Segment Route Comparison:

Preferred Route Segment: Cross Street and Washington Street in Winchester and

Noticed Green Street Variation Segment: RR ROW, Green Street and Montvale Ave in Woburn

As shown in Figure 5-11 in Section 5 Routing of the of the Woburn-Wakefield Project EFSB Analysis referenced in the Petition (JP-1), the Preferred Route includes the segment through Winchester between Cross Street near Main Street, Woburn to Washington St at the intersection of Montvale Ave, Woburn (Winchester Segment.

A noticed variation is the Green Street Variation also shown in Figure 5-11. The Green Street Variation (Woburn Segment) consists of a railroad Right of Way (RR ROW), Green Street from the end of the RR ROW, and Montvale Ave, Woburn from Green Street to Washington Street.

The purpose of this report is to summarize the findings of this comparison using the same criteria and weightings described in Section 5 and document the method used for the comparison. The Town of Winchester requested this comparison because the Petition compares the siting criteria of the various candidates routes in their entirety. This analysis is to simply make the binary comparison between the two segments, Winchester and Woburn as both segments terminate at common locations.

Findings

The analysis determined that when comparing these two segments using the criteria, weighting and data supplied by the company that the Green Street Variation Segment is scored as lower than the Winchester segment. The lowest score is ranked superior.

Methodololgy

1. Data was gathered from the following sources:

TOW-RS-15(1) Raw Data and Traffic Congestion Rankings

Table 5-2 Route Evaluation Criteria Weighting Scale

Table 5-5 Candidate Route Scoring

Google

Google Earth

Figure 1 Town of Winchester 345kV Route Exhibit

Figure 2 MA DEP site - Woburn

Figure 3 Environmental Justice Map

2. For the Preferred Route Winchester Segment the data from TOW-RS-15(1) – Winchester Raw Data was used. The Central Route column contains the counts and estimates for the various Scoring Criteria within the borders of Winchester. In order to have the entire data set for this segment and because the data was not explicitly available in the Petition or the IRs, it was necessary to gather data for the portion of the segment along Washington Street in Woburn from the Winchester border to Montvale. This data was gathered from Google and Google Earth such as number of Residential Structures, Sensitive Receptors, Street Widths, Public Transit, Public Shade Trees. Note the number of residential units could not be determined so only the number of structures were used as a comparison which is a reasonable assumption for this area.

The counts for the various criteria of Washington Street, Woburn portion of this route were added to the Central Route counts to determine a total for each criteria.

3. For the Green St Variation Segment referred to as the Woburn Segment, the data was used from the TOW-RS-15(1) Woburn Raw Data. This segment's raw data numbers were calculated by subtracting the Central Route counts from the Central Route with Green Street Variation, to determine the counts for each Scoring Criteria for this Woburn Segment.

4. The raw numbers were then input into a spreadsheet similar to that of Table 5-5 Candiate Route Scoring. The same approach used in Table 5-5 was applied to this binary comparison. A ratio score was calculated based on dividing the total number of units for each segment by the highest number of units of the two segments. Then the same weighting for each criteria category as listed in Table 5-2.

5. The weighting, scoring and results are presented in Table 1 Winchester and Woburn Segment Route Scoring.

6. Notes addressing adjustments and where data presented in petition is different than counts or estimates from sources.

Supplemental Information

The following information further supports that Green Street Variation Segment as the lower scoring alternative compared to the Winchester Segment (lowest score ranks best).

1. The data in TOW-RS-15(1) was found to be in error in the following areas. The scoring result did not change as a result of these errors. Cross St width is less than 30 feet. The Washington St Width is less than 30 feet in Winchester and more than 30 feet in Woburn.

2. Based on the methodology and using the data from TOW-RS-15(1) the calculation of the length of the Green Street Variation was 9050 feet. This was not used because in checking lengths using Google Earth the Green Street Variation is 11440 feet. The Winchester Segment is 10840 feet. Overall, the Green Street Variation is 600 feet longer than the Winchester Segment.

3. However, it is important to point out that the Green Street Variation consists of:
    a. 3400 ft of RR ROW
    b. 5820 ft – Green Street
    c. 2220 ft – Montvale Ave, Woburn

   which totals to 11440 feet.

4. An important factor to consider in scoring are comparing the Roadway Excavation Lengths versus the Overall Lengths. The Roadway Excavation Lengths are:
    a. 10840 ft – Winchester Segment (Cross St/Washington St)
    b. 8040 ft – Green St Variation

   Where the Green St Variation has 2800 feet less of roadway trenching diminishing traffic impacts, utility conflicts, connections and reconnections. Additionally the RR ROW width is 40 feet providing excellent clearance. In the context of street work and congestion, the Green St Variation is 26% less roadway excavation than the Winchester Segment.

5. MA DEP sites shown in Figure 5-8 do not completely reflect what is in the database, see Figure 2 MA DEP Woburn Sites. There is an open site near Cross St and the 4 sites along the RR ROW are closed. The open Cross St Site is referenced in Figure 1 Town of Winchester 345kV Route Exhibit which also used the MA DEP site for reference.

6. Environmental Justice is discussed in the Petition but there it is not included in the scoring. Figure 3 Environmental Justice Map shows that the entire Winchester segment is routed along the Environmental Justice areas in Winchester and Woburn. It also shows that the Green St Variation Segment also abuts Environmental Justice areas in Woburn.

   Environmental Justice Lengths:
    a. 10840 feet – Winchester Segment (Cross/Washington)
    b. 3260 feet – Green St Variation Segment

7. The Sensitive Receptors in the Raw Data did not capture all the receptors in the area along both route segments. See Figure 1 for the 13 Sensitive Receptors along the Winchester Segment in both Winchester and Woburn. Adjustments were made for both segments.

8. If these were categories included in the scoring the weighting in favor of Green Street Variation Segment would be greater based on the data. The categories are:
    a. Roadway Excavation Lengths
    b. Environmental Justice

   Another siting issue that is not scored between the candidate routes, is Electric and Magnetic Fields (EMF). In this case the two segments are nearly the same in terms of the number of residents so scoring EMF does not make a difference in comparing these two segments. However, if there was siting criteria that weighted the transmission line and its EMF away from residents and business areas sensitive to magnetic fields, it may help allay the issue.

9. It is important to point out that the Winchester Segment, Cross St and Washington St, include two jack and bores, Green St Variation does not. It does have one high impact crossing. Both jack and bores cross the Aberjona River, one on Washington St and one on Cross St. At Cross St the jack and bore is a double jack and bore meaning it will span 3 pits, 1 entrance pit and 2 pits for a length of over 350 feet boring under a railroad bridge and the Aberjona River. At the RR bridge abutments narrow Cross St to under 24 feet (desktop measure). Discussions with Eversource mentioned considering HDD technology to accomplish this crossing as well as discussion with private abutters to relocate this challenging crossing. This crossing has the characteristics to be a high impact crossing. Eversource does not know for certain how long the operation will take to complete. Both high impact crossings may be mitigated with the smaller lighter cross section of HPFF-PTC of 4 pipes as compared to the HVED-XLPE cross section of 8 pipes.

TABLE 1

TABLE 1																			
COMPARISON		Residential Land Use	Commercial or Industrial Land Use	Sensitive Receptors	Public Transit Facilities	Historic Resources	Potential for Traffic Congestion	High Impact Crossings	Public Shade Trees	Wetlands	ACECS or ORWs	Potential for Subsurface Contamination	Length	Street Width <30ft	Utility Density	Angles > 30 deg	Trenchless Crossings	TOTAL SCORE	
Weight		3	3	2	1	1	3	3	1	1	2	1	1	2	2	1	1		
Winchester	Ratio Score	1.00	0.44	1.00	0.00	1.00	2.50	0.00	1.00	1.00	0.00	1.00	0.94	1.00	1.00	1.00	1.00	13.88	
	Weighted Score	3.00	1.32	2.00	0.00	1.00	7.50	0.00	1.00	1.00	0.00	1.00	0.94	2.00	2.00	1.00	1.00	24.76	
Green St Variation	Ratio Score	0.76	1.00	0.00	0.00	0.18	1.50	1.00	0.06	0.60	1.00	0.00	1.00	0.63	0.86	0.50	0.00	9.08	
	Weighted Score	2.28	3.00	0.00	0.00	0.18	4.50	3.00	0.06	0.60	2.00	0.00	1.00	1.25	1.71	0.50	0.00	20.08	
RAW DATA	TOW-RS-15(1)																		
Winchester		141	11	8	0	11	Cross St Rar	0	50	2026	0	0	10800	3	7	4	2		
Green St Variation		107	25	0	1	2	RR ROW Ra	1	3	1217	5665	4	11440	7	6	2	1		
ADJUSTMENTS see Notes																			
Winchester		141	11	13	0	11	2.5	0	50	2026	0	1	10800	8	7	4	2		
Green St Variation		107	25	3	0	2	2	1	3	1217	5665	0	11440	5	6	2	0		
		Note A		Note E	Note B		Note C					Note D							
Denominator: Largest Count																			
of Both Segments Using Adjusted Data		141	25	9	0	11	2.5	1	50	2026	5665	1	11440	8	7	4	2		
Winchester	Ratio Score	1.00	0.44	1.44	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	0.94	1.00	1.00	1.00	1.00	13.88	
		3.00	1.32	2.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	0.94	2.00	2.00	1.00	1.00	24.76	
Green St Variation	Ratio Score	0.76	1.00	0.33	0.00	0.18	0.80	1.00	0.06	0.60	1.00	0.00	1.00	0.63	0.86	0.50	0.00	9.08	
		2.28	3.00	0.00	0.00	0.18	4.50	3.00	0.06	0.60	2.00	0.00	1.00	1.25	1.71	0.50	0.00	20.08	Low Value

Notes

A Residential structures were used for comparison rather than residential units because data for the Woburn portion of Washington St was not available or could not be counted using Google Earth

B. There are no Public Transit Facilities within these segments, both Google and checked with the Town. The one facility referred to appears to be on Main St, Woburn near the corner of Green St.

B. This route segment intersects Green St to the east of Main Street, not at Main St.

B. Furthermore it appears some of the counts may be higher for Green Street because the counts were done on Main St which parallels the RR ROW.

B. Access to the businesses and residents from Main St will not be impacted based on an installation along the RR ROW.

C. Rankings from TOW-RS-15(1) for traffic congestion were averaged for the portions of the segments.

C. Even though the widths shown on EFSB-T-22(1) are incorrect for Cross St and Washington St Winchester,

C. The congestion ranking is still better for Green St Route with the RR ROW being number 1 and Green St roadway being number 2

C. Using desktop measurement of Google Earth, similar to methods noted in the Petition, Cross St per 1000 feet is less than 30 feet wide. Washington St Winchester is also less than 30 feet wide.

C. Washington St, Woburn is wider than 30 feet.

D. MA DEP site was accessed. There are 4 closed sites in Woburn and 1 open site in Winchester. The 4 closed sites were counted as 0. The 1 open site is counted as 1.

E. A review of the sensitive receptors in the sources of data gathered found 3 in Woburn and 13 in Winchester along these two segments.

F. Washington Street Woburn Segment Data	19	2	3	0	0	Rank 3	0	1	0	0	0	2333	0	0	1	0

F. Utility Density was estimated at 0 because the area is very sparsely populated given the cemeteries, field and only 19 residential structures.

FIGURE 1 TOWN OF WINCHESTER 345Kv ROUTE

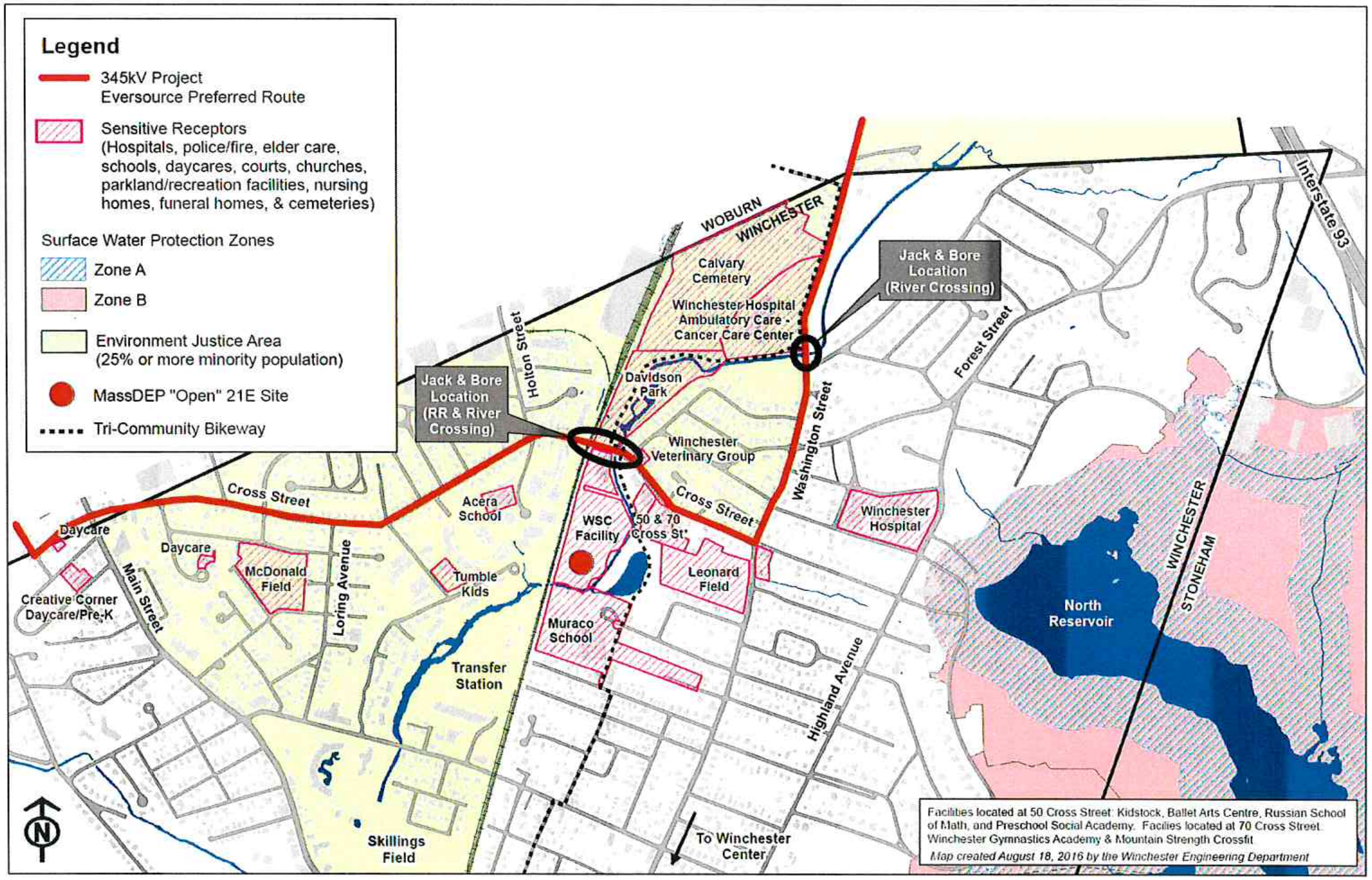
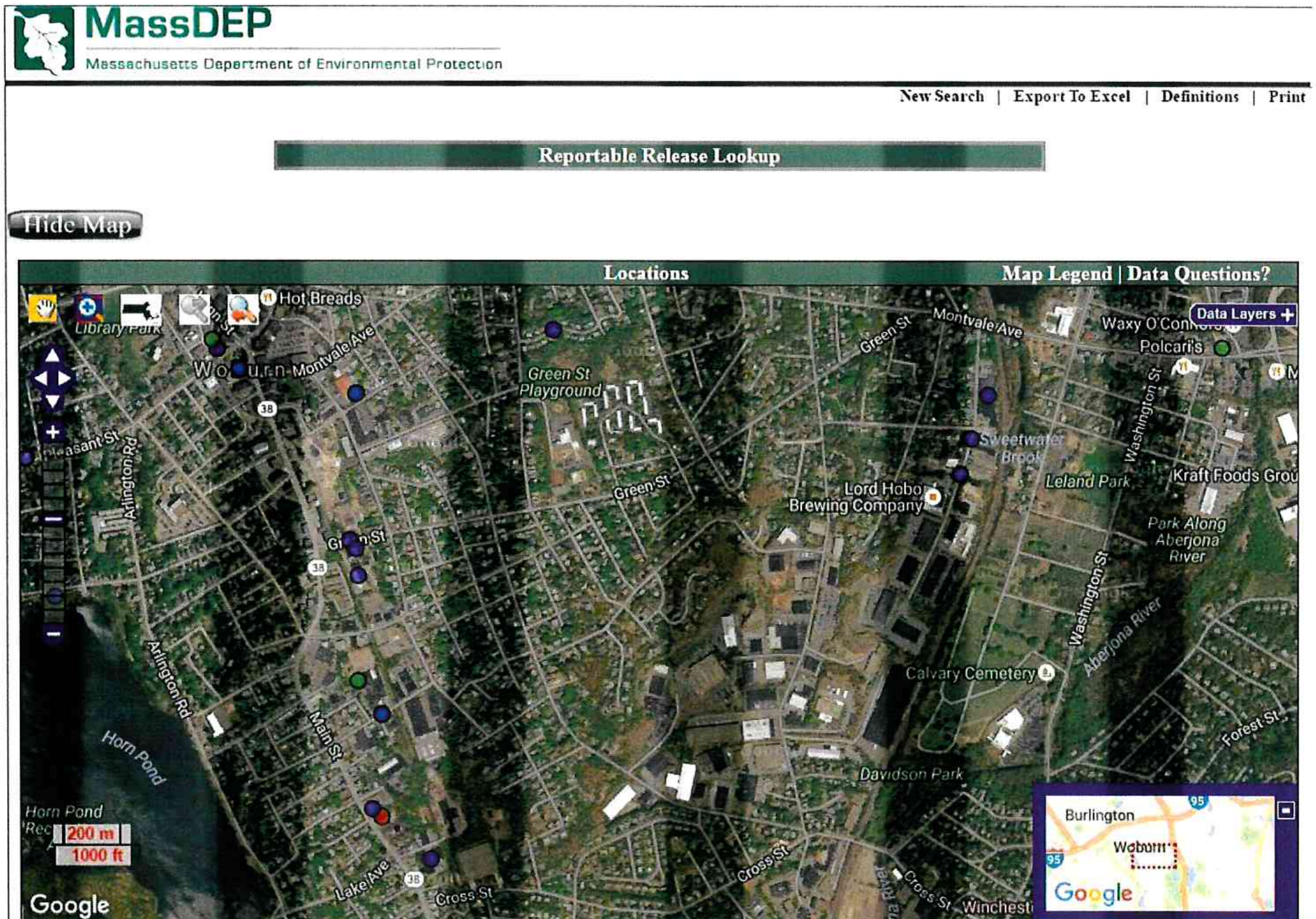
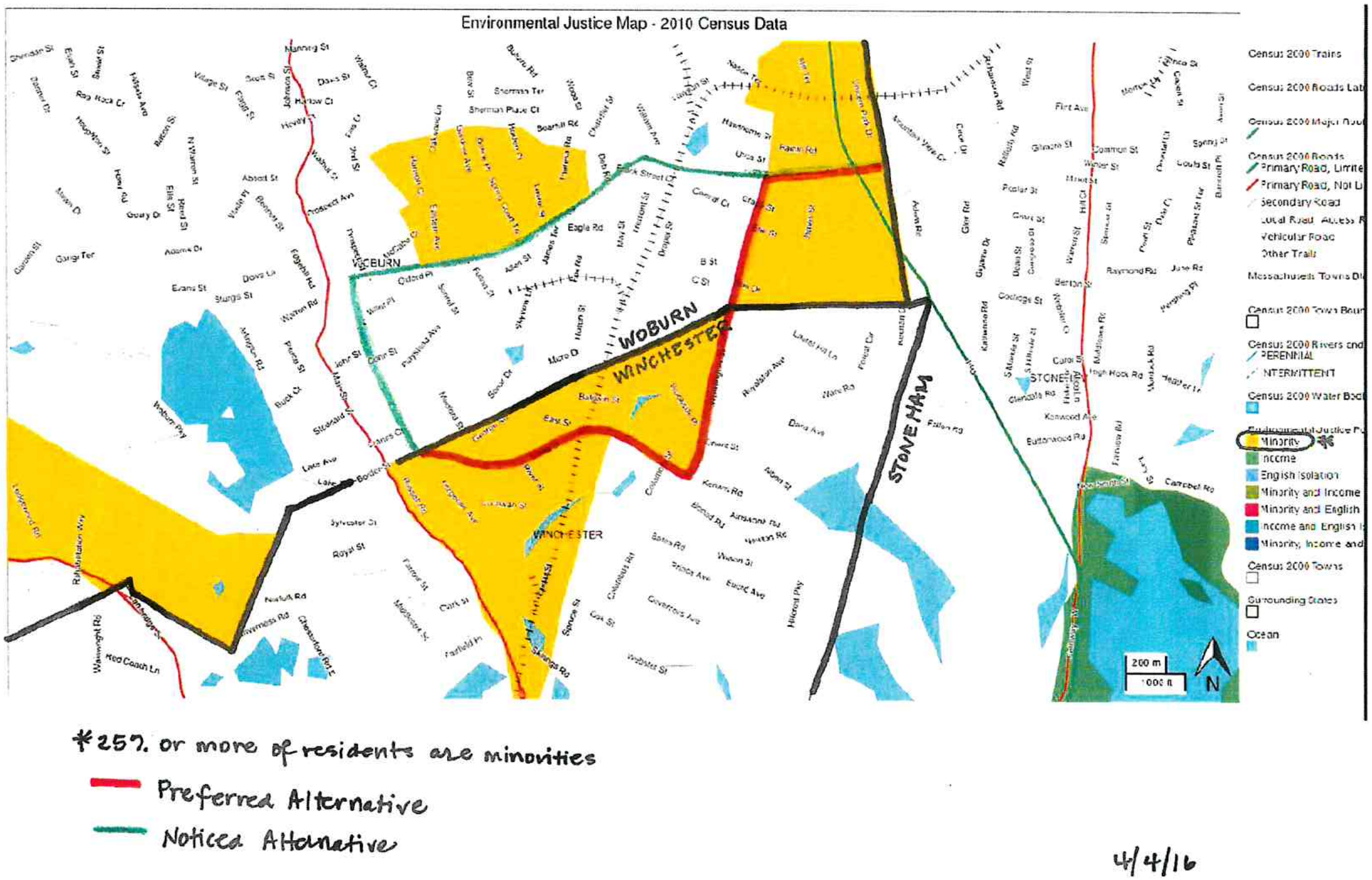


FIGURE 2 MA DEP WOBURN SITES

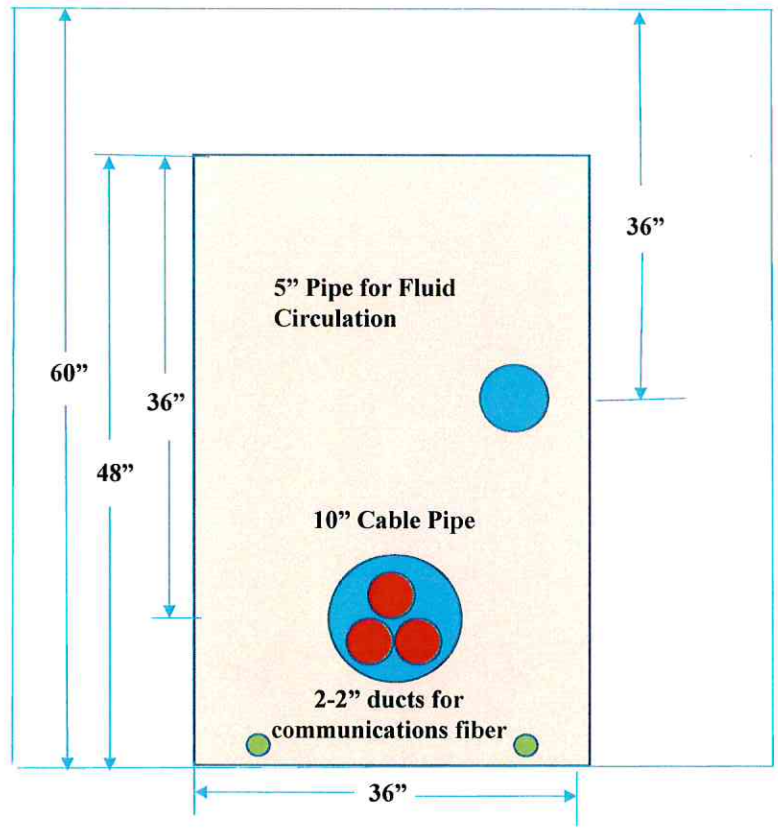


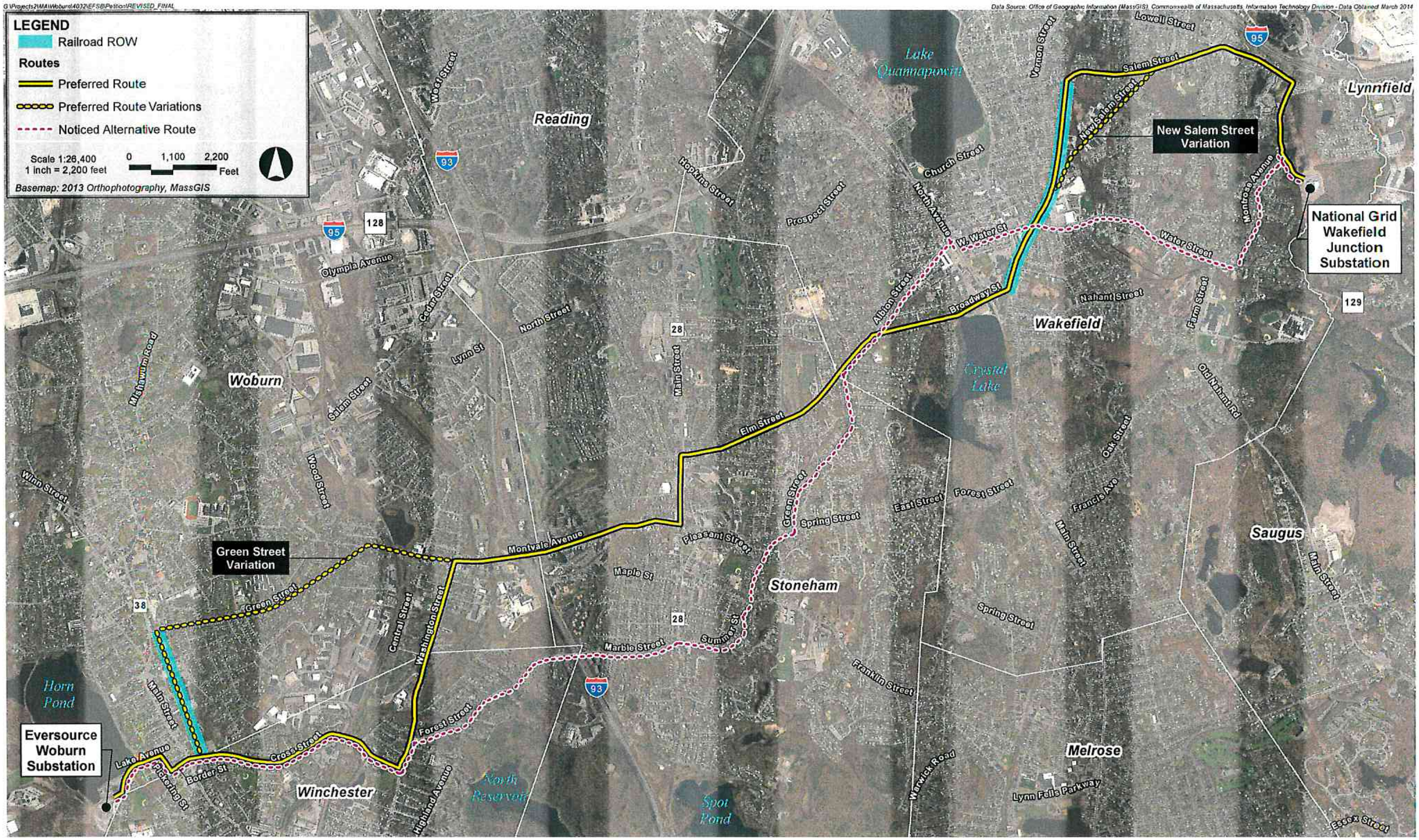
● Open Sites ● Closed Sites ● Closed Sites with Use Limitation

FIGURE 3 ENVIRONMENTAL JUSTICE



HPFF Trench Cross-Section





Woburn to Wakefield Line Project

EVERSOURCE nationalgrid

Figure 5-11
Preferred Route and Noticed Alternative Route

COMMONWEALTH OF MASSACHUSETTS
ENERGY FACILITIES SITING BOARD

Petition of NSTAR Electric Company d/b/a Eversource Energy and New England Power Company d/b/a National Grid for Approval to Construct and Maintain a New 345-kV Underground Transmission Line in Woburn, Winchester, Stoneham, and Wakefield Pursuant to G.L. c. 164, § 69J	EFSB 15-04
Petition of NSTAR Electric Company d/b/a Eversource Energy and New England Power Company d/b/a National Grid for Approval to Construct and Operate a New 345 kV Underground Transmission Line in Woburn, Winchester, Stoneham, and Wakefield Pursuant to G.L. c. 164, § 72	D.P.U. 15-140
Petition of NSTAR Electric Company d/b/a Eversource Energy and New England Power Company d/b/a National Grid for Individual and Comprehensive Zoning Exemptions from the Zoning Ordinance of the City of Woburn and the Zoning By-law of the Town of Wakefield Pursuant to G.L. c. 40A, § 3	D.P.U. 15-141

TESTIMONY OF PETER TIRINZONI, P.E.

ON BEHALF OF THE

TOWNS OF WINCHESTER AND STONEHAM

August 22, 2016

Q: Please state your name, position and business address.

A. My name is Peter L. Tirinzoni. I am a Senior Engineer with Power Delivery Consultants, Inc. My business address is 12 Plains Rd, Suite 308, Essex, CT 06426.

Q. On whose behalf are you testifying?

A. I am testifying on behalf of the Town of Winchester and the Town of Stoneham, which have retained me as an expert with respect to underground transmission cables. Specifically, to analyze the difference between PTC (Pipe-Type Cable or High Pressure Fluid Filled Cable) and HVED (High Voltage Extruded Dielectric or XLPE) cable construction and recommend the type of cable construction that is most appropriate for an underground 345kV installation in the streets of Winchester and Stoneham. In view of a number of considerations including the highly congested nature of the streets on the preferred route, the large number of ageing utility infrastructure facilities already in the streets and the lack of available space in those streets for a major new transmission line, I believe PTC cable is the better choice.

Q. Please summarize your professional and educational background.

A. I received a Bachelor of Science degree in Mechanical Engineering from the University of Connecticut in 1982, a Master of Science degree in Mechanical Engineering from Rensselaer Polytechnic Institute in 1988, and a Master of Science degree in Electrical and Computer Engineering from Worcester Polytechnic Institute in 2011

After graduating from the University of Connecticut I spent three years at the General Electric Company's Knolls Atomic Power Laboratory, where I was trained on the nuclear propulsion systems used by the US Navy. I qualified on two submarine propulsion systems at General

Electric, before joining Eversource (previously known as Northeast Utilities) in 1985 as an engineer in their Nuclear Engineering and Design (NED) Department.

I spent 15 years in Eversource's NED Department, performing many analyses, design modifications, and major upgrades to critical plant systems. In 2000, I transferred to an unregulated part of Eversource, where I was responsible for the procurement, installation, and commissioning of the world's largest fuel cell farm (1200 kW) for use as the primary power supply to a juvenile detention facility in Connecticut.

In 2003, I joined Eversource's Transmission Department, where I became involved in underground transmission projects. During my 13 years in the Transmission Department, I was the lead cable engineer on several major transmission projects in Southwest Connecticut, including overseeing the final cable and duct bank system design, manufacturing, factory testing, installation and commissioning of the world's longest (24-mile, double circuit) 345-kV XLPE cable project. I was also the technical lead for the design, specification, duct bank construction, cable installation, and commissioning of a 9-mile, double circuit 115-kV XLPE cable system and the replacement of seven, 12-mile, 138-kV single-core Self Contained Fluid Filled (SCFF) cables under the Long Island Sound with three 3-core XLPE submarine cables.

I was also the technical lead for the design of the underground cable portions of an HVDC transmission system to bring hydroelectric power from Canada to central New England, with responsibility for vendor prequalification, cable system specification and RFP development, and bid evaluations and negotiations.

I am a member of the IEEE, its Power & Energy Society, and Standards Association. I am actively involved in the IEEE PES Insulated Conductors Committee (ICC) and served as chair of its Educational Committee. While at Eversource, I was a member and chair of the Association of Edison Illuminating Companies (AEIC) Cable Engineering Committee, as well as chair of the Task Group performing a major update to AEIC CS9, "Specification for Extruded Insulation Power Cables and Their Accessories Rated above 46 kV Through 345 kV."

I am a past member of CEATI and the EPRI Underground Transmission Task Force (UTTF), and a past chair of the UTTF and served as a utility advisor on several EPRI and CEATI projects.

I have taught courses with Power Delivery Consultants, Inc. for several years, and joined the firm in 2015 where I continue to specialize in underground transmission cable systems.

I am a registered Professional Engineer in the state of Connecticut.

A copy of my resume is attached as Exhibit A.

Q. Have you testified previously in any regulatory proceedings? If so, please list them.

A. No.

Q. Have you provided technical support in any regulatory proceedings?

A. I provided technical support for one regulatory proceeding in Connecticut. It was Connecticut Siting Council Docket 461 - Eversource Energy application for a Certificate of Environmental Compatibility and Public Need for the construction, maintenance, and operation of a 115-kilovolt (kV) bulk substation located at 290 Railroad Avenue, Greenwich, Connecticut, and two 115-kV underground transmission circuits extending approximately 2.3 miles between the proposed substation and the existing Cos Cob Substation, Greenwich, Connecticut, and related substation improvements.

Q. What is your role with respect to the Towns of Winchester and Stoneham's participation in this proceeding?

A. Winchester and Stoneham retained me to provide a conceptual design and cost evaluation for a 345 kV PTC system that is capable of meeting the Summer Long Term Emergency rating identified by Eversource, along with a similar estimate for the XLPE cable system proposed by Eversource. I was also asked to discuss the advantages and disadvantages of each technology.

Q. Did you determine if there is an equivalent HPFF-PTC ("PTC") design capable of achieving the specified Long Term Emergency rating of 1040 MVA?

A. Yes. The use of 3500 kcmil copper conductor cables in a 10-inch nominal steel cable pipe will meet the required summer LTE rating. A parallel 5-inch fluid is required to allow fluid circulation to achieve the required summer LTE ratings at the deepest cable burial depths.

Q. What are the design parameters that you used to determine the capacity?

A. From a Winchester Information Request Response, the required rating for the circuit is the Summer LTE (12 hour) of 1040 MVA (1740 Amperes). The design parameters were identified to be:

- Ambient earth temperature = 25°C
- Native earth thermal resistivity = 90C°-cm/watt
- Thermal resistivity of trench backfill = 65C°-cm/watt
- Load factor = 75% - Not specified anywhere; however 75% is a typical load factor.

Q. Please describe the PTC design that matches or exceeds the specified require Long Term Emergency rating of 1040 MVA?

A. Please see attached cross section, Figure 1. The design uses 3500 kcmil LPP copper conductor within a 10-5/8 inch diameter pipe. The design also includes a 5 inch diameter fluid pipe to allow circulation of the dielectric fluid, to smooth out any hot spots along the route. The design also incorporates the two 2-inch PVC conduits for communication fibers as Eversource shows in the response to TOS-C-1.

Q. Does this technology have the ability of increasing the capacity of its line rating?

A. Yes. There are several methods for increasing the capacity of a PTC system, especially if properly designed for at the beginning of the project.

Q. Please explain how that can be done.

A. In a static PTC system (i.e. no circulation of the dielectric fluid), the heat generated in the conductor is transferred from the cable, to the dielectric fluid, to the cable pipe, to the earth and ultimately to the ambient air. Methods of increasing the capacity (ampacity) of a PTC system simply provide additional paths of removing the heat generated in the conductor. This includes fluid circulation to smooth out hot spots, forced cooling using an air cooler to remove heat from the dielectric fluid and/or air conditioning chillers which have the ability to cool the dielectric fluid below the temperature of the surrounding air.

Q. By how much can you increase the capacity of this design?

A. The ability to increase the capacity of a PTC system is specific to each system and its unique installation; however, capacity increases of 30% (or more) are possible.

Q. If the capacity of this design is increased by 30% by circulating chilled fluid, does the magnetic field increase? If so by how much over the pipe and at 10 feet away?

A. Yes. The magnetic field is a function of the current flowing through the cable. A 30% increased in this current would results is an approximately 30% increase in the magnetic field, both directly above the pipe and at 10 feet away from the cable pipe.

Q. Can you confirm Peter Valberg's statement that XLPE's magnetic field is generally 5 to 10 times that of PTC?

A. The relative magnetic field from an XLPE cable system can be much higher than a PTC system, depending upon cable configuration and sheath bonding. In some cases, the difference can be as much as a factor of 50 times.

Q. You stated earlier that you were asked to perform a cost evaluation of the equivalent design and compare it to the proposed HVED-XLPE. Did you prepare an evaluatione?

A. Yes.

Q. What are the extra costs that PTC typically has that XLPE does not?

A. PTC differs from XLPE cable, as all three conductors are contained inside a single pipe that is filled with dielectric fluid at a nominal 200 psig. The extra equipment required for a PTC system includes the dielectric fluid, and a cathodic protection system to prevent corrosion of the steel pipes. Typically a fluid pressurization plant would also be required, however, NSTAR has two open positions available on the pressurization plant at Mystic substation, so there is no need to install a complete pressurization system. To connect this new PTC circuit to the existing pressurization system would only require the addition of a circulating pump and an increase in the capacity of the existing fluid storage tank because of the additional fluid volume changes from the new circuit. While not an "extra" piece of equipment, the steel pipes cost more than the plastic conduit that is used for XLPE cable systems.

These PTC specific costs can be considered "extras", however there are certain savings that come from using PTC, such as: reduction in the number of cable splices and vault splice vaults (due to longer lengths of cable that can be pulled) and less excavation and backfill (due to a smaller trench profile). Depending on project specific installation conditions, these savings often outweigh the cost of the extra equipment needed for PTC systems.

Q. Does this estimate include the reduction in impact and cost to the Towns' utilities?

A. No it does not. This is an added benefit and cost reduction that is difficult to estimate. But empirically with less excavation, it is reasonable to assume that there will be less impacts and less conflicts with existing utility and other unexpected obstacles.

Q. What are the other advantages of PTC over XLPE?

A.

- The rating of a PTC system can be increased by adding an air cooler or a chiller to cool the circulating dielectric fluid. Rating increases of up to 30% (or more) can be realized without further excavating along the route.

  The ampacity (current carrying capability) of an XLPE cable system cannot be easily increased. At most, the effects of some hot spots can be reduced by filling the annulus between the cable and the conduit with water or a thermal grout or installing heat pipes to counteract the effect of undesirable heat sources, such as crossing distribution cables or a steam or hot water pipe.
- PTC system result in a lower magnetic field because of better cancellation due to the conductors being in close proximity to each other (they are touching) and the attenuation from the steel pipe. XLPE cables cannot get this close to each other and they typically do not have a steel pipe to reduce the magnetic fields.
- PTC systems are very reliable and have experienced very few faults considering the many miles of cable installed and the years the systems have been in operation. The fact that 345KV PTC systems have been in service since 1964 demonstrates that it is a mature, well-proven technology.

Q. What are the disadvantages of PTC over XLPE?

A.

1) Concerns with Pipe Corrosion: The PTC system needs to stay filled with dielectric fluid and pressurized to a nominal 200 psig. The main disadvantage of PTC systems is the possible corrosion of the steel pipes. However, NSTAR Electric has been operating PTC since the 1940's, with over 200 miles of PTC.

2) Fluid Loss Due to Corrosion or Dig-In: Although the dielectric fluid is environmentally safe, any fluid spills must be cleaned up and handled by an authorized firm.

3) Additional Maintenance: A PTC system requires periodic monitoring of the pressurization system as well as the cathodic protection system. In addition, periodically samples of the dielectric fluid should be sampled to ensure the system is operating properly. However, Eversource currently has a significant PTC system, and the additional maintenance needs from this one additional circuit should be inconsequential

Q. The Middleton – Norwalk Project is referenced as the longest 345 kV XLPE project in the US in the response to the information requests. Do you know how many faults it has since it was installed in 2008? If so, how many?

A. Yes, 1.

Q. Can you compare the reliability of PTC to XLPE?

A. Both PTC and XLPE cable systems are very reliable. The majority of cable system failures are related to the accessories, which are installed by skilled splicers in the field. Although infrequent, the human error in the splicing can result in a failure at the accessory.

Less frequent is a failure of the cable itself. Both cable types are thoroughly tested at the factory before being shipped to the customer. However, defects can be introduced at the manufacturing facility and not noticed until after the cable has been installed and placed in service. PTC are more forgiving than XLPE insulated cables with respect for operating in the presence of a small manufacturing defect. The pipe contains dielectric fluid under a nominal 200 psig, which aids in suppressing any arcing or breakdown of the insulation. PTC systems can also develop leaks due to corrosion of the steel pipes, however if the cathodic protection system is maintained, the steel pipes are protected from corrosion. The cathodic protection system is part of the PTC infrastructure and normal maintenance activities.

Q. Where is it appropriate to use XLPE?

A. XLPE cable systems are appropriate for many different types of installations, including:

1. When utility does not have experience with PTC and the requirements to operate and maintain the pumping stations and cathodic protection systems.
2. Areas that do not have a significant amount of utility congestion.
3. Short lengths of cable that make the purchase of a pumping station cost prohibited
4. When the availability requirements of the circuit justify installing a spare phase to get the circuit back in service shortly after a cable failure.

Q. What happens to the capacity of XLPE or PTC when it is installed deeper than the proposed typical depth?

A. The capacity of the transmission line is often lower at deeper burial depths than the balance of the circuit, since it takes longer for the heat generated in the conductor to reach the earth's surface. These localized areas are called hot spots. A PTC employing fluid circulation can minimize or eliminate the ampacity reduction caused by the hot spot by continually introducing cooler dielectric fluid into the affected area.

Q. A response to an information request indicates that there are two spare positions for additional circuits at their Mystic pump house. Given these spare positions, are there any additional costs that NSTAR will need to account for that are not in your evaluation?

A. No, I prepared two separate estimates for comparison purposes; one for an XLPE cable system and one for a PTC system. The estimates accounted for the cost to furnish and install the two complete cable system. Internal utility costs and charges, taxes and maintenances cost were not included. As previously stated, given Eversource's current fleet of PTC circuits, the additional maintenance needs from this one additional circuit should be inconsequential.

Q. Is there a requirement for a redundant pump house at the opposite end of a PTC circuit?

A. There is no requirement for a redundant pump house at the opposite end of a PTC circuit.

Q. Is it your opinion that if the capacity is met, the costs are comparable, the infrastructure is in place to operate and maintain the PTC circuit, the footprint is smaller, the resulting magnetic field is lower and the reliability is well proven over time, PTC is the reasonable choice?

A. Yes

Q. How does the cost of the two technologies compare?

A. Based on nominal installation conditions, the costs for the two different cable technologies are essentially the same within the accuracy of the available information at this conceptual design stage. However, there are several other advantages of HPFF cable systems that should be considered.

HPFF cables are smaller and lighter than comparably sized XLPE cables, so longer lengths of HPFF cable can be placed on a reel and delivered to the job site. This allows for longer distances between adjacent splice vaults for HPFF cables over that for XLPE cables. The greater spacing between the cable splice vaults results in a significant reduction in the number of cable splices and cable splice vaults that have to be installed. Cable splice vaults can be difficult to install in older city streets, given their massive size and number of existing underground utilities. It is also well known that cable accessories such as splices and terminations are typically the "weak-link" with regards to cable system reliability.

A splice vault for a 345-kV XLPE cable system typically has outside dimensions of 10 ft. wide x 10 ft. high x 32 ft. long, while for 345-kV HPFF cable, the splice vault is typically less than 9 ft. wide x 9 ft. high x 24 ft. long. The smaller vaults for the HPFF cable systems are easier to install in a street already filled with existing utilities or in areas where rock needs to be excavated. It is also possible to put two or more HPFF circuits in the same splice vault, and allow workers to enter the vault with any or all of the circuits energized. Safety regulations typically do not allow workers to enter XLPE splice vaults while a circuit is energized, so utilities typically only put a single circuit in an XLPE splice vault.

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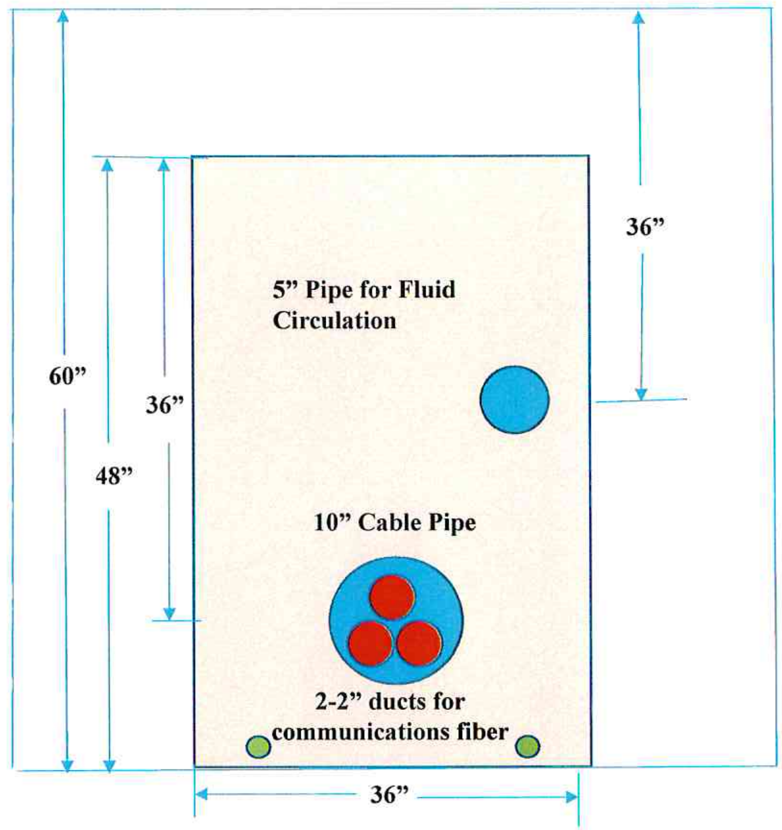
XLPE cables are typically installed in individual plastic conduits (one per phase, nominally 6 or 8 inches in diameter), while HPFF cables are installed with all three phases in a single steel pipe (nominally 8 or 10 inches in diameter). Trenches for pipe-type cables are significantly smaller than those for XLPE cables. Installing a 10-inch steel pipe is much easier in a city street than installing a large concrete duct bank with multiple conduits, especially when trying to thread the circuit around existing underground utilities. Additionally, the large concrete duct banks of XLPE cable systems make it difficult for future utilities to navigate around.

Q. Does this complete your testimony?

A. Yes.

SIGNED UNDER THE PAINS AND PENALTIES OF PERJURY THIS 22 DAY OF August 2016.

HPFF Trench Cross-Section



PETER L. TIRINZONI – SENIOR ENGINEER

Peter L. Tirinzoni received a Bachelor of Science degree in Mechanical Engineering from the University of Connecticut in 1982, a Master of Science degree in Mechanical Engineering from Rensselaer Polytechnic Institute in 1988, and a Master of Science degree in Electrical and Computer Engineering from Worcester Polytechnic Institute in 2011.

After qualifying on two submarine propulsion systems at General Electric, Mr. Tirinzoni joined Northeast Utilities (NU) in 1985 as an engineer in their Nuclear Engineering and Design Division. During his 15 years in the Nuclear Department, he performed many analyses, design modifications, and major upgrades to critical plant systems. Additionally, he was responsible for the procurement, installation, and commissioning of the world's largest fuel cell farm for use as the primary power supply to a juvenile detention facility in Connecticut.

In 2003, Mr. Tirinzoni joined the utility's Transmission Department where he performed engineering assignments related to the design, specification, construction, operation and maintenance of underground and subsea transmission cable projects. He has extensive experience witnessing sample, production and type testing and has been involved in several cable failure analyses and repairs. He developed many underground transmission standards, addressing material, design, and construction, and conducted technical and economic studies of alternate underground systems and route analyses.

Mr. Tirinzoni was responsible for several significant cable projects in Southwest Connecticut, including overseeing the final cable and duct bank system design, manufacturing, factory testing, installation and commissioning of the world's longest (24-mile, double circuit) 345-kV extruded cable project. He was also the technical lead for the design, specification, duct bank construction, cable installation, and commissioning of a 9-mile, double circuit 115-kV XLPE cable system and the replacement of seven, 12-mile, 138-kV single-core Self Contained Fluid Filled (SCFF) cables under the Long Island Sound with three 3-core XLPE submarine cables.

Mr. Tirinzoni was the technical lead for the design of the underground HVDC cable system to bring clean hydroelectric power to central New England, with responsibilities for vendor prequalification, cable system specification and RFP development, and bid evaluations and negotiations.

Mr. Tirinzoni is a senior member of the IEEE, its Power & Energy Society, and Standards Association. He is actively involved in the IEEE PES Insulated Conductors Committee (ICC) and serves as chair of its Educational Committee. While at NU, he was a member and chair of the Association of Edison Illuminating Companies (AEIC) Cable Engineering Committee, as well as chair of the Task Group performing a major update to AEIC CS9, "Specification for Extruded Insulation Power Cables and Their Accessories Rated above 46 kV Through 345 kV."

Mr. Tirinzoni is a past member of CEATI and the EPRI Underground Transmission Task Force (UTTF). He is also a past chair of the UTTF and served as a utility advisor on several EPRI and CEATI projects.

Mr. Tirinzoni has taught courses with Power Delivery Consultants, Inc. for several years, and joined the firm in 2015 where he continues to specialize in underground transmission cable systems.

Mr. Tirinzoni is a registered Professional Engineer in the state of Connecticut.

This is the testimony from the Mystic – Chelsea 14-04 Docket on Feb 04 p694-695 of the transcript.

Q. And in terms of -- I believe this project is using the XPLE type of cable?

A. [ZICKO] XLPE, cross-link polyethylene.

Q. Is there any difference in magnetic field between the XLPE versus oil-filled cables?

A. [VALBERG] Yes. The oil-filled, the conductors are brought much closer together, and that's why you need the oil-filled, because they need to conduct that heat away. So the fields from HPFF are lower.

Q. And in terms of a magnitude, do you have an idea of what the difference would be?

A. [VALBERG] It's somewhere between five- and tenfold. Partly -- there's two factors that apply there. One is the conductors are much closer together, so you get better cancellation. And No. 2, HPFF is surrounded by a metal pipe, and so that metal pipe, the ferromagnetic nature of that metal pipe also helps attenuate the field. So the combination of those factors makes it about five- or tenfold lower for comparable currents, as compared to XLPE.