act also imposed a moratorium on any new proposals for projects to cross Long Island Sound until June 2003. This moratorium on Long Island Sound projects was subsequently extended through June 2005 by Public Act No. 04-222.

additional alternatives to the 345-kV proposal. Such alternatives may include route variations, use of lower height structures, and the use of underground technologies.”

It appeared to the Company that the Council would conclude that the optimum configuration that would best balance cost, reliability, and environmental considerations could well be one that included diverse elements of all of the three basic configurations identified in the application, as opposed to an all overhead configuration. The Company concluded that the Council would likely issue a certificate of environmental compatibility and public need for one of the many “mix and match” configurations, or for another configuration that included elements of some of them. At the same time, going through the process of evaluating and attempting to improve upon suggested configurations had caused the Company to see that there could be a hybrid configuration that would meet the urgent need for a 345-kV circuit between Bethel and Norwalk, with acceptable reliability, but without many of the features that other parties and intervenors found most objectionable. The Company also appreciated that a consensus with key stakeholders concerning the ultimate configuration of the line could well assure that the line would be built and operating much sooner than it would be if it had to be certified and defended over their continued opposition and legal appeals. Since the line had already been seriously delayed by the imposition of the legislative moratorium that delayed the siting proceedings, this was a very important consideration. The Company was concerned that, absent some sort of “compromise” configuration, it was reasonably possible that the legislature might intervene in the siting process once again, and that the Project could be delayed by years. Moreover, the likelihood of a judicial stay during an appeal of the ruling – which could have substantially delayed construction - was materially increased absent this type of compromise configuration that included elements of all three basic designs.

There was one thing about which the Company had no doubt – there was a critical need for a new 345-kV transmission line between Bethel and Norwalk, and the completion of a 345-kV loop after that by construction of a Middletown to Norwalk line.

After receiving input from the towns regarding their concerns about the impacts of the line, the Company developed a hybrid design (called “Configuration X”) that incorporated overhead and underground elements. This configuration was feasible and represented a balance of the competing

considerations of all parties and intervenors that the Siting Council is required to assess. This configuration was subsequently presented to the Council for approval.

In its Decision and Order, the Siting Council approved the proposed configuration, including some additional modifications in Bethel supported by the Company, but also ordered the Company to install additional underground facilities from Norwalk Junction in Wilton to Norwalk Substation. Specifically, the Siting Council ordered that the Company move one of the existing 115-kV lines off the ROW and install it underground in the streets, thus allowing the 345-kV overhead line to be installed on shorter towers.

6.3 Description of the Overhead Alternative

6.3.1 Introduction

An “all overhead” alternative was neither practical nor feasible because such a configuration would have to have been modified to address unique circumstances in Wilton and Bethel. Modifications in these locations would be consistent with current engineering design and construction practices in the region. Therefore, for purposes of comparing the proposed Project to an “Overhead Alternative” that is consistent with current engineering design and construction practices in the region, the “Overhead Alternative” includes underground 345-kV cable in two locations: (1) a 4.3-mile section⁸ of 345-kV HPFF cables from Mather Street/Honey Hill Road to Norwalk Junction in Wilton that is needed to avoid impacts to the Cannondale Historic District, to avoid takings of homes in the Pimpewaug Road area, and to bypass a segment of the ROW constrained by Route 7, the Norwalk River, and a railroad corridor; and (2) a 2.1-mile section of 345-kV XLPE cables from Plumtree Substation to Hoyts Hill Transition Station arising from the need to avoid installing an overhead 345-kV line through a large educational park in Bethel. Figure 6-1 provides a schematic diagram of this Overhead Alternative. The use of 345-kV cables in these sections of Wilton and Bethel (as part of the Overhead Alternative) is consistent with what other utilities would consider implementing under similar circumstances.

⁸ The distance of an underground route in this section of Wilton is 4.3 miles, as opposed to 4.2 miles for an overhead route in this same area.

6.3.2 Good Utility Practice and Current Engineering Design and Construction Practices in the Region.

The term “Good Utility Practice” is defined in section 1.34 of the NEPOOL Transmission Tariff:

Any of the practices, methods and acts engaged in or approved by a significant portion of the electric utility industry during the relevant time period, or any of the practices, methods and acts which, in the exercise of reasonable judgment in light of the facts known at the time the decision was made, could have been expected to accomplish the desired result at a reasonable cost consistent with good business practices, reliability, safety and expedition. Good Utility Practice is not intended to be limited to the optimum practice, method, or act to the exclusion of all others, but rather includes all acceptable practices, methods, or acts generally accepted in the region.

The current engineering design and construction practices in SWCT are also relevant in the Schedule 12C process. As set forth in section 5.7 of this Application, there are numerous examples of underground transmission facilities in densely developed urban areas in SWCT, and the need to consider underground installations in suburban areas has grown as the density of suburban development has increased in areas north of Norwalk Substation.

The installation of underground facilities in heavily developed areas is found elsewhere in Connecticut and New England. For example, 115-kV underground cables are found in Danbury, Norwalk, Stamford, Bridgeport, New Haven, Hartford, and New London. In the greater Boston area, there are approximately 42 miles of 345-kV underground cables. In NSTAR’s recent Transmission Cost Allocation application for the installation of three new 345-kV HPFF cables originating in Stoughton, Massachusetts, NSTAR cited the difficulties of siting overhead transmission lines in constrained, heavily developed areas, the likely delays associated with such efforts, and the resulting need to install underground facilities in such locations. (See NSTAR TCA Application at 3-9, 3-10)

Finally, transmission line design practice is, by its very nature, an evolving concept, not a static rule. As governmental and public pressures regarding siting issues continue to grow, and as new transmission technologies emerge and mature, utilities in New England and throughout the nation

are necessarily required to consider whether there are design elements that can address these concerns. The use of underground facilities at particular areas to address site-specific concerns and impacts is not unique to the Project; rather, it is consistent with a trend in the region. In short, transmission owners throughout New England should reasonably expect that future upgrades to their transmission systems may incorporate some design elements, including underground components in particular areas, that were not envisioned when construction of the interconnected 345-kV grid began in the 1960s.

6.3.3 Routing Constraints in Portions of Wilton and Bethel Rendered An Overhead 345-kV Line Infeasible and Impractical in these Areas.

The existing CL&P ROW between the Plumtree and Norwalk Substations is the only available route for a new overhead transmission line between these two substations. There is no alternative route for a new overhead transmission in this area due to the intensive development of land for other uses. Moreover, there are no other utility corridors to consider for expansion, or highway corridors to consider for paralleling, and the existing ROW already parallels a railroad corridor for a significant distance in Norwalk and Wilton until that railroad corridor veers northwest to Danbury.

A detailed description of CL&P's existing ROW, segment by segment, can be found in Section 5.1 of this application, including a discussion of ROW expansion constraints in particular segments. To add a 345-kV line along the existing route, the ROW requires expansion. The minimum ROW width required for a 345-kV line is 125 feet, when the line is constructed in a vertical configuration on a common pole structure with a reconstructed 115-kV line. These structures would average 130 feet in height. Lower height structures can be used for a 345-kV line over this route only if the ROW is expanded to widths greater than 125 feet, even where the existing 115-kV line was removed from the ROW and replaced underground following a street route. ROW expansion to 125 feet was particularly difficult in many locations along the route given local land uses, but the most problematic areas for construction of an all-overhead line were in Wilton and Bethel.

6.3.4 Wilton

The constraints to ROW expansion for an overhead 345-kV line over the 4.2 mile segment in Wilton from Mather Street/Honey Hill Road to Norwalk Junction are as follows:

- With a railroad corridor adjacent on one side, all ROW expansion or shifting must occur to the other side; encompassing portions of the railroad corridor within the expanded right-of-way for a 345-kV line faced opposition by Metro-North, the railroad operator, because of concerns for potential interference to communications signaling systems integral to railroad safety and interference with future railroad electrification;
- The ROW traverses the Cannondale National Register Historic District for about 1 mile. Within this district, which is over 1/3rd –mile wide at its widest point, the existing line passes directly over two historic buildings in Cannondale Village and within 500 feet of 36 other historic properties. An expansion of this ROW for an overhead 345-kV line would encompass as many as seven buildings and several small sheds and outbuildings in this area. At this location ROW expansion and relocation to avoid having any buildings within the ROW is not possible, and it is not feasible to move or demolish these buildings. Therefore, a new 345-kV overhead line would have to have been installed very high over the existing historic buildings; (See photographs in Figures 5-5, 5-6, and 5-7.)
- Beginning just south of the Cannondale Historic District is a 0.8-mile stretch of ROW where Pimpewaug Road runs parallel to the railroad corridor. Over this stretch, the ROW moves a short distance away from the railroad corridor to the opposite side of Pimpewaug Road in a couple of places. Here the ROW closely abuts several houses, one or two of which would have to have been acquired (likely by eminent domain) and removed to allow for a ROW expansion to accommodate an overhead 345-kV line. (See photographs in Figures 5-8 and 5-9.) The ROW also crosses a sawmill property at Pimpewaug Road and CT Route 7;
- Moving south from this intersection, the ROW passes just east of the boundary of the Wilton Historic District, and over a distance of approximately 0.8 miles squeezes between busy CT Route 7, the railroad corridor and the Norwalk River. (See photographs in Figures 5-10, 5-11, and 5-12.) Here a ROW expansion to 125 feet would encompass a railroad station building and up to 10 residential and commercial buildings, some or all of which would have to be removed. A few of the commercial buildings are crossed by the existing 115-kV line;

- Over the remainder of the distance south to Norwalk Junction, the ROW passes over parking areas behind commercial buildings.

By installing the 345-kV line underground in Cannondale area, the Company was able to accomplish the following:

- Avoid takings of homes and commercial structures that were required for the ROW expansion (and thereby decreased the likelihood of litigation-related delays caused by eminent domain litigation);
- Avoid additional visual impacts to the Cannondale Historic District; and,
- Avoid in several locations having to build a new 345-kV line on ROWs in which privately-owned buildings and/or parking areas are situated.

6.3.5 Bethel

The main constraint to ROW expansion for an overhead 345-kV line in Bethel is that the existing ROW traverses the David W. Deakin Educational Park, passing directly in front of an elementary school and a middle school, over parking lots for each school, adjacent to a skateboard park, and adjacent to athletic fields. (See Figures 5-2, 5-3, and 5-4 for photographs of the site.) This would require the relocation and expansion of the ROW to a 125-foot width for a combination 345/115-kV line on 130-foot tall structures. More importantly, the acquisition of additional ROW for an overhead line within the Educational Park (or for a bypass of the Park) would have been subject to the approval of the Connecticut Department of Environmental Protection because the ROW traverses state-granted “open space” lands that are dedicated to recreational uses.

Finally, the prudence of utilizing underground construction in such an area is directly correlated to the urgency of the need for a project and the likelihood of delay in the absence of underground construction. Both of these factors dictate that the “Overhead Alternative” should include underground facilities in the vicinity of the Deakin Educational Park.

The Bethel educational complex is located approximately one-half mile from Plumtree Substation. Rather than building this half-mile segment of the line overhead and then having to construct a transition station on or near the educational complex, the Company decided to begin the 345-kV

underground cable at Plumtree Substation. This avoids the building of a transition station, building a half-mile of overhead 345-kV line, rebuilding a half-mile of 115-kV line, and the associated costs of this work. In addition, this design avoids an additional “porpoising” of the line and enables the XLPE cable sheath to be grounded to a substantial ground grid at Plumtree Substation, as recommended by the Company’s underground technology consultants.

6.4 Cost of the Project and the Overhead Alternative

The estimated costs of the proposed Project and the Overhead Alternative are:

	Cost (\$ Millions)	Cost of Ancillary Facilities (\$ Millions)	Total Cost (\$ Millions)
Proposed Project	\$350	\$7	\$357
Overhead Alternative	\$272	\$7	\$279

Cost schedules for the Project, the Overhead Alternative, and the ancillary facilities are found in Appendix A.

6.5 Timing of Implementation of the Project and the Overhead Alternative

Given clear signals from the Connecticut Siting Council that any configuration it would approve would have to include some underground 345-kV sections, and given the likelihood of time-consuming appeals and injunctions delaying construction if a substantially overhead configuration were approved, CL&P recognized the likelihood that an overhead alternative could not be built in a timely manner. It became clear that, for all intents and purposes, any substantially overhead alternative was equivalent to a “no build” alternative, even though it was “technically feasible” purely from an engineering standpoint. Since a “no action” alternative was unacceptable from a system reliability standpoint, the only feasible and practical alternative was a configuration like the proposed Project that included substantial amounts of underground cable.

The proposed Project could be sited and built in a timely manner because it attempted to address concerns of various stakeholders in the siting process. The proposed Project was clearly superior to an overhead alternative in this regard. The urgent need for the new 345-kV line cannot be underestimated, and therefore timing of implementation is a critical factor in comparing the proposed Project and the Overhead Alternative.

6.6 Operating and Maintenance Costs of the Project and the Overhead Alternative

The facilities that make up the proposed Project are similar to facilities that CL&P currently operates and maintains elsewhere in its system, with the exception of the 345-kV XLPE cables. The use of 345-kV XLPE cables is discussed in section 5.7.2.

Operating and maintenance costs for the Project and for the Overhead Alternative would be approximately the same because of basic similarities in the components of these two designs. Specifically, both alternatives would require costs relating to operations (e.g., switching), substation maintenance, ROW maintenance, overhead line maintenance, cable system maintenance, and transition station maintenance. The difference in the extent of underground and overhead facilities between the proposed Project and the Overhead Alternative described above would not be expected to create a significant differential in the operating and maintenance costs.

6.7 Reliability Benefits of the Project and the Overhead Alternative

The proposed Project and the Overhead Alternative provide comparable reliability benefits because both:

- provide a 345-kV circuit with identical capacity;
- maintain the existing capacity of the 115-kV circuits between Plumtree and Norwalk Substations; and,
- strengthen the entire New England transmission system by enhancing interconnections between SWCT and the rest of the New England 345-kV system.

As a result, both the Project and the Overhead Alternative, including construction of the ancillary facilities, provide the following reliability benefits to the system:

- an increase in transfer limits into SWCT and the Norwalk-Stamford Sub-area;
- mitigation of transmission line overloads; and,
- mitigation of voltage and short-circuit problems.

Finally, both alternatives are consistent with a long term plan for the expansion the electric power grid.

7. Conclusion

The need for the Project is clear. The Project is the initial step in the construction of the SWCT 345-kV loop, the solution to SWCT's reliability needs first identified by system planners decades ago and reaffirmed through ISO-NE's RTEP process.

However, not only is the need for the Project universally recognized, the *urgency of the need* is equally acknowledged. In various forums, FERC and ISO-NE have reiterated their concerns about the need to address SWCT's reliability issues *now*, and the potential risks to the entire New England transmission grid if the line is not built in a timely manner. With the recent record peak load growth in SWCT and the potential losses of generation, CL&P does not have the luxury of time in getting this line built. It has proceeded to develop a Project that addresses the SWCT reliability issues and can be sited, permitted, and built in the necessary timeframe.

CL&P seeks regional cost support for the entire Project based not only upon the relevant FERC rulings discussed in section 1.5 above, but also upon a fair application of the standards set forth in Schedule 12C of the NEPOOL Tariff and NEPOOL/ISO-NE Planning Procedure No. 4. Specifically, the Project qualifies for full regional cost support because it is the only "practical and feasible" alternative that CL&P could actually permit and construct in the required time frame.

Appendix A

Bethel To Norwalk Project Cost Summary	
Plumtree Substation	\$26,896,000
Norwalk Substation	\$60,997,000
Transition Stations	\$26,610,000
115 kV XLPE	\$74,442,000
345 kV HPFF	\$90,616,000
345 kV XLPE	\$35,511,000
Overhead Lines	\$34,928,000
TOTAL	\$350,000,000

Proposed 345-kV Bethel to Norwalk Project - Substation Costs (\$, Thousands)

Location	Element	Work Description	Quantity	Material	Contracted Services	NU Labor	Total
Plumtree S/S, Bethel, CT	Foundations and Structural Steel	Foundations / structural steel for the new 345-kV lightning arresters, termination structures, line traps, and bus supports. Removal and disposal of contaminated soil from site.		\$ 48.00	\$ 844.00	\$ -	\$ 892.00
	Yard Equipment	345-kV lightning arresters, wave traps, and 115-kV lightning arrester upgrades. Upgrade the existing ground grid to accommodate new 345-kV expansion.		\$ 285.00	\$ 362.00	\$ 27.00	\$ 674.00
	Protection and Control	Two redundant systems will be used on all new elements in compliance with NPCC requirements. Installation of new D-20 Scada system complete with communications back to the control center. New station service transformers, transfer switches, battery banks		\$ 969.00	\$ 1,274.00	\$ 484.00	\$ 2,727.00
	GIS-Gas Insulated Substation	Construction of a three bay, 7-breaker, 345-kV breaker-and-a-half compact outdoor GIS with pre-insertion resistors, and a new gas insulated transmission line from the 345-kV breaker bay to the termination structure of 321 Line.		\$ -	\$ 16,479.00	\$ -	\$ 16,479.00
	Reactor	One (1) 75-150MVA shunt reactor complete with circuit switcher (including foundations).	1	\$ 3,117.00	\$ 373.00	\$ -	\$ 3,490.00
	Removal of Existing Equipment				\$ 50.00		\$ 50.00
	Engineering, Administration and Other	Includes planning, engineering, siting, surveying, land planning and drafting. Administrative costs including legal, purchasing, contract administration, project management, etc.	1	\$ -	\$ 718.00	\$ 1,866.00	\$ 2,584.00
		Total Plumtree Substation		\$ 4,419.00	\$ 20,100.00	\$ 2,377.00	\$ 26,896.00

Proposed 345-kV Bethel to Norwalk Project - Substation Costs (\$,Thousands)

Location	Element	Work Description	Quantity	Material	Contracted Services	NU Labor	Total
Norwalk S/S, Norwalk, CT	Site Preparation and Control House	Site clearing, grading, fill, relocation of existing underground utilities, new utility hookups. Retaining walls for raising site grade above flood levels and aquifer protection. 1 (one) control house (2 levels) (all controls for GIS and 115-kV yard - all		\$ 1,124.00	\$ 8,750.00	\$ -	\$ 9,874.00
	Conduit Banks for Power, Control and Fiber Optic Cables	115-kV power cable duct banks and control cable conduit banks to GIS installation and existing 115-kV yard.		\$ 7,480.00	\$ 7,835.00	\$ -	\$ 15,316.00
	Foundations, Yard Equipment and Bus Work	Upgrade the ground grid on the existing 115-kV yard due to low soil resistivity in the area. New 115-kV breaker bay to reduce outages for this project and provide future line positions. CCVT's, MOD's, lightning arresters, bus work, foundations, terminatio		\$ 1,385.00	\$ 3,058.00	\$ -	\$ 4,443.00
	Protection and Control	Control cabling, testing and terminating for GIS and 115-kV yard (all 4 bays). Installation of new D-20 Scada system complete with communications back to the control center. New station service transformers, transfer switches, battery banks and associated		\$ 1,295.00	\$ 3,424.00	\$ -	\$ 4,719.00
	GIS-Gas Insulated Substation	4 (four) single phase, low noise 345/115-kV autotransformers, 4 (four) 345-kV GIS breakers with pre-insertion resistors, building and pad for ultimate build out of 4 bays of breaker and a half scheme to accommodate twenty breakers and twelve line position		\$ -	\$ 21,111.00	\$ -	\$ 21,111.00
	Capacitor Banks and Circuit Switcher	34.8-MVAR capacitor banks and circuit switcher		\$ 111.00	\$ 21.00	\$ -	\$ 132.00
	Removal	Removal of Existing Equipment (1-bay, capacitor bank, reactor, existing MH, etc.)			\$ 200.00		\$ 200.00
	Engineering, Administration and Other	Includes planning, engineering, siting, surveying, land planning and drafting. Administrative costs including legal, purchasing, contract administration, project management, etc.		\$ -	\$ 1,750.00	\$ 3,452.00	\$ 5,202.00
		Total Norwalk Substation		\$ 11,395.00	\$ 46,149.00	\$ 3,452.00	\$ 60,997.00

Proposed 345-kV Bethel to Norwalk Project - Transition Stations Costs (\$,Thousands)							
Location	Element	Work Description	Quantity	Material	Contracted Services	NU Labor	Total
3 Locations	Site Work	Site clearing, site grading, access roads, retaining walls, erosion control, fencing and landscaping.		\$ 1,523.00	\$ 2,281.00	\$ -	\$ 3,804.00
	Foundations and Structural Steel	345-kV deadend structure, 345-kV disconnect switch stand, 345-kV SA/terminator stand, 345-kV bus support stand, 345-kV CCVT stand and 90' lightning mast.		\$ 1,403.00	\$ 1,060.00	\$ -	\$ 2,463.00
	Control Buildings	3 Relay and control enclosures, pre-engineered / assembled / wired.		\$ 1,205.00	\$ 70.00	\$ -	\$ 1,275.00
	Conduit and Raceway			\$ 309.00	\$ 385.00	\$ -	\$ 694.00
	Power and Control Cable, Grounding System			\$ 160.00	\$ 382.00	\$ -	\$ 542.00
	Bus Work			\$ 397.00	\$ 498.00	\$ -	\$ 895.00
	Major Equipment	Circuit breakers, 345-kV, current transformers, voltage transformers, disconnect switches and surge arresters.		\$ 2,978.00	\$ 425.00	\$ -	\$ 3,403.00
	Reactor	345-kV, 75-150 MVAR, includes assembly and oil-filling.	2	\$ 7,002.00	\$ 206.00	\$ -	\$ 7,208.00
	Station Service Equipment and Outdoor Lighting			\$ 174.00	\$ 66.00	\$ -	\$ 240.00
	Compensatory Wet Lands			\$ 302.00		\$ -	\$ 302.00
	Engineering, Administration and Other	Includes planning, engineering, siting, surveying, land planning and drafting. Administrative costs including legal, purchasing, contract administration, project management, etc.	1	\$ -	\$ 1,784.00	\$ 1,200.00	\$ 2,984.00
	Right of Way		1			\$ 2,800.00	\$ 2,800.00
		Total Three Transition Stations		\$ 15,453.00	\$ 7,157.00	\$ 4,000.00	\$ 26,610.00

Note: ROW costs above represent legal, engineering, cost of land and easements and miscellaneous other NU labor and outside services

Proposed 345-kV Bethel to Norwalk Project - Transmission Line Costs (\$,Thousands)

Location	Element	Work Description	Quantity	Material	Contracted Services	NU Labor	Total
115-kV XLPE 10 Miles							
	Cable and Accessories	115-kV XLPE cable	173,195	\$ 13,470.00	\$ 1,323.00	\$ -	\$ 14,793.00
		115-kV terminators	24	\$ 217.00	\$ 240.00	\$ -	\$ 457.00
		115-kV arresters	18	\$ 37.00	\$ 55.00	\$ -	\$ 92.00
		115-kV splices	24	\$ 153.00	\$ 120.00	\$ -	\$ 273.00
		115-kV cross-bond splice	60	\$ 500.00	\$ 265.00	\$ -	\$ 765.00
		Vault grounding systems	30	\$ 150.00	\$ 80.00	\$ -	\$ 230.00
		Link box without SVL's	15	\$ 10.00	\$ 24.00	\$ -	\$ 34.00
		Link box with SVL	9	\$ 11.00	\$ 25.00	\$ -	\$ 36.00
		115-kV cable clamps	270	\$ 10.00	\$ 40.00	\$ -	\$ 50.00
		Continuity conductor	56,500	\$ 300.00	\$ 210.00	\$ -	\$ 510.00
		Manufacturer's field supervisor	200	\$ -	\$ 230.00	\$ -	\$ 230.00
		Total Cable and Accessories:		\$ 14,858.00	\$ 2,612.00	\$ -	\$ 17,470.00
	Communication Conduits	Fiber-optic cable (by others)					
		Feet HDPE conduit	104,500	\$ 400.00	\$ 576.00	\$ -	\$ 976.00
		Hand holes	26	\$ 81.00	\$ 46.00	\$ -	\$ 127.00
		Total Communication Conduits:		\$ 481.00	\$ 622.00	\$ -	\$ 1,103.00
	Temperature Monitoring System	Fiber-optic cable	60,000	\$ 57.00	\$ 180.00	\$ -	\$ 237.00
		Fiber-optic cable splices (includes enclosures)	12	\$ 2.00	\$ 7.00	\$ -	\$ 9.00
		Terminal equipment / software / instrumentation	6	\$ 16.00	\$ 21.00	\$ -	\$ 37.00
		2" HDPE conduit, feet	29,700	\$ 134.00	\$ 759.00	\$ -	\$ 893.00
		Thermocouples, each	54	\$ 8.00	\$ 97.00	\$ -	\$ 105.00
		Test stations, each	37	\$ 12.00	\$ 92.00	\$ -	\$ 104.00
		Temperature probes, each	6	\$ 1.00	\$ 2.00	\$ -	\$ 3.00
		Total Temperature Monitoring System:		\$ 230.00	\$ 1,158.00	\$ -	\$ 1,388.00
	115-kV Riser Structure	115-kV Riser Structure	6	\$ 238.00	\$ 72.00	\$ -	\$ 310.00
	Duct Bank and Earthwork	Conduit	281,925	\$ 1,073.00	\$ 1,495.00	\$ -	\$ 2,568.00
		Spacers	45,280	\$ 255.00	\$ 7.00	\$ -	\$ 262.00
		Excavation, no rock, per cubic yard, including hauling	42,114	\$ -	\$ 3,594.00	\$ -	\$ 3,594.00
		Fluidized Thermal Backfill (FTB™)	24,263	\$ 3,236.00	\$ 618.00	\$ -	\$ 3,854.00
		Duct encasement concrete	14,883	\$ 2,248.00	\$ 496.00	\$ -	\$ 2,744.00
		Vault	28	\$ 663.00	\$ 834.00	\$ -	\$ 1,497.00
		Jack and bore	412	\$ 206.00	\$ 677.00	\$ -	\$ 883.00
		Dewatering, per trench foot	10,000	\$ -	\$ 221.00	\$ -	\$ 221.00
		1" steel plating	140,000	\$ 354.00	\$ 589.00	\$ -	\$ 943.00
		Sheeting and shoring	52,425	\$ 530.00	\$ 589.00	\$ -	\$ 1,119.00
		Pavement repair	171,920	\$ 1,310.00	\$ 966.00	\$ -	\$ 2,276.00
		Curb repair	185	\$ 4.00	\$ 4.00	\$ -	\$ 8.00
		Sidewalk repair	1,500	\$ 7.00	\$ 13.00	\$ -	\$ 20.00
		Landscape restoration	1	\$ 19.00	\$ 19.00	\$ -	\$ 38.00
		Traffic control	1	\$ -	\$ 700.00	\$ -	\$ 700.00
		Loam and seed	5,000	\$ 18.00	\$ 36.00	\$ -	\$ 54.00
		Survey	1	\$ -	\$ 220.00	\$ -	\$ 220.00
		115-kV riser pole foundation	5	\$ 81.00	\$ 280.00	\$ -	\$ 361.00
		Sediment control	1	\$ 14.00	\$ 33.00	\$ -	\$ 47.00
		Clear and grub	1	\$ -	\$ 74.00	\$ -	\$ 74.00
		Testing	1	\$ -	\$ 950.00	\$ -	\$ 950.00
		Bituminous concrete	95,662	\$ -	\$ 515.00	\$ -	\$ 515.00
		2" Bituminous concrete overlay	10,762	\$ 820.00	\$ 302.00	\$ -	\$ 1,122.00
		1 Loop repairs	1	\$ -	\$ 71.00	\$ -	\$ 71.00
		Rock Excavation	1	\$ -	\$ 20,903.00	\$ -	\$ 20,903.00
		Total Duct Bank and Earthwork:		\$ 10,838.00	\$ 34,206.00	\$ -	\$ 45,044.00
	Engineering, Administration and Other	Includes planning, engineering, siting, surveying, land planning and drafting. Administrative costs including legal, purchasing, contract administration, project	1	\$ -	\$ 4,725.00	\$ 3,302.00	\$ 8,027.00
	Right of Way					\$ 1,100.00	\$ 1,100.00
		Total 115-kV XLPE		\$ 26,645.00	\$ 43,395.00	\$ 4,402.00	\$ 74,442.00

Note: ROW costs above represent legal, engineering, cost of land and easements and miscellaneous other NU labor and outside services

Proposed 345-kV Bethel to Norwalk Project - Transmission Line Costs (\$,Thousands)

Location	Element	Work Description	Quantity	Material	Contracted Services	NU Labor	Total
345-kV HPFF 9.4 Miles							
	Pipe and Accessories Section	Cable pipe, 8-inch nominal, pritec, per foot	100900	\$ 4,290.00	\$ 3,925.00	\$ -	\$ 8,215.00
		Spacers	3200	\$ 65.00	\$ 130.00	\$ -	\$ 195.00
		Excavation, no rock, per cubic yard, including hauling	20	\$ 2.00	\$ 55.00	\$ -	\$ 57.00
		Fluidized Thermal Backfill (FTB™)	2530	\$ 126.00	\$ 268.00	\$ -	\$ 394.00
		Duct encasement concrete	2700	\$ 95.00	\$ 268.00	\$ -	\$ 363.00
		Splicing trifurcator	4	\$ 98.00	\$ 344.00	\$ -	\$ 442.00
		Riser pipe stainless steel 5-inch	840	\$ 91.00	\$ 191.00	\$ -	\$ 282.00
		Cathodic protection	1	\$ 97.00	\$ 153.00	\$ -	\$ 250.00
		Pressurization plant	2	\$ 1,288.00	\$ 43.00	\$ -	\$ 1,331.00
		Leak detection system	1	\$ 993.00	\$ 344.00	\$ -	\$ 1,337.00
		Coated 2 inch pipe schedule 80 including valves, etc.	250	\$ 6.00	\$ 41.00	\$ -	\$ 47.00
		Gallons of polybutene dielectric fluid	179068	\$ 1,193.00	\$ 243.00	\$ -	\$ 1,436.00
		Vaults (including grounding)	22	\$ 993.00	\$ 497.00	\$ -	\$ 1,490.00
		Total Pipe and Accessories Section		\$ 9,337.00	\$ 6,502.00	\$ -	\$ 15,839.00
	Cable and Accessories:	345-kV cable	305508	\$ 29,550.00	\$ 1,147.00	\$ -	\$ 30,697.00
		Normal 3-phase joints	34	\$ 682.00	\$ 3,241.00	\$ -	\$ 3,923.00
		Semi stop joints with bypass piping	2	\$ 56.00	\$ 197.00	\$ -	\$ 253.00
		Complete terminators	12	\$ 1,311.00	\$ 104.00	\$ -	\$ 1,415.00
		Arresters	12	\$ 136.00	\$ 69.00	\$ -	\$ 205.00
		Total Cable and Accessories:		\$ 31,735.00	\$ 4,758.00	\$ -	\$ 36,493.00
	Communication Conduits:	Fiber-optic cable (by others)		\$ -	\$ -	\$ -	\$ -
		Fiber-optic cable splices (by others)		\$ -	\$ -	\$ -	\$ -
		Feet HDPE Conduit	100900	\$ 252.00	\$ 183.00	\$ -	\$ 435.00
		Hand holes	40	\$ 47.00	\$ 19.00	\$ -	\$ 66.00
		Total Communication conduits:		\$ 299.00	\$ 202.00	\$ -	\$ 501.00
	Temperature Monitoring System	Fiber-optic cable	51000	\$ 164.00	\$ 41.00	\$ -	\$ 205.00
		Fiber-optic cable splices (including enclosures)	5	\$ 5.00	\$ 19.00	\$ -	\$ 24.00
		2" HDPE conduit, feet	51000	\$ 80.00	\$ 28.00	\$ -	\$ 108.00
		Thermocouples, each	36	\$ 14.00	\$ 39.00	\$ -	\$ 53.00
		Test stations, each	18	\$ 7.00	\$ 40.00	\$ -	\$ 47.00
		Temperature probes, each	36	\$ 14.00	\$ 29.00	\$ -	\$ 43.00
		Total Temperature Monitoring System:		\$ 284.00	\$ 196.00	\$ -	\$ 480.00
	Duct Bank and Earthwork:	Excavation, no rock, per cubic yard, including hauling	40000	\$ 1,159.00	\$ 6,129.00	\$ -	\$ 7,288.00
		Soil backfill	17300	\$ 608.00	\$ 152.00	\$ -	\$ 760.00
		Excavation for vault	1800	\$ 23.00	\$ 141.00	\$ -	\$ 164.00
		Fluidized Thermal Backfill (FTB™)	20000	\$ 3,440.00	\$ -	\$ -	\$ 3,440.00
		Horizontal vertical drilling	1400	\$ 88.00	\$ 344.00	\$ -	\$ 432.00
		Jack and bore	185	\$ 298.00	\$ 2,865.00	\$ -	\$ 3,163.00
		Sheeting and shoring	5000	\$ 115.00	\$ 161.00	\$ -	\$ 276.00
		Pavement repair	650000	\$ 443.00	\$ 955.00	\$ -	\$ 1,398.00
		Curb repair	20000	\$ 13.00	\$ 52.00	\$ -	\$ 65.00
		Sidewalk repair	1200	\$ 4.00	\$ 6.00	\$ -	\$ 10.00
		Landscape restoration	1	\$ 64.00	\$ 97.00	\$ -	\$ 161.00
		Traffic control	1	\$ 33.00	\$ 1,091.00	\$ -	\$ 1,124.00
		Loam and seed	10000	\$ 33.00	\$ 48.00	\$ -	\$ 81.00
		Survey	1	\$ 33.00	\$ 161.00	\$ -	\$ 194.00
		Rock Excavation	1	\$ -	\$ 9,997.00	\$ -	\$ 9,997.00
		Total Duct Bank and Earthwork:		\$ 6,354.00	\$ 22,199.00	\$ -	\$ 28,553.00
	Engineering, Administration and Other	Includes planning, engineering, siting, surveying, land planning and drafting. Administrative costs including legal, purchasing, contract administration, project	1	\$ -	\$ 4,950.00	\$ 3,300.00	\$ 8,250.00
	Right of Way					\$ 500.00	\$ 500.00
		Total 345-kV HPFF		\$ 48,009.00	\$ 38,807.00	\$ 3,800.00	\$ 90,616.00

Note: ROW costs above represent legal, engineering, cost of land and easements and miscellaneous other NU labor and outside services

Proposed 345-kV Bethel to Norwalk Project - Transmission Line Costs (\$,Thousands)

Location	Element	Work Description	Quantity	Material	Contracted Services	NU Labor	Total
345-kV XLPE 2.1 Miles							
	Cable and Accessories:	345-kV XLPE cable	70,000	\$ 5,214.00	\$ 1,564.00	\$ -	\$ 6,778.00
		345-kV terminators	12	\$ 268.00	\$ 268.00	\$ -	\$ 536.00
		345-kV arresters	12	\$ 180.00	\$ 90.00	\$ -	\$ 270.00
		345-kV splices	36	\$ 804.00	\$ 536.00	\$ -	\$ 1,340.00
		345-kV cross-bond splice	24	\$ 625.00	\$ 357.00	\$ -	\$ 982.00
		Vault grounding systems	12	\$ 27.00	\$ 45.00	\$ -	\$ 72.00
		Link box without SVL's	3	\$ 20.00	\$ 10.00	\$ -	\$ 30.00
		Link box with SVL	5	\$ 40.00	\$ 20.00	\$ -	\$ 60.00
		345-kV cable clamps	300	\$ 89.00	\$ 45.00	\$ -	\$ 134.00
		Feet continuity conductor	24,000	\$ 465.00	\$ 179.00	\$ -	\$ 644.00
		Feet continuity conduit	23,000	\$ 52.00	\$ 274.00	\$ -	\$ 326.00
		Jacket integrity test	84	\$ -	\$ 313.00	\$ -	\$ 313.00
		Type test	1	\$ 302.00	\$ -	\$ -	\$ 302.00
		Total Cable and Accessories:		\$ 8,086.00	\$ 3,701.00	\$ -	\$ 11,787.00
	Communication Conduits:	Fiber-optic cable (by others)		\$ -	\$ -	\$ -	\$ -
		Fiber-optic cable splices (by others)		\$ -	\$ -	\$ -	\$ -
		Feet HDPE conduit	23,000	\$ 103.00	\$ 257.00	\$ -	\$ 360.00
		Hand holes	8	\$ 47.00	\$ 47.00	\$ -	\$ 94.00
		Total Communication Conduits:		\$ 150.00	\$ 304.00	\$ -	\$ 454.00
	Temperature Monitoring System:	Fiber-optic cable	26,000	\$ 58.00	\$ 154.00	\$ -	\$ 212.00
		Fiber-optic cable splices (including enclosures)	2	\$ 12.00	\$ 8.00	\$ -	\$ 20.00
		Terminal equipment / software / instrumentation	4	\$ 14.00	\$ 21.00	\$ -	\$ 35.00
		2" HDPE conduit, feet	23,000	\$ 52.00	\$ 274.00	\$ -	\$ 326.00
		Thermocouples, each	20	\$ 2.00	\$ 45.00	\$ -	\$ 47.00
		Test stations, each	10	\$ 7.00	\$ 14.00	\$ -	\$ 21.00
		Temperature probes, each	2	\$ 1.00	\$ 2.00	\$ -	\$ 3.00
		Total Temperature Monitoring System:		\$ 146.00	\$ 518.00	\$ -	\$ 664.00
	345-kV Riser Structure	345-kV riser Structure	1	\$ 91.00	\$ 41.00		\$ 132.00
	Duct Bank and Earthwork:	Feet conduit	69,000	\$ 719.00	\$ 1,641.00	\$ -	\$ 2,360.00
		Spacers	18,400	\$ 220.00	\$ 412.00	\$ -	\$ 632.00
		Excavation, no rock, per cubic yard, including hauling	11,000	\$ -	\$ 984.00	\$ -	\$ 984.00
		Fluidized Thermal Backfill (FTB™)	8,000	\$ 1,311.00	\$ 238.00	\$ -	\$ 1,549.00
		Duct encasement concrete	3,000	\$ 581.00	\$ 89.00	\$ -	\$ 670.00
		Vault	12	\$ 760.00	\$ 447.00	\$ -	\$ 1,207.00
		Jack and bore	160	\$ 95.00	\$ 238.00	\$ -	\$ 333.00
		Dewatering, per trench foot	5,700	\$ 68.00	\$ 128.00	\$ -	\$ 196.00
		1/4" stone	3	\$ -	\$ -	\$ -	\$ -
		Sheeting and shoring	9,200	\$ 138.00	\$ 205.00	\$ -	\$ 343.00
		Pavement repair	126,000	\$ 939.00	\$ 939.00	\$ -	\$ 1,878.00
		Curb repair	500	\$ 11.00	\$ 4.00	\$ -	\$ 15.00
		Sidewalk repair	3,000	\$ 68.00	\$ 68.00	\$ -	\$ 136.00
		Landscape restoration	1	\$ -	\$ 75.00	\$ -	\$ 75.00
		Traffic control	1	\$ -	\$ 373.00	\$ -	\$ 373.00
		Loam and seed	4,000	\$ 59.00	\$ 59.00	\$ -	\$ 118.00
		Survey	1	\$ -	\$ 37.00	\$ -	\$ 37.00
		Rock Excavation	1	\$ -	\$ 7,484.00	\$ -	\$ 7,484.00
		Total Duct Bank and Earthwork:		\$ 4,969.00	\$ 13,421.00	\$ -	\$ 18,390.00
	Engineering, Administration and Other	Includes planning, engineering, siting, surveying, land planning and drafting. Administrative costs including legal, purchasing, contract administration, project	1	\$ -	\$ 2,499.00	\$ 985.00	\$ 3,484.00
	Right of Way					\$ 600.00	\$ 600.00
		Total 345-kV XLPE		\$ 13,442.00	\$ 20,484.00	\$ 1,585.00	\$ 35,511.00

Note: ROW costs above represent legal, engineering, cost of land and easements and miscellaneous other NU labor and outside services

Proposed 345-kV Bethel to Norwalk Project - Transmission Line Costs (\$,Thousands)

Location	Element	Work Description	Quantity	Material	Contracted Services	NU Labor	Total
Overhead Lines							
Gallows Hill to Archers Lane							
Single Circuit 345-kV/115-kV Monopole 1.3 miles		Clearing, access roads, erosion control, etc.	29	\$ 157.00	\$ 204.00	\$ -	\$ 361.00
		Excavation and foundations	14	\$ 126.00	\$ 705.00	\$ -	\$ 831.00
		Structure	14	\$ 1,044.00	\$ 276.00	\$ -	\$ 1,320.00
		Counterpoise	1	\$ 99.00	\$ 37.00	\$ -	\$ 136.00
		Grounding	1	\$ 6.00	\$ 28.00	\$ -	\$ 34.00
		Cable 345-kV 1590 KCMIL 47/7 2C / phase	58,600	\$ 365.00	\$ 135.00	\$ -	\$ 500.00
		Cable 115-kV 1272 45/7 1C / phase	26,700	\$ 142.00	\$ 72.00	\$ -	\$ 214.00
		Shield wire	16,368	\$ 24.00	\$ 28.00	\$ -	\$ 52.00
		Total Gallows Hill to Archers Lane	101,727	\$ 1,963.00	\$ 1,485.00	\$ -	\$ 3,448.00
Hoyts Hill to Gallows Hill							
Single Circuit 345-kV H Frame 3.6		Clearing, access roads, erosion control, etc.	43	\$ 286.00	\$ 390.00	\$ -	\$ 676.00
		Excavation and foundations (if required)	68	\$ 24.00	\$ 216.00	\$ -	\$ 240.00
		Structure H frame	31	\$ 599.00	\$ 524.00	\$ -	\$ 1,123.00
		Structure monopole	3	\$ 183.00	\$ 37.00	\$ -	\$ 220.00
		Counterpoise	1	\$ 249.00	\$ 94.00	\$ -	\$ 343.00
		Grounding	1	\$ 35.00	\$ 153.00	\$ -	\$ 188.00
		Cable 345-kV 1590 KCMIL 47/7 2C / phase	140,800	\$ 864.00	\$ 321.00	\$ -	\$ 1,185.00
		Shield wire	19,000	\$ 30.00	\$ 34.00	\$ -	\$ 64.00
		Total Hoyts Hill to Archers Lane		\$ 2,270.00	\$ 1,769.00	\$ -	\$ 4,039.00
Norwalk Jct to Norwalk Substation							
Single Circuit 345-kV Delta Monopole 3.7 miles		Clearing, access roads, erosion control, etc.	36	\$ 238.00	\$ 391.00	\$ -	\$ 629.00
Double Circuit 115-kV Monopole 0.5 miles		Excavation and foundations (if required)	42	\$ 331.00	\$ 1,957.00	\$ -	\$ 2,288.00
		Structure monopole	42	\$ 3,158.00	\$ 654.00	\$ -	\$ 3,812.00
		Counterpoise	1	\$ 274.00	\$ 104.00	\$ -	\$ 378.00
		Grounding	1	\$ 16.00	\$ 76.00	\$ -	\$ 92.00
		Cable 345-kV 1590 KCMIL 47/7 2C / phase	129,300	\$ 779.00	\$ 288.00	\$ -	\$ 1,067.00
		Cable 115-kV 1272 45/7	62,100	\$ 88.00	\$ 35.00	\$ -	\$ 123.00
		Shield wire	47,500	\$ 64.00	\$ 75.00	\$ -	\$ 139.00
		Total Hoyts Hill to Archers Lane	239,022	\$ 4,948.00	\$ 3,580.00	\$ -	\$ 8,528.00
	Removal				\$ 1,200.00	\$ -	\$ 1,200.00
	Fiber Optics	20.1 miles of primary and backup circuits		\$ 1,214.00	\$ 3,965.00		\$ 5,179.00
	Relocation	Temporary relocation of lines at Norwalk Substation			\$ 400.00		\$ 400.00
	Engineering, Administration and Other	Includes all planning, engineering, siting, surveying, land planning and drafting. Administrative costs including legal, purchasing, contract administration, project management, etc.	1	\$ -	\$ 1,200.00	\$ 3,034.00	\$ 4,234.00
	Right of Way		77			\$ 7,900.00	\$ 7,900.00
		Total Overhead Lines		\$ 10,395.00	\$ 13,599.00	\$ 10,934.00	\$ 34,928.00
		Project Total		\$ 129,758.00	\$ 189,691.00	\$ 30,550.00	\$ 350,000.00

Note: ROW costs above represent legal, engineering, cost of land and easements and miscellaneous other NU labor and outside services

Overhead Alternative - 345-kV Bethel to Norwalk Project

Location	Work Description	Total (\$,Thousands)
Plumtree Substation	Installation of seven 345 kV GIS breakers, with pre-insertion resistors, at the Plumtree Substation and interconnecting them into the existing system.	\$23,406.00
Norwalk Substation	Installation of 345 kV GIS breakers, with pre-insertion resistors, one new 400MVA autotransformer, and upgrades to the existing 115 kV equipment at the Norwalk Substation and interconnecting them into the existing system.	\$60,996.00
Transition Stations	Installation of three new Transition Stations at Hoyt's Hill, Honey Hill area and Norwalk Junction with the installation of two 80-150 MVA variable Shunt Reactors at Norwalk Junction	\$26,610.00
345 kV HPFF Underground Line	Install 4.3 miles of double circuit 345 kV HPFF underground line between Honey Hill and Norwalk Junction.	\$46,232.00
345 kV XLPE Underground Line	Install 2.1 miles of 345 kV XLPE underground line between Plumtree Substation and Hoyt's Hill Transition Station.	\$35,511.00
115 kV XLPE Underground Line	Installation of 1500' of 115 kV XLPE cable in existing ductbank in the Norwalk Substation	\$667.00
Overhead Lines	345/115 kV lines between Plumtree and Norwalk and a single 115 kV line between Norwalk Junction Transition Station and Norwalk Substation	\$78,578.00
Total		\$272,000.00

Overhead Alternative to 345-kV Bethel to Norwalk Project - Substation Costs (\$,Thousands)

Location	Element	Work Description	Quantity	Material	Contracted Services	NU Labor	Total
Plumtree S/S, Bethel, CT	Foundations and Structural Steel	Foundations / structural steel for the new 345-kV lightning arresters, termination structures, line traps, and bus supports. Removal and disposal of contaminated soil from site.		\$ 48.00	\$ 844.00	\$ -	\$ 892.00
	Yard Equipment	345-kV lightning arresters, wave traps, and 115-kV lightning arrester upgrades. Upgrade the existing ground grid to accommodate new 345-kV expansion.		\$ 285.00	\$ 362.00	\$ 27.00	\$ 674.00
	Protection and Control	Two redundant systems will be used on all new elements in compliance with NPCC requirements. Installation of new D-20 Scada system complete with communications back to the control center. New station service transformers, transfer switches, battery banks		\$ 969.00	\$ 1,274.00	\$ 484.00	\$ 2,727.00
	GIS-Gas Insulated Substation	Construction of a three bay, 7-breaker, 345-kV breaker-and-a-half compact outdoor GIS, and a new gas insulated transmission line from the 345-kV breaker bay to the termination structure of 321 Line.		\$ -	\$ 16,479.00	\$ -	\$ 16,479.00
	Removal of Existing Equipment				\$ 50.00		\$ 50.00
	Engineering, Administration and Other	Includes planning, engineering, siting, surveying, land planning and drafting. Administrative costs including legal, purchasing, contract administration, project management, etc.	1	\$ -	\$ 718.00	\$ 1,866.00	\$ 2,584.00
		Total Plumtree Substation		\$ 1,302.00	\$ 19,727.00	\$ 2,377.00	\$ 23,406.00

Overhead Alternative to 345-kV Bethel to Norwalk Project - Substation Costs (\$,Thousands)

Location	Element	Work Description	Quantity	Material	Contracted Services	NU Labor	Total
Norwalk S/S, Norwalk, CT	Site Preparation and Control House	Site clearing, grading, fill, relocation of existing underground utilities, new utility hookups. Retaining walls for raising site grade above flood levels and aquifer protection. 1 (one) control house (2 levels) (all controls for GIS and 115-kV yard - all		\$ 1,124.00	\$ 8,750.00	\$ -	\$ 9,874.00
	Conduit Banks for Power, Control and Fiber Optic Cables	115-kV Power cable duct banks and control cable conduit banks to GIS installation and existing 115-kV yard.	5,989	\$ 7,480.00	\$ 7,835.00	\$ -	\$ 15,315.00
	Foundations, Yard Equipment and Bus Work	Upgrade the ground grid on the existing 115-kV yard due to low soil resistivity in the area. New 115-kV breaker bay to reduce outages for this project and provide future line positions. CCVT's, MOD's, lightning arresters, bus work, foundations, terminatio		\$ 1,385.00	\$ 3,058.00	\$ -	\$ 4,443.00
	Protection and Control	Control cabling, testing and terminating for GIS and 115-kV yard (all 4 bays). Installation of new D-20 Scada system complete with communications back to the control center. New station service transformers, transfer switches, battery banks and associated		\$ 1,295.00	\$ 3,424.00	\$ -	\$ 4,719.00
	GIS-Gas Insulated Substation	4 (four) single phase, low noise 345/115-kV autotransformers with pre-insertion resistors, 4 (four) 345-kV GIS breakers, building and pad for ultimate build out of 4 bays of breaker and a half scheme to accommodate twenty breakers and twelve line positio		\$ -	\$ 21,111.00	\$ -	\$ 21,111.00
	Capacitor Banks and Circuit Switcher	34.8-MVAR capacitor banks and circuit switcher.		\$ 111.00	\$ 21.00	\$ -	\$ 132.00
Removal	Removal of Existing Equipment (1-Bay, capacitor bank, reactor, existing MH, etc.)				\$ 200.00		\$ 200.00
	Engineering, Administration and Other	Includes planning engineering, siting, surveying, land planing and drafting. Administrative costs including legal, purchasing, contract administration, project management, etc.		\$ -	\$ 1,750.00	\$ 3,452.00	\$ 5,202.00
		Total Norwalk Substation		\$ 11,395.00	\$ 46,149.00	\$ 3,452.00	\$ 60,996.00

Overhead Alternative to 345-kV Bethel to Norwalk Project - Transition Stations Costs (\$,Thousands)							
Location	Element	Work Description	Quantity	Material	Contracted Services	NU Labor	Total
3 Locations	Site Work	Site clearing, site grading, access roads, retaining walls, erosion control, fencing and landscaping.		\$ 1,523.00	\$ 2,281.00	\$ -	\$ 3,804.00
	Foundations and Structural Steel	345-kV deadend structure, 345-kV disconnect switch stand, 345-kV SA/terminator stand, 345-kV bus support stand, 345-kV CCVT stand and 90' lightning mast.		\$ 1,403.00	\$ 1,060.00	\$ -	\$ 2,463.00
	Control Buildings	3 Relay and control enclosures, pre-engineered / assembled / wired.		\$ 1,205.00	\$ 70.00	\$ -	\$ 1,275.00
	Conduit and Raceway			\$ 309.00	\$ 385.00	\$ -	\$ 694.00
	Power and Control Cable, Grounding System			\$ 160.00	\$ 382.00	\$ -	\$ 542.00
	Bus Work			\$ 397.00	\$ 498.00	\$ -	\$ 895.00
	Major Equipment	Circuit breakers, 345-kV, current transformers, voltage transformers, disconnect switches and surge arresters.		\$ 2,978.00	\$ 425.00	\$ -	\$ 3,403.00
	Reactor	345-kV, 75-150 MVAR, includes assembly and oil-filling.	2	\$ 7,002.00	\$ 206.00	\$ -	\$ 7,208.00
	Station Service Equipment and Outdoor Lighting			\$ 174.00	\$ 66.00	\$ -	\$ 240.00
	Compensatory Wet Lands			\$ 302.00		\$ -	\$ 302.00
	Engineering, Administration and Other	Includes planning engineering, siting, surveying, land planing and drafting. Administrative costs including legal, purchasing, contract administration, project management, etc.			\$ 1,784.00	\$ 1,200.00	\$ 2,984.00
	ROW					\$ 2,800.00	\$ 2,800.00
		Total Three Transition Stations		\$ 15,453.00	\$ 7,157.00	\$ 4,000.00	\$ 26,610.00

Note: Row costs above represent outside services, cost of land and easements and NU labor

Overhead Alternative to 345-kV Bethel to Norwalk Project - Transmission Line Costs (\$,Thousands)

Location	Element	Work Description	Quantity	Material	Contracted Services	NU Labor	Total
345-kV HPFF 4.3 Miles	Pipe and Accessories Section	Cable pipe, 8-inch nominal, pritec, per foot	47,230	\$ 2,009.00	\$ 1,840.00	\$ -	\$ 3,849.00
		Feet cable pipe, 8-inch nominal, fusion bonded	1,498	\$ 31.00	\$ 61.00	\$ -	\$ 92.00
		Cable pipe field flares	9	\$ 1.00	\$ 19.00	\$ -	\$ 20.00
		Cable pipe chill rings	1,184	\$ 59.00	\$ 125.00	\$ -	\$ 184.00
		Cable pipe joint and pipe-casting repair sleeves	1,264	\$ 45.00	\$ 125.00	\$ -	\$ 170.00
		Splicing trifurcator	4	\$ 98.00	\$ 345.00	\$ -	\$ 443.00
		Riser pipe stainless steel 5-inch	393	\$ 43.00	\$ 90.00	\$ -	\$ 133.00
		Cathodic protection	1	\$ 45.00	\$ 72.00	\$ -	\$ 117.00
		Pressurization plant	2	\$ 1,290.00	\$ 44.00	\$ -	\$ 1,334.00
		Leak detection system	1	\$ 1,000.00	\$ 345.00	\$ -	\$ 1,345.00
		Coated 2 inch pipe schedule 80 including valves, etc.	117	\$ 3.00	\$ 20.00	\$ -	\$ 23.00
		Gallons of polybutene dielectric fluid	83,819	\$ 560.00	\$ 115.00	\$ -	\$ 675.00
		Vaults (including grounding)	10	\$ 464.00	\$ 235.00	\$ -	\$ 699.00
				Total Pipe and Accessories Section		\$ 5,648.00	\$ 3,436.00
	Cable and Accessories:	345-kV Cable	143,004	\$ 13,850.00	\$ 550.00	\$ -	\$ 14,400.00
		Normal 3-phas Joints	14	\$ 320.00	\$ 1,520.00	\$ -	\$ 1,840.00
		Semi Stop Joints with bypass piping	2	\$ 30.00	\$ 95.00	\$ -	\$ 125.00
		Complete Terminators	12	\$ 620.00	\$ 50.00	\$ -	\$ 670.00
		Arresters	12	\$ 65.00	\$ 35.00	\$ -	\$ 100.00
		Total Cable and Accessories:		\$ 14,885.00	\$ 2,250.00	\$ -	\$ 17,135.00
	Communication Conduits:	Fiber-optic cable (by others)		\$ -	\$ -	\$ -	\$ -
		Fiber-optic cable splices (by others)		\$ -	\$ -	\$ -	\$ -
		Feet HDPE conduit	47,230	\$ 120.00	\$ 86.00	\$ -	\$ 206.00
		Hand holes	20	\$ 25.00	\$ 10.00	\$ -	\$ 35.00
		Total Communication Conduits:		\$ 145.00	\$ 96.00	\$ -	\$ 241.00
	Temperature Monitoring System	Fiber-optic cable	23,872	\$ 77.00	\$ 20.00	\$ -	\$ 97.00
		Fiber-optic cable splices (including enclosures)	3	\$ 3.00	\$ 10.00	\$ -	\$ 13.00
		2" HDPE conduit, feet	23,872	\$ 38.00	\$ 13.00	\$ -	\$ 51.00
		Thermocouples, each	17	\$ 7.00	\$ 19.00	\$ -	\$ 26.00
		Test stations, each	18	\$ 4.00	\$ 19.00	\$ -	\$ 23.00
		Temperature probes, each	17	\$ 7.00	\$ 14.00	\$ -	\$ 21.00
		Total Temperature Monitoring System:		\$ 136.00	\$ 95.00	\$ -	\$ 231.00
	Duct Bank and Earthwork:	Excavation, no rock, per cubic yard, including hauling	18,723	\$ 545.00	\$ 2,870.00	\$ -	\$ 3,415.00
		Soil backfill	8,098	\$ 285.00	\$ 72.00	\$ -	\$ 357.00
		Excavation for vault	1,800	\$ 11.00	\$ 70.00	\$ -	\$ 81.00
		Fluidized Thermal Backfill (FTB™)	9,362	\$ 1,610.00	\$ -	\$ -	\$ 1,610.00
		Horizontal vertical drilling	1,400	\$ 42.00	\$ 162.00	\$ -	\$ 204.00
		Jack and bore	185	\$ 140.00	\$ 1,345.00	\$ -	\$ 1,485.00
		Sheeting and shoring	2,340	\$ 55.00	\$ 75.00	\$ -	\$ 130.00
		Pavement repair	304,255	\$ 210.00	\$ 450.00	\$ -	\$ 660.00
		Curb repair	9,362	\$ 6.00	\$ 25.00	\$ -	\$ 31.00
		Sidewalk repair	562	\$ 2.00	\$ 3.00	\$ -	\$ 5.00
		Landscape restoration	1	\$ 30.00	\$ 45.00	\$ -	\$ 75.00
		Traffic control	1	\$ 16.00	\$ 510.00	\$ -	\$ 526.00
		Loam and seed	4,681	\$ 16.00	\$ 25.00	\$ -	\$ 41.00
		Survey	1	\$ 16.00	\$ 75.00	\$ -	\$ 91.00
		Rock Excavation	1	\$ -	\$ 4,680.00	\$ -	\$ 4,680.00
				\$ 2,984.00	\$ 10,407.00	\$ -	\$ 13,391.00
		Total Duct Bank and Earthwork:					
	Engineering, Administration and Other	Includes planning engineering, siting, surveying, land planing and drafting. Administrative costs including			\$ 3,450.00	\$ 2,200.00	\$ 5,650.00
	ROW					\$ 500.00	\$ 500.00
		Total 345-kV HPFF		\$ 23,798.00	\$ 19,734.00	\$ 2,700.00	\$ 46,232.00

Note: Row costs above represent outside services, cost of land and easements and NU labor

Overhead Alternative to 345-kV Bethel to Norwalk Project - Transmission Line Costs (\$,Thousands)

Location	Element	Work Description	Quantity	Material	Contracted Services	NU Labor	Total		
345-kV XLPE 2.1 Miles	Cable and Accessories:	345-kV XLPE cable	70,000	\$ 5,214.00	\$ 1,564.00	\$ -	\$ 6,778.00		
		345-kV terminators	12	\$ 268.00	\$ 268.00	\$ -	\$ 536.00		
		345-kV arresters	12	\$ 180.00	\$ 90.00	\$ -	\$ 270.00		
		345-kV splices	36	\$ 804.00	\$ 536.00	\$ -	\$ 1,340.00		
		345-kV cross-bond splice	24	\$ 625.00	\$ 357.00	\$ -	\$ 982.00		
		Vault grounding systems	12	\$ 27.00	\$ 45.00	\$ -	\$ 72.00		
		Link box without SVL's	3	\$ 20.00	\$ 10.00	\$ -	\$ 30.00		
		Link box with SVL	5	\$ 40.00	\$ 20.00	\$ -	\$ 60.00		
		345-kV cable clamps	300	\$ 89.00	\$ 45.00	\$ -	\$ 134.00		
		Feet continuity conductor	24,000	\$ 465.00	\$ 179.00	\$ -	\$ 644.00		
		Feet continuity conduit	23,000	\$ 52.00	\$ 274.00	\$ -	\$ 326.00		
		Jacket integrity test	84	\$ -	\$ 313.00	\$ -	\$ 313.00		
		Type test	1	\$ 302.00	\$ -	\$ -	\$ 302.00		
			Total Cable and Accessories:			\$ 8,086.00	\$ 3,701.00	\$ -	\$ 11,787.00
			Communication Conduits:	Fiber-optic cable (by others)		\$ -	\$ -	\$ -	\$ -
		Fiber-optic cable splices (by others)		\$ -	\$ -	\$ -	\$ -		
		Feet HDPE conduit	23,000	\$ 103.00	\$ 257.00	\$ -	\$ 360.00		
		Hand holes	8	\$ 47.00	\$ 47.00	\$ -	\$ 94.00		
		Total Communication Conduits:		\$ 150.00	\$ 304.00	\$ -	\$ 454.00		
	Temperature Monitoring System:	Fiber-optic cable	26,000	\$ 58.00	\$ 154.00	\$ -	\$ 212.00		
		Fiber-optic cable splices (including enclosures)	2	\$ 12.00	\$ 8.00	\$ -	\$ 20.00		
		Terminal equipment / software / instrumentation	4	\$ 14.00	\$ 21.00	\$ -	\$ 35.00		
		2" HDPE conduit, feet	23,000	\$ 52.00	\$ 274.00	\$ -	\$ 326.00		
		Thermocouples, each	20	\$ 2.00	\$ 45.00	\$ -	\$ 47.00		
		Test stations, each	10	\$ 7.00	\$ 14.00	\$ -	\$ 21.00		
		Temperature probes, each	2	\$ 1.00	\$ 2.00	\$ -	\$ 3.00		
		Total Temperature Monitoring System:		\$ 146.00	\$ 518.00	\$ -	\$ 664.00		
	345-kV Riser Structure	345-kV Riser Structure	1	\$ 91.00	\$ 41.00		\$ 132.00		
	Duct Bank and Earthwork:	Feet conduit	69,000	\$ 719.00	\$ 1,641.00	\$ -	\$ 2,360.00		
		Spacers	18,400	\$ 220.00	\$ 412.00	\$ -	\$ 632.00		
		Excavation, no rock, per cubic yard, including hauling	11,000	\$ -	\$ 984.00	\$ -	\$ 984.00		
		Fluidized Thermal Backfill (FTB™)	8,000	\$ 1,311.00	\$ 238.00	\$ -	\$ 1,549.00		
		Duct encasement concrete	3,000	\$ 581.00	\$ 89.00	\$ -	\$ 670.00		
		Vault	12	\$ 760.00	\$ 447.00	\$ -	\$ 1,207.00		
		Jack and bore	160	\$ 95.00	\$ 238.00	\$ -	\$ 333.00		
		Dewatering, per trench foot	5,700	\$ 68.00	\$ 128.00	\$ -	\$ 196.00		
		1/4" stone	3	\$ -	\$ -	\$ -	\$ -		
		Sheeting and shoring	9,200	\$ 138.00	\$ 205.00	\$ -	\$ 343.00		
		Pavement repair	126,000	\$ 939.00	\$ 939.00	\$ -	\$ 1,878.00		
		Curb repair	500	\$ 11.00	\$ 4.00	\$ -	\$ 15.00		
		Sidewalk repair	3,000	\$ 68.00	\$ 68.00	\$ -	\$ 136.00		
		Landscape restoration	1	\$ -	\$ 75.00	\$ -	\$ 75.00		
		Traffic control	1	\$ -	\$ 373.00	\$ -	\$ 373.00		
		Loam and seed	4,000	\$ 59.00	\$ 59.00	\$ -	\$ 118.00		
		Survey	1	\$ -	\$ 37.00	\$ -	\$ 37.00		
		Rock Excavation	1	\$ -	\$ 7,484.00	\$ -	\$ 7,484.00		
		Total Duct Bank and Earthwork:		\$ 4,969.00	\$ 13,421.00	\$ -	\$ 18,390.00		
	Engineering, Administration and Other	Includes planning engineering, siting, surveying, land planing and drafting. Administrative costs including legal, purchasing, contract administration, project management, etc.			\$ 2,499.00	\$ 985.00	\$ 3,484.00		
	ROW					\$ 600.00	\$ 600.00		
		Total 345-kV XLPE		\$ 13,442.00	\$ 20,484.00	\$ 1,585.00	\$ 35,511.00		

Note: Row costs above represent outside services, cost of land and easements and NU labor

Overhead Alternative to 345-kV Bethel to Norwalk Project - Transmission Line Costs (\$,Thousands)

Location	Element	Work Description	Quantity	Material	Contracted Services	NU Labor	Total
115-kV XLPE (3 1500' circuits at Norwalk Substation)	Cable and Accessories	115-kV XLPE cable	4,500	\$340.00	\$35.00	\$-	\$375.00
		115-kV terminators	3	\$ 12.00	\$ 12.00	\$-	\$24.00
		115-kV arresters	3	\$ 1.00	\$ 2.00	\$-	\$3.00
				\$ -	\$ 5.00		
		Manufacturer's field supervisor	1			\$-	\$5.00
	115-kV Riser Structure	115-kV riser structure	2	\$ 160.00	\$ 40.00		\$200.00
	Engineering, Administration and Other	Includes planning engineering, siting, surveying, land planing and drafting. Administrative costs including legal, purchasing, contract administration, project management, etc.				\$ 60.00	\$ 60.00
	ROW						\$ -
		Total 115-kV XLPE		\$ 513.00	\$ 94.00	\$ 60.00	\$ 667.00

Note: Row costs above represent outside services, cost of land and easements and NU labor

Overhead Alternative to 345-kV Bethel to Norwalk Project - Transmission Line Costs (\$,Thousands)

Location	Element	Work Description	Quantity	Material	Contracted Services	NU Labor	Total
Overhead Lines							
Plumtree to Norwalk Overhead 345/115 kV							
		Clearing, Access Roads, Erosion Control	1	\$1,800.00	\$2,200.00		\$4,000.00
		Foundations	155	\$1,395.00	\$7,806.00	\$ -	\$9,201.00
		Structure monopole	155	\$11,618.00	\$3,315.00	\$ -	\$14,933.00
		345-kV insul and hardware	155	\$555.00	\$1,165.00	\$ -	\$1,720.00
		115-kV insul and hardware	155	\$156.00	\$700.00	\$ -	\$856.00
		Cable 345-kV 1590 KCMIL 47/7 2C / phase	84 miles	\$2,770.00	\$1,025.00	\$ -	\$3,795.00
		Cable 115-kV 1272 45/7	42 miles	\$1,200.00	\$600.00	\$ -	\$1,800.00
		Shield wire	29 miles	\$225.00	\$262.00	\$ -	\$487.00
		Counterpoise	1	\$535.00	\$100.00		\$635.00
		Total 345/115kV Overhead		\$ 20,254.00	\$ 17,173.00	\$ -	\$ 37,427.00
				\$ 1,081.00	\$ 1,396.00		
	115 kV Modifications						\$2,477.00
		Total 115-kV Modifications		\$ 1,081.00	\$ 1,396.00	\$ -	\$ 2,477.00
	Engineering, Administration and Other	Includes planning engineering, siting, surveying, land planing and drafting. Administrative costs including legal, purchasing, contract administration, project management, etc.			\$ 5,035.00	\$ 3,550.00	\$ 8,585.00
	ROW					\$ 23,660.00	\$ 23,660.00
	Relocation	temporary relocation of lines at Norwalk Substation		\$ 216.00	\$ -	\$ -	\$ 250.00
	Fiber Optics	20.1 miles of primary and backup circuits	40	\$ 3,965.00	\$ 1,214.00	\$ -	\$ 5,179.00
	Removal				\$ 1,000.00	\$ -	\$ 1,000.00
		Total Overhead Lines		\$ 25,516.00	\$ 25,818.00	\$ 27,210.00	\$ 78,578.00
		Project Total		\$ 91,419.00	\$ 139,163.00	\$ 41,384.00	\$ 272,000.00

Note: ROW costs above represent legal, engineering, cost of land and easements and miscellaneous other NU labour and outside services

Proposed 345-kV Bethel to Norwalk Project - Ancillary Facilities

Location	Element	Work Description	Total (\$,Thousands)
Southington Substation	Series Reactors	Install 115-kV series reactors at the Southington Substation in the 1910 and 1950 lines	\$2,780.0
Long Mountain Substation	Circuit Breakers	Install an additional 345-kV circuit breaker at the Long Mountain Switching Station.	\$2,960.0
Glenbrook Substation	Special Protection System	Install Special Protection System (SPS) at the Glenbrook Substation.	\$368.0
Norwalk Harbor Substation	Circuit Breakers	Replace 115-kV Circuit Breakers at the Norwalk Harbor Substation.	\$625.0
Southington & Millstone Substations	Terminal Equipment	Replace terminal equipment at the Southington and Millstone 345-kV substations.	\$430.0
		Total Ancillary Facilities	\$7,163.0

Appendix B

Reliability Planning Process and Reliability Criteria

The goal of CL&P's transmission reliability planning process is to develop a plan which safely and reliably meets near term and future peak customer demands for electricity. New investments in transmission facilities ensure the continuance of a reliable and dependable electric system which supports the expansion of the Connecticut economy.

The determination of new transmission facilities is based on the need for system reinforcements to maintain reliability performance in accordance with national and regional standards. The transmission planning process involves numerous elements ranging from: 1) compiling generation, transmission and load system data; 2) developing aggregate electrical system models and configurations; and 3) testing system models with computer simulations against pre-defined acceptance criteria. These elements, when combined, form a process by which the identification of transmission upgrades is achieved. The sole purpose of this process is to plan facilities that ensure continuance of a reliable and dependable New England transmission grid.

Electric Utility Transmission Planning Process

ISO-NE is responsible for developing and maintaining a process that creates a system plan on a coordinated New England-wide basis. This system plan includes the necessary facilities to ensure the reliability of the New England power system, taking into account load growth and known resource changes. Contained within this plan, are transmission upgrades to improve reliability that will increase current carrying capabilities, provide acceptable stability response, mitigate short-circuits, and increase system voltage levels.

The RTEP conforms to Good Utility Practice, applicable reliability principles, guidelines, criteria, rules, procedures and standards of NERC and NPCC, applicable local reliability criteria, and the NEPOOL/ISO-NE system rules. The plan recommendations are based on the results of a comprehensive transmission expansion and enhancement study conducted at least once every three years.

CL&P continuously analyzes its transmission systems against transmission reliability standards. Each year CL&P provides to the Connecticut Siting Council transmission plans over a 10 year horizon. These plans are continuously updated to reflect current system conditions and changes in assumptions that could impact future transmission system needs. CL&P assists ISO-NE in performing transmission planning studies to determine upgrades and/or reinforcements to the New England transmission system that are to be included in the RTEP.

The framework for developing the RTEP includes a Transmission Expansion Advisory Committee (TEAC) comprised of New England transmission owners and other interested stakeholders including generator owners, marketers, load serving entities, and state agencies. The TEAC is a sounding board for consideration of alternatives and is responsible for providing input to ISO-NE on the plan's development. CL&P participates and closely coordinates its transmission plans with ISO-NE and all TEAC stakeholders. Since the first RTEP was published in 2001, the 345-kV loop has been included in the RTEP with annual reviews by TEAC stakeholders through the public forums.

Planning Standards

The North American Electric Reliability Council (NERC) is charged with developing the fundamental requirements for planning a reliable interconnected bulk electric system. NERC carries out its reliability mission by:

- Establishing Reliability Policies, Standards, Principles, and Guides
- Measuring Performance Relative to NERC Policies, Standards, Principles, and Guides
- Ensuring Conformance to and Compliance with NERC Policies, Standards, Principles, and Guides

NERC has developed national standards that contain the minimum acceptable design criteria that each Regional Council across the United States must follow. Regional Councils can develop more stringent criteria to meet unique regional needs.

The Northeast Power Coordinating Council's (NPCC) Basic Criteria for Design and Operation of Interconnected Power Systems promote the reliability and efficiency of electric service on the bulk power system in the northeastern United States, Ontario, Quebec, and the Canadian Maritime Provinces. NPCC regional criteria are consistent with the NERC standards.

The Reliability Standards for the New England Power Pool (NEPOOL) assure the reliability and efficiency of the New England interconnected bulk power supply system through coordination of system planning, design and operation. These standards apply to all facilities comprising the New England interconnected bulk power supply system. These include the facilities of electric utilities in Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont. The NEPOOL area standards are consistent with the regional NPCC and national NERC standards.

Reliability standards for facilities that are part of the interconnected bulk power system are set by NERC, NPCC and NEPOOL. The NERC, NPCC and NEPOOL standards form the basis for utility planning standards within the region.

The Connecticut transmission system is interconnected to the New England bulk power transmission grid. CL&P's transmission reliability standards for Connecticut comply with these recognized national standards and regional criteria.

These transmission reliability standards determine the adequacy and security of the Connecticut transmission grid. The framework for a reliable national transmission grid is centered on contingency analyses based on predictable and probable events. The consistent use of contingency planning that is applied across an area ensures such design contingency events do not cascade outside of the area and adversely impact neighboring electric systems. The ISO-NE/NEPOOL reliability standards that are based on NPCC criteria state:

The interconnected bulk power supply system shall be designed for a level of reliability such that the loss of a major portion of the system, or unintentional separation of any portion of the system, will not result from reasonably foreseeable contingencies. Analyses of

simulations of these contingencies should include assessment of the potential for widespread cascading outages due to overloads, instability or voltage collapse.¹

Design contingencies are simulated using computer models developed to represent actual and future system conditions. The system performance under such contingencies must fall within pre-defined thermal, voltage and stability limits. If the simulation shows that transmission line power flows exceed emergency ratings, or voltages fall outside of acceptable criteria, then corrective action must be implemented to ensure that integrity of the transmission grid is maintained.

New England evaluates the adequacy and security of the transmission network to meet varying load demands under reasonably foreseeable generation and transmission system conditions. Certain scenarios assume that all system generation resources and transmission lines are available, while other scenarios assume that certain generation and transmission facilities are unavailable due either to bid dispatch, scheduled maintenance or unplanned outages. The purpose is to demonstrate that the electrical network is sufficiently robust to withstand a reasonable level of facility outages and still reliably and economically serve the electrical needs of customers.

The loss of a generator, a transmission line or combinations of both (which could occur for any number of reasons), causes increased power flows on the remaining in-service transmission lines. Transmission capacity for an area must be designed, therefore, not only to transmit the imported power required to offset anticipated generating deficits under optimal conditions, but also to transmit that power reliably following design criteria contingencies. Otherwise, power flows could exceed transmission line emergency ratings and force utilities to disrupt service to large blocks of customers to prevent permanent damage to electric systems.

NERC, NPCC and NEPOOL reliability standards prescribe tests for transmission contingencies with diverse generation dispatch scenarios, including multiple generating units unavailable in a local area, thereby stressing area transmission interfaces to a greater degree. The requirement for transmission systems to withstand outages of more than one generating unit recognizes that units may be unavailable for many reasons such as economics, equipment failure, adequacy of fuel supply and maintenance. Also, more severe environmental restrictions (e.g., emissions) are targeted for

¹ Reliability Standards for the New England Power Pool, dated July 9, 1999

fossil-fueled generating stations in Connecticut and elsewhere. If adopted, these restrictions could affect continuous operation of the units or result in their permanent closure. The potential loss of local generation in southwest Connecticut was considered in developing dispatch scenarios for this study.

Criteria

Performance standards, a pre-defined set of criteria, are applied to system models to determine the acceptability of the contingency results. Simulation results that fall outside of the criteria must be addressed to ensure overall system reliability is maintained.

Power-Flow

New England electric utilities have developed a standard procedure for rating transmission equipment. Each electrical component has a normal and emergency rating. The normal rating is defined as the amount of current which, under specified ambient and load cycle conditions, will not cause equipment loss-of-life above design criteria. Emergency ratings are greater than normal ratings. The emergency ratings allow utilities to operate electrical equipment above a manufacturer's continuous nameplate rating, recognizing the inherent capabilities of this equipment to operate at higher current levels for short periods of time with acceptable loss-of-life.

New England adopted three rating levels that have been used in planning and daily operations for over 30 years. These are:

- normal rating (N)
- long-time emergency (LTE)
- short-time emergency (STE)

New England utilities follow a planning philosophy whereby normal ratings shall not be violated under all-lines-in conditions, and emergency ratings shall not be violated under contingency conditions. The table below contains the thermal loading performance criteria applied to transmission lines in this reliability study. The use of LTE ratings in planning studies recognizes the limited switching and dispatch options available to operations.

Thermal Loading Performance Criteria

System Condition	Maximum Allowable Facility Loading
Pre-Contingency (all-lines-in)	Normal Rating
Post-Contingency	LTE Rating

Voltage

Transmission voltage must be maintained within a prescribed bandwidth to ensure proper operation of electrical equipment and supply adequate voltage to customers. Equipment damage and widespread power outages are more likely to occur when transmission-level voltages are not maintained within pre-defined limits. The table below contains the voltage performance criteria used in routine analyses for the CL&P system.

Voltage Performance Criteria

Voltage Level	Bus Voltage Limits	
	Normal Conditions	Emergency Conditions
≥ 115 kV	+ 5% of nominal	+ 5% of nominal
Millstone 345 kV	100 to 105% of nominal	100 to 105% of nominal

Short Circuit

Connecticut utilities address safety concerns and ensure reliable system performance by restricting fault duties imposed on circuit breakers and other equipment. The interrupting capability of a circuit breaker shall be limited to 100% of the de-rated value prescribed in ANSI standards that account for the X/R ratio, automatic reclosing and expected normal operating voltages. Substation ground grids, bus and disconnect switches, and transmission lines must be designed for safety and reliability when subjected to high short-circuit currents.

Stability

The transmission system transient stability state responses are monitored to ensure conformance to the "Reliability Standards for the New England Power Pool", PP-3, dated July 9, 1999. The New

England power supply system shall remain stable during and following design criteria contingencies. Acceptable damping with time domain analysis requires running a transient stability simulation for sufficient time (up to 30 seconds) that only a single mode of oscillation remains. A 50% reduction in the magnitude of the oscillation must then be observed over four periods of the oscillation. A sufficient number of system quantities including rotor angle, voltage, and interface transfers should be analyzed to ensure that adequate system damping is observed.