282-520 & 282-521
115-kV Lines HPFF Refurbishment

Planning Advisory Committee Meeting

July 22nd, 2021

Agenda

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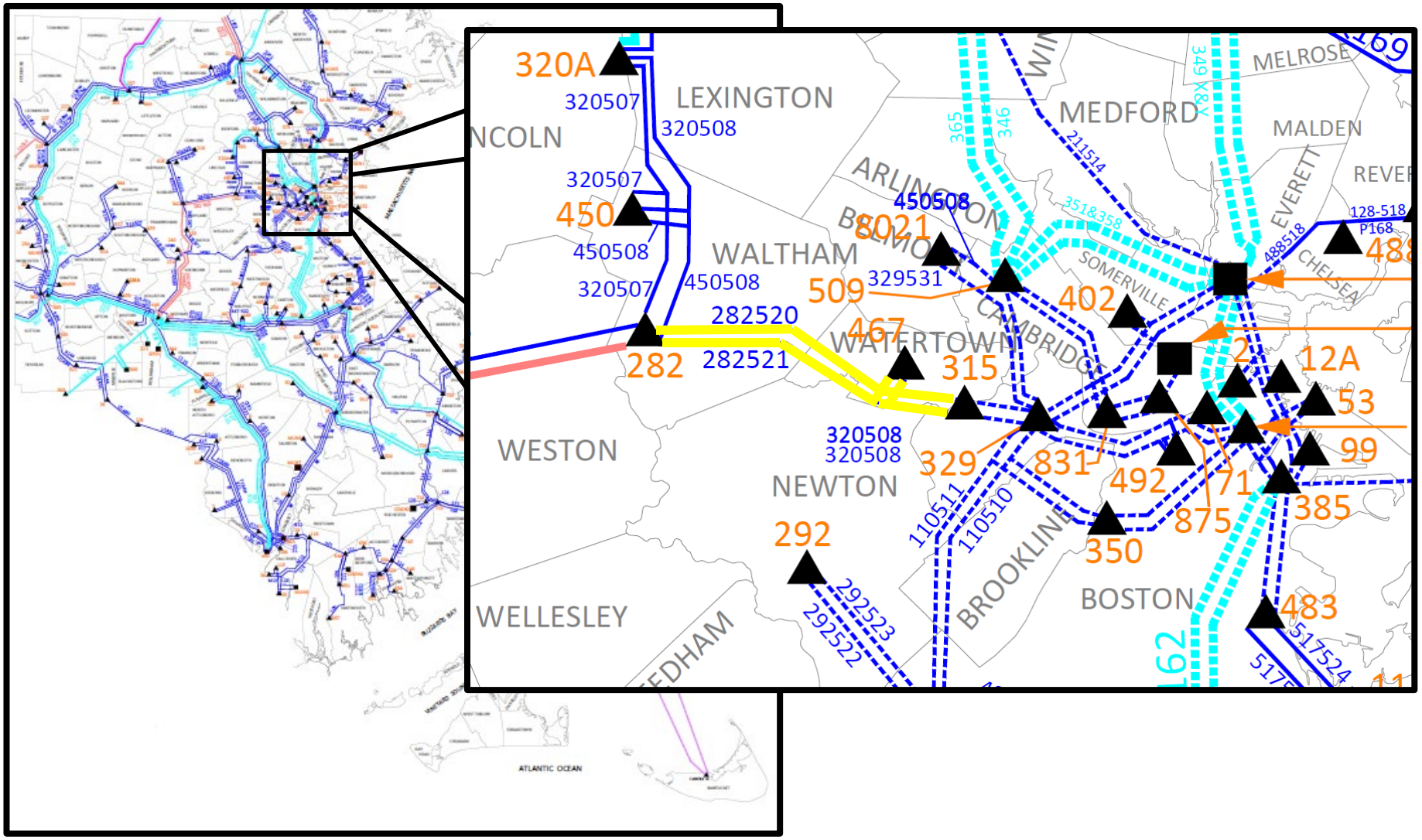
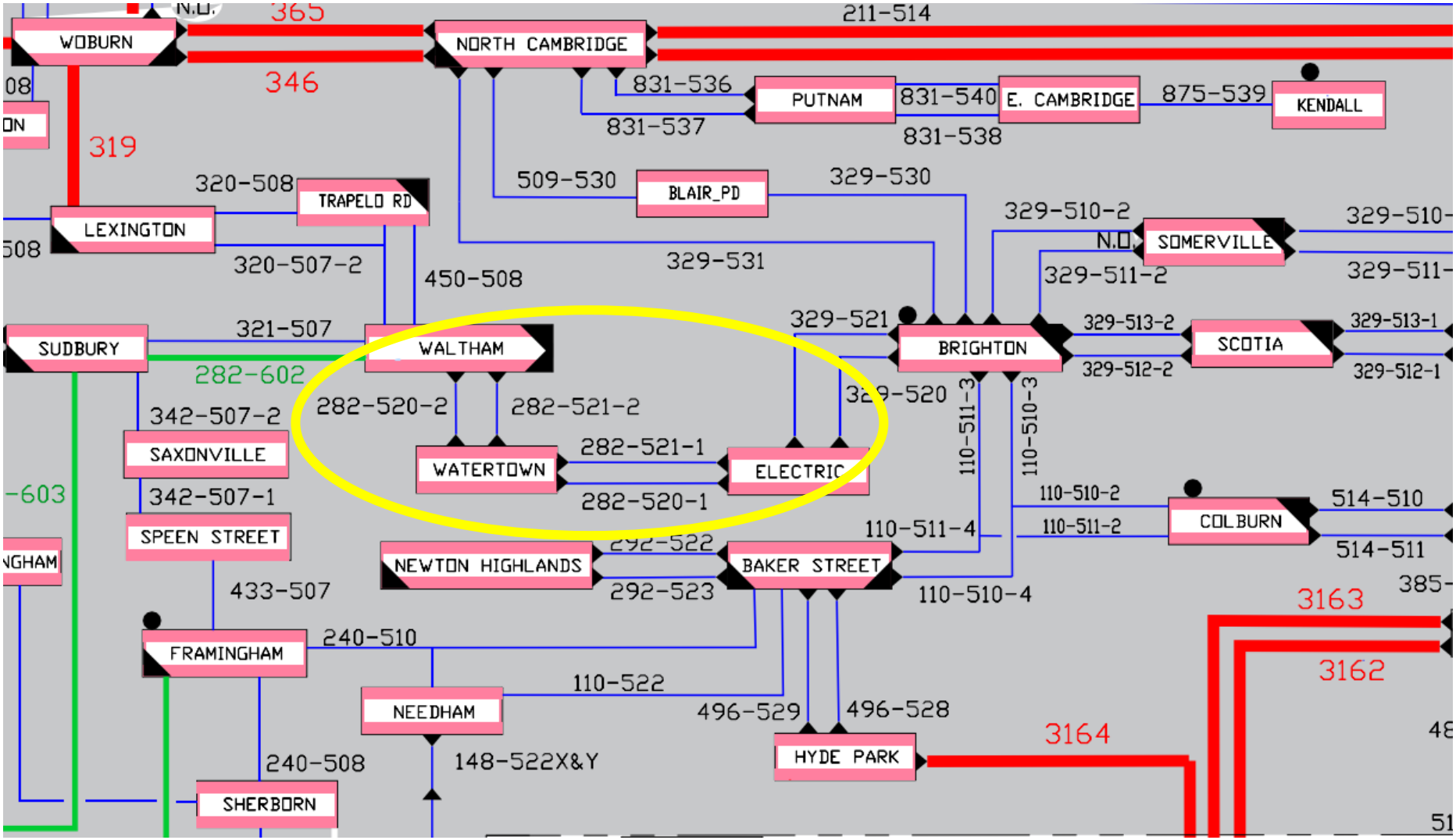
Line Details

- Lines 282-520 & 282-521
  - Lines 282-520 & 282-521 are 115-kV underground lines that supply power from Waltham Station 282 to Watertown Station 467 and Electric Avenue Station 315
  - 115-kV High Pressure Fluid Filled (HPFF) Pipe Type Cable (PTC) Circuit
  - Mostly 1250 kcmil Copper (Cu)
  - Paper insulation
  - Both lines were installed in 1967 and are over 50 years old
  - 12.66 circuit miles in length (total for both 282-520 and 282-521)

Project Location



Project Location – One Line Diagram



Project Drivers – Condition of Pipe

- Vintage of Lines
  - First segment of lines were installed in 1967 – over 50 years old
  - Cable design life expectancy is approximately 40 years
- Pipe Conditions
  - Over time, pipe exposure to the elements, proximity to neighboring utilities, and constant construction have caused significant degradation to the pipe coating and wall

Typical Pipe Degradation – Line 282-520

Typical Pipe Degradation – Line 282-520

Project Drivers – Condition of Pipe (Cont'd)

- Condition of Pipe in Manholes
  - Pipe condition inside manholes can be poor due to road salt seeping through manhole covers, causing further wall degradation over time
  - Most recent leak (2018) shows the need for enhancement of pipe condition at most exposed and susceptible areas (i.e., pipe sections in manholes)

Typical Pipe Degradation – Line 282-521

Typical Pipe Degradation – Line 282-521

Project Drivers - Environmental

- Leak History
  - Leaks over time have spilled more than 24,000 gallons of dielectric fluid/mineral oil
  - 45% of total gallons leaked were over two major events in the last six years
  - Leaks result in significant cleanup costs
  - Leaks include release to waterbodies
- EPA and MA DEP oversight and inquiries at a national and state level
  - Increasing scrutiny to eliminate/reduce leaks – lack of action may result in significant penalty

Date of Incident	Location	Leak (Gallons)
07/28/1985	Main St. and Spring St., Waltham	10,000
10/29/1986	1022 Main St., Waltham	550
03/23/2002	Station 282 Main St., Waltham	300
08/04/2008	Irving St., Watertown	2,500
02/14/2015	Main St. and Spring St., Waltham	4,000
07/31/2018	Main St. and Cuba St., Watertown	6,800

Project Drivers – Suppliers

- There is only one remaining supplier of HPFF cables in the world
- Potential loss of last remaining supplier of HPFF cable would make replacement with solid dielectric cable (i.e., XLPE) the only technically viable option
  - This would add time and considerable costs from the preferred solution

Project Drivers – Efficiency

- Opportunities to validate and improve pipe and cable condition at the same time
  - Most effective way to validate pipe integrity is while cable is removed (magnetic flux measurements)
  - Cable removal allows the installation of new, larger cables
- Reconductoring both cables sequentially optimizes mobilization and material costs
- Significant rehabilitation of manholes, pipes, splices, and cable will extend life of asset
- Refurbishment will extend service life of cable system while reconductoring is still a viable option

Project Drivers – Summary

- Pipe Condition
  - Over time, pipe exposure to the elements, proximity to neighboring utilities, and construction have caused degradation to the pipe coating and wall in specific areas, making loss of fluid a significant concern
  - These areas of thinning pipe wall are difficult to locate and identify with our traditional methods of pipe maintenance and testing
- Single Supplier
  - Potential loss of last remaining supplier of HPFF cable would make replacement with solid dielectric cable the only option
- Reliability
  - Fluid leaks typically take weeks to locate and repair, resulting in extended outages

Project Drivers – Summary

- Safety/Environmental Risks
  - This project will mitigate safety and environmental risks associated with a cable failure and/or pipe breach
  - Fluid entering waterways is of high concern to the public and environmental regulators
    - Cleanup costs when fluid impacts a waterway are extremely high
  - Environmental actions from the state Department of Environmental Protection, federal Environmental Protection Agency, and United States Coast Guard are expected when fluid enters a waterway
  - Fluid on the roadways has resulted in safety concerns to the public, roadways being shut down, and extensive cleanup costs

Project Scope – Pipe and Manhole Condition Mitigation

- Coating Testing and Resistance Measurements
  - To be completed segment by segment (i.e., vault to vault) to determine locations of coating holidays (i.e., loss of coating protection)
- Manhole Pipe Rehabilitation
  - At all manhole locations, all pipe shall be recoated and all pipe (including penetrations into the vault) shall be stripped, inspected, repaired, and re-sleeved to address and prevent further degradation
- Magnetic Flux Density (Smart Pigging)
  - Run the smart pig through each section of vacant pipe to document exact level of remaining wall thickness
  - Areas where wall thickness has deteriorated will be addressed as necessary (i.e., repair sleeves, pipe wrapping, etc.)
- Bend and Buried Joint Evaluation
  - Aggressive bends and locations of existing buried joints (two locations) shall be evaluated for possible opportunities for line realignment and removal

Project Scope – Cable Reconductoring

- Replace 12.66 miles of 115-kV three phase high pressure fluid filled (HPFF) underground cable between Waltham Station 282, Watertown Station 467, and Electric Avenue Station 315
- Existing 1250 kcmil paper insulated copper conductor will be replaced with 2000 kcmil Laminated Paper-Polypropylene (LPP) insulated copper conductor
  - 2000 kcmil is standard for Eversource in replacement considerations to minimize number of spare reels and accessories on hand (for 115-kV in 6” pipe)
  - Larger conductors allow cable to run cooler (increased life), and have increased ratings
- Install 115-kV splices (10 per circuit) and replace six (6) air potheads (transition component from overhead line to underground cable) at Waltham Station 282, and twelve (12) at Watertown Station 467

Project Scope – Ratings and Impedances

Line Section	Existing Conductor Summer Rating (MVA)			New Conductor Summer Rating (MVA)		
	Normal	LTE	STE	Normal	LTE	STE
Both Lines In						
282-520 - Station 282 to 467	120	155	240	120	252	602
282-520 - Station 467 to 315	120	155	240	120	252	602
282-521 - Station 282 to 467	120	155	240	120	252	602
282-521 - Station 467 to 315	120	155	240	120	252	602
One-Line In						
282-520 - Station 282 to 467	140	155	240	149	267	609
282-520 - Station 467 to 315	140	155	240	149	267	609
282-521 - Station 282 to 467	140	155	240	149	267	609
282-521 - Station 467 to 315	140	155	240	149	267	609

Current and Proposed Summer Line Ratings

Line	Existing Conductor Impedance and Charging Power %			New Conductor Impedance and Charging Power %		
	R	X	B	R	X	B
282-520 Station 282 to 467	0.24	0.89	14.46	0.173	0.771	20.4
282-520 Station 467 to 315	0.0778	0.2706	5.176	0.056	0.252	6.7
282-521 Station 282 to 467	0.24	0.9	14.46	0.173	0.771	20.4
282-521 Station 467 to 315	0.0778	0.2706	5.176	0.056	0.252	6.7

Current and Proposed Impedance and Charging Power

Project Alternatives

- Do nothing
  - Not a prudent option due to the demonstrated asset condition issues documented in this presentation in a critical part of the system
- Rebuild the lines with XLPE
  - Requires all new ductbank, civil work, and lengthy siting, permitting, and construction processes
  - Does not quickly address critical condition of existing 282-520 and 282-521 HPFF cables

Summary

- Complete comprehensive pipe investigation and mitigation plan on lines 282-520 and 282-521
- Replace 12.66 miles of existing 1250 kcmil copper HPFF conductor with 2000 kcmil LPP copper conductor on the underground 115-kV lines between Waltham Station 282, Watertown Station 467, and Electric Avenue Station 315

Estimated Cost = $69.6 Million (-25% / + 50%)

Projected In-Service Date: Q3 2023

Questions