EVERSOURCE ENERGY

To: Planning Advisory Committee

From: Eversource Energy

Date: June 12, 2024

Subject: Stakeholder Feedback on Eversource's Proposed X-178 Rebuild Project

Following Eversource's initial presentation of the X-178 Rebuild project to the Planning Advisory Committee on February 28, 2024[1], stakeholder feedback was requested by March 14, 2024. In order to provide a more cohesive response to lines of questioning that were repeated by several stakeholders, rather than responding to individual questions, Eversource has drafted this memo to provide additional information to stakeholders on the following topics:

- The history of the X-178 line
- The selection of transmission line conductor, including the extent to which the replacement of the conductor will address potential future needs identified in the ISO-NE 2050 Study
- Telecommunications needs and analysis driving the proposed installation of Optical Ground Wire (OPGW) as part of this project
- Project reporting and outreach efforts
- Development and analysis of solution alternatives in addition to those originally presented in February

Questions that may be better addressed in other forums or that do not meet ISO-NE's Guidelines for Public Comment[2] can be submitted to Eversource at nhprojectsinfo@eversource.com. Additionally, Eversource is only responding to questions that were received through March 14, 2024.

[1] https://www.iso-ne.com/static-assets/documents/100008/a05_2024_02_28_pac_line_x178_rebuild_presentation.pdf
[2] https://www.iso-ne.com/static-assets/documents/100008/2024_02_27_pac_guidelines_for_public_comments.pdf

History of the New Hampshire X-178 Line and Surrounding Region

The X-178 line consists of 3 segments. See Figure 1 for an overview map of the segments.

- Segment 1 (X-178-1, Southern Segment) is located between Beebe River Substation, located in Campton, and North Woodstock Substation, located in Woodstock. Segment 1 was previously part of the A-111 line until it was renamed to the X-178 line in 1976.
- Segment 2 (X-178-2, Middle Segment) is located between North Woodstock Substation and Streeter Pond Tap in Sugar Hill. Segment 2 is approximately 14 miles long and reaches elevations of over 2,600 feet. A 9-mile portion of this segment runs through the White Mountain National Forest (WMNF) and has a single right-of-way (ROW) access point, which will require extremely long access roads for structure replacements. To replace certain structures, construction equipment will likely need to be delivered by helicopter.
- Segment 3 (X-178-3, Northern Segment) is located between Streeter Pond Tap in Sugar Hill, and Whitefield Substation in Whitefield.

All three segments of the X-178 line were originally constructed with wood structures and placed in-service in the early 1950s. In 1969, Segment 3 was rebuilt between Streeter Pond Tap and Whitefield Substation with new wood structures and was also reconductored using 795 ACSR 26/7. Most of the structures installed in 1969 and the 795 ACSR 26/7 ACSR remain in place today. Segments 1 and 2, from Beebe River Substation to Streeter Pond Tap were reconstructed in 1985 using wood structures and also reconductored using 795 ACSR 26/7.

Today, most of the structures on the X-178 line date back to the 1969 or 1985 reconstructions, though a limited number of structures were replaced at other times as part of smaller construction projects and a small number of original 1950s-vintage structures remain. Tables 1 and 2 provide an overview of the structure ages and materials used.

Figure 1 – Line X-178 Geographical Location

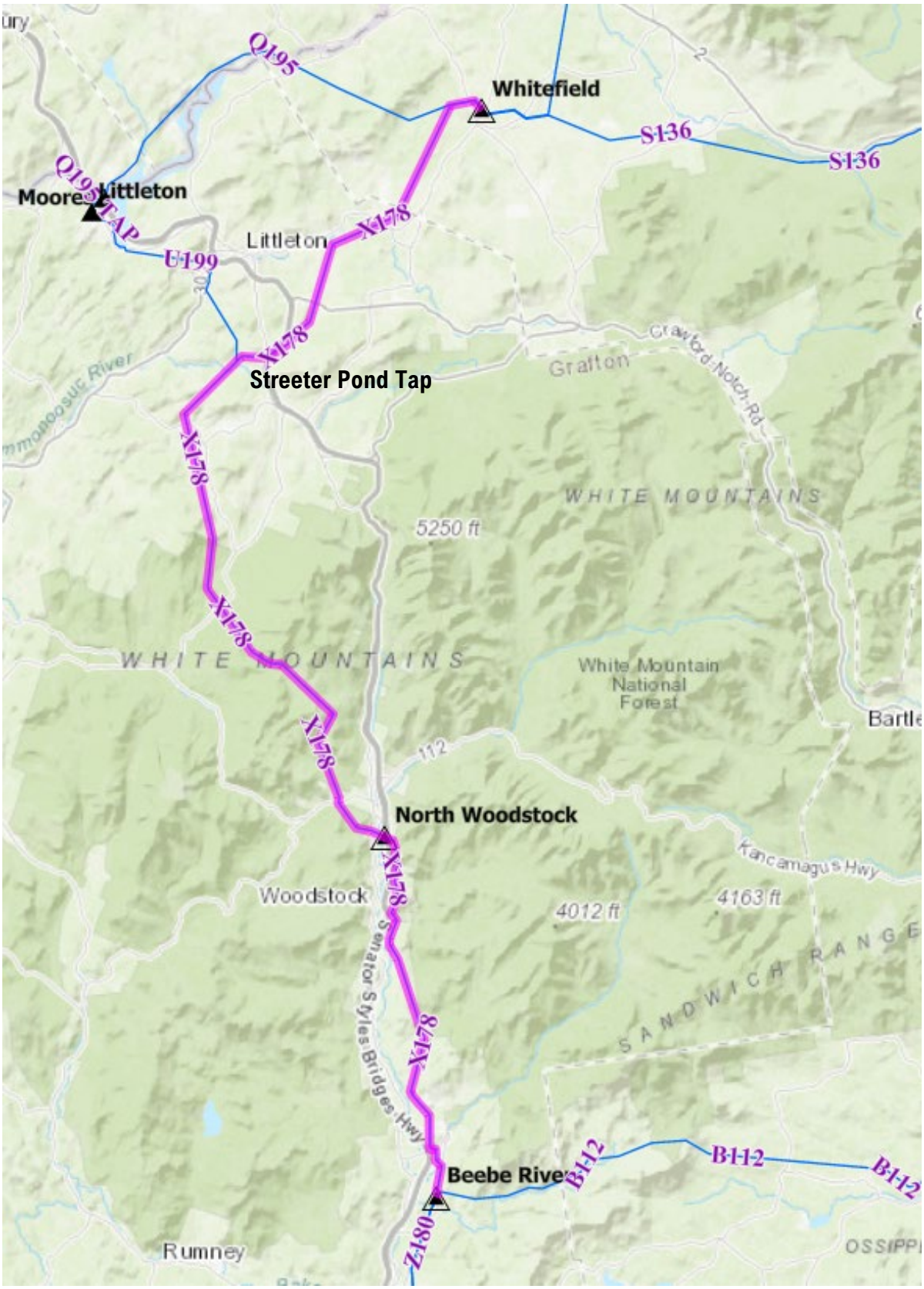

Table 1 – X-178 Structure In-Service Years

Year	X-178	Segment 1	Segment 2	Segment 3
1953[3]	28	28	0	0
1958	2	0	0	2
1969	175	0	0	175
1971	22	21	1	0
1983	83	1	79	3
1985	266	112	151	3
2002	2	0	0	2
2012	2	0	1	1
2015	1	1	0	0
2020	11	11	0	0
2023	2	1	0	1
Total	**594**	**175**	**232**	**187**

Table 2 – Line X-178 – Existing Structure Types

Structure Type	Segment 1	Segment 2	Segment 3	Total
Natural Wood	163	231	185	579
Laminated Wood	0	1	1	2
Steel	11	0	0	11
Weathering Steel	1	0	1	2

Eversource performs several types of inspections on our transmission lines, including biennial drone inspections. The inspection data provided on slide 5 of our February presentation on the X-178 was a result of the 2022 inspection, which was the most recently completed inspection at the time the presentation was prepared. The results of the 2022 inspection are shown in Table 3. Eversource utilizes Electric Power Research Institute's (EPRI) Field Guides of visual inspections to grade the condition of structures, as summarized in Table 4. The guidelines have four maintenance priority ratings from A to D.

[3] Some structures may have been installed earlier than 1953, as the line was constructed.

Table 3 – Line X-178 – 2022 Drone Inspection – Structure Ratings

Structure Rating	Segment 1	Segment 2	Segment 3	Total
A	9	0	1	10
B	148	227	168	543
C	18	5	18	41
D	0	0	0	0

Table 4 – EPRI Visual Inspection Priority Ratings

Maintenance Priority Rating	Definition
A	Nominal defect No action required
B	Minimal defect Monitor degradation
C	Moderate defect Rehabilitation recommended as scheduled maintenance[4]
D	Severe defect Repair, reinforce, or replace as soon as possible[5]

Drone inspections account for visual inspection of above ground condition of the structures. Other aspects of concern such as pole rot below grade and grounding condition are identified with ground line inspections.

As a result of the 2022 drone inspections, a total of 41 natural wood structures were classified as priority C with one or more of the following deficiencies: woodpecker damage, pole top rot, cracked arms, split pole top, and/or decay. These 41 structures are dispersed throughout the 49-mile length of the line. Two B-rated Laminated Wood System (LWS) switch structures at Streeter Pond Tap were also identified as high-priority asset condition concerns.[6]

The X-178 line is Eversource's only 115 kV transmission line between central and northern New Hampshire. In October 2018[7], Eversource presented to the PAC an asset condition project for the line, targeting replacement of 56 structures on the X-178 line primarily due to asset condition needs. This

[4] Identification of C-rated structures would cause Eversource to begin planning a construction project to replace the structures, though it may take up to several years to complete a construction project based on the time needed for design, engineering, procurement, permitting, outage scheduling, etc.
[5] A D-rated structure is at risk of failure and would typically be replaced or repaired within days.
[6] Eversource has been systematically and proactively replacing all LWS structures across our entire transmission system. LWS structures are particularly susceptible to internal rot and degradation, which cannot be detected during visual aerial or ground inspections. See https://www.iso-ne.com/static-assets/documents/2023/06/a05_2023_06_15_pac_laminated_wood_structure_replacements_phase_3.pdf
[7] https://www.iso-ne.com/static-assets/documents/2018/10/a5_115kv_structure_replacement_and_asset_conditions_multiple_lines.pdf

project was later canceled due to project delays and updated line inspections which identified additional needs.

X-178 Line Design and Conductor Selection

Even seemingly simple project design decisions, such as conductor selection, are affected by numerous factors, including, material cost, tensile strength, electrical characteristics, product availability, capacity, line loading, clearance requirements and availability/cost of replacement parts and equipment. For most projects, Eversource uses widely available standard conductor sizes and technologies in order to take advantage of supply chain efficiencies, simplify designs, and lower long-term maintenance costs. Conductors typically evaluated include:

- ACSR (Aluminum Conductor, Steel Reinforced). This conductor uses a stranded steel core to help support several outer layers of aluminum stranding, which carry most of the electrical current in the line. ACSR was the standard conductor type for Eversource for many decades.
- ACSS (Aluminum Conductor, Steel Supported). This conductor uses a stranded steel core similar to ACSR, but uses *annealed* aluminum stranding to allow operation at higher temperatures, and with lower sag, compared to ACSR. This has been Eversource's standard conductor for over a decade.
- ACCC (Aluminum Conductor, Composite Core). This conductor uses a carbon fiber composite core surrounded by annealed aluminum stranding similar to ACSS. This wire type has a higher material unit cost compared to ACSS because of the proprietary composite core and annealed aluminum. The high strength of this wire and lighter weight allows for increased span lengths.
- ACCR (Aluminum Conductor, Composite Reinforced). This conductor makes use of alumina oxide strands suspended in an aluminum zirconium matrix to make up the core strands. The outer strands are made up of a hardened aluminum dope with zirconium to make the hardened aluminum thermally stable allowing for very high operating temperatures without losing strength to annealing. This conductor has the highest cost of any of the commercially available conductor technologies because of the doping elements used in the production.
- TS Conductor. This conductor is similar to ACCC conductor in that the conductor has a carbon fiber core, but the entire core is encapsulated in aluminum. This encapsulation provides higher mechanical strength relative to ACCC while still maintaining the low sag at higher temperatures. Also similar to ACCC, the outer strands are completely annealed and provide little strength to the overall conductor. This conductor also has a higher cost relative to ACSS.

As part of the development and design phase of this project, Eversource evaluated several options for conductor replacement and concluded that, for a number of reasons, ACSS is the best choice.

ACSS has similar sag and conductor spacing in comparison with the existing line, which enables a design that has improved construction efficiency for several reasons. First, new structures can be placed near existing structures using shared construction pads, which reduces cost and the overall construction footprint. Second, use of ACSS allows more construction to be performed using live-line methods, minimizing the number of line outages that will be required. ACCC conductor has different mechanical properties and would result in some new structures being placed at locations that are mid-span on the existing line.

All of the evaluated conductor types would increase the average structure heights on the line. The average existing structure height for the X-178 line is 50.6 feet and the proposed average structure height is 63.6 feet when utilizing ACSS. This results in an average height increase of just under 13 feet. The primary driver of the height increase is Rule 250D of the National Electrical Safety Code. Rule 250D was introduced in 2007 and currently requires that transmission lines in this area of New Hampshire be designed to withstand 1-inch of radial ice with 40 mile-per-hour winds.

While many High-Temperature Low-Sag ("HTLS") conductors, including ACCC, ACCR and TS conductors, offer lower sag at higher temperatures, the maximum sag evaluated for the X-178 line design is governed by ice loading, not the conductor temperature. Under ice load, the maximum sag of HTLS conductors is similar to ACSS. For most portions of the X-178 line, no structure height savings would be possible with the use of a HTLS conductor compared to the use of ACSS.

Role of Optical Ground Wire and X-178 Communications Needs

Communications between substations plays a key role in maintaining a safe and reliable transmission system. When identifying needs related to existing or legacy communications infrastructure, Eversource considers the following:

1) Mandatory standards and requirements. Key standards include:
    a. North American Electric Reliability Corporation (NERC) Critical Infrastructure Protection (CIP) standards and Protection and Control (PRC) standards
    b. Northeast Power Coordinating Council (NPCC) Directory D4 – Bulk Power System Protection Criteria
    c. ISO-NE Operating Procedure No. 18 (OP-18)
2) Industry and Eversource best practices and standards. Key standards include:
    a. IEEE C37.113 IEEE Guide for Protective Relay Applications to Transmission Lines
    b. IEEE 1613 – Consideration of Service Provider Infrastructure
3) Bulk Electric System (BES) classification and impact rating of the associated substations
4) Availability of equipment and potential end-of-life issues
5) Reliability of equipment and communication channels
6) Added value benefits of communications infrastructure upgrades

Seven transmission substations in northern New Hampshire will be connected to Eversource's fiber communications network once Optical Ground Wire (OPGW) is installed on the X-178 line. Today, each of these substations is dependent on 3rd party leased line services. This means that communications to support the metering and telemetry required by ISO-NE OP-18, control and security systems needed to comply with the NERC CIP standards, and, in some cases, system fault protection (relaying) are being carried over "land line" services leased from a third-party telecommunication provider. These leased lines have become increasingly unreliable over the past 10 years, furthermore, some services may be discontinued before the end of the decade. The installation of OPGW technology will improve communications and reduce reliance on 3rd party leased line services.

X-178 Line Outreach Efforts

Stakeholder outreach efforts for the X-178 Rebuild project began in April 2023 with the notification and project briefing to municipal officials in the nine towns along the X-178 line. Once the municipal briefings were completed, project introduction letters were sent to property owners containing information about the project, including an anticipated timeline and New Hampshire Projects Hotline contact information where stakeholders could reach an Eversource representative to get additional information or request a site visit. Three months after the project introductions were mailed, postcards were sent to property owners and provided to municipal officials inviting stakeholders to attend two Public Information Sessions scheduled for August 2023. These were held in towns along the X-178 ROW and included subject matter experts from the construction and environmental licensing and permitting teams. These project experts provided project mapping and town-specific details about the project at each session and provided stakeholders the opportunity to ask specific questions in-person. In late October 2023, another postcard was sent to property owners and municipal officials along the X-178 line inviting them to contact Eversource with questions, concerns, or request to meet with us at their property. Following this mailing, targeted door-to-door outreach was conducted in all communities to further connect with property owners.

Eversource also offered and held multiple briefings to municipal Conservation Commissions ahead of submitting permit applications to share information, including a project overview, schedule, and permits to be submitted. Since April 2023, Project outreach representatives have made over 73 unique commitments and have made over 200 direct contacts with abutting property owners, through either email, phone or in person site visits. The dedicated project outreach representatives can be reached by contacting the Hotline at 1-888-926-5334 or through the link, NHProjectsInfo@eversource.com. For most larger projects, including the X-178 Rebuild project, Eversource also develops and maintains a project webpage on our website. Project websites can be found by navigating to the "Major Projects"[8] page from the main Eversource.com website. These project websites provide specific information about upcoming or active projects, including a project overview, schedule, mapping, recent communications and local construction updates (once the project is in active construction). Project websites are reviewed regularly and updated when new information is available, such as refreshed mapping or communications.

Solution Alternatives Development

As noted in the history section above, the 43 structures (41 priority C structures and two LWS structures) identified during the latest line drone inspection are dispersed throughout the 49-mile length of the X-178 line. Access challenges are present due to the remote location of the transmission line and the nature of the terrain. Further, additional environmental protections in areas such as the

[8] https://www.eversource.com/content/residential/about/transmission-distribution/projects/new-hampshire-projects/beebe-river-to-whitefield-line-rebuild-project

White Mountain National Forest present unique and costly challenges to access many portions of the right-of-way.

In response to stakeholder feedback, Eversource has developed additional solution alternatives for consideration. Alternatives 1 and 2, described below, are new solution alternatives that were developed since the original February 28 PAC presentation, and are different than the solutions alternatives originally described. Alternative 1 from the original PAC presentation has not been advanced for further consideration. Alternative 2 (full rebuild) from the original PAC presentation continues to be a viable alternative and is presented below as Alternative 3.

Alternative 1 would involve the replacement of the 43 structures that require immediate replacement and any nearby structures that become overstressed due to conductor and/or shield wire tensions created by the installation of replacement structures. This alternative does not include reconductoring or the replacement of the existing shield wire with OPGW.

Alternative 2 would include all of the structure replacements from Alternative 1, plus any additional structures that can be efficiently replaced during the construction activities necessary to access the structures that would be replaced as part of Alternative 1. This alternative does not include reconductoring or the replacement of existing shield wire with OPGW. All of the additional structures to be replaced would be older than 40 years and rated as priority B during the most recent inspection. A total of 170 structures would be replaced as part of Alternative 2. The cost estimate for Alternative 2 is $91.7 million (in 2024 dollars).

Constructing Alternative 2 would leave many structures that are older than 40 years in-place on the line. These structures will continue to deteriorate and will eventually need to be replaced through future projects. For example, additional priority C structures not included in Alternative 2 have already been identified during the 2024 aerial inspection cycle, which remains ongoing. Eversource attempted to quantify the potential costs of additional future projects. We assumed that two additional projects would be required over the next 13 years as additional structures deteriorate on the line. The first additional project would be constructed in approximately 2030 and would involve replacement of approximately 50% of the remaining wood structures on the line. This project was estimated to cost $110.6 million (in 2024 dollars). The second additional project would be constructed in 2038 and would involve the replacement of all remaining wood structures on the line, along with the installation of new conductor and OPGW. This project was estimated to cost $234.3 million (in 2024 dollars). The total cost in the line would be $436.6 million (in 2024 dollars) and would effectively result in a complete rebuild of the line over a 13-year period, concluding in 2038. The total cost would be $574.1 million when the estimates are escalated to the assumed year of construction.

The exact timing of future construction projects on the X-178 would be based on future inspection results and telecommunications needs and may differ from the hypothetical projects described above. For example, structures could deteriorate more quickly than assumed or leased telecommunications services could be discontinued prior to the assumed installation of OPGW in 2038. Any of these factors could lead to additional construction projects on the X-178 beyond the hypothetical projects described above, including the possibility of a full line rebuild being necessary prior to 2038.

Alternative 3 would include a full rebuild of the X-178 line by approximately 2026, as presented to PAC on February 28, 2024, with a cost estimate of $384.6 million (in 2026 dollars). This estimate is equivalent to $360.8 million in 2024 dollars.

Comparative Analysis of Solution Alternatives

Pursuing Alternative 1 would lead to many additional, future structure replacement projects on the line in the near-term as existing structures continue to deteriorate. Additional structure replacements under future projects would require access to the same portions of the ROW, which would be inefficient from a construction and cost perspective and result in higher environmental and community impact due to repeatedly accessing the ROW over the course of several years. As a result, Alternative 1 was eliminated from further consideration. A cost estimate was not developed for Alternative 1.

Table 5 is a comparison matrix comparing Alternative 2 and Alternative 3.

Table 5 – Solution Alternative Comparison Matrix

Key Factors	Alt 2	Alt 3
Lowest initial cost	✓	✗
Lowest long-term cost	✗	✓
Overall System Performance and Reliability	✗	✓
Expected ease of permitting	✗	✓
Ease of constructability	✓	✓
Shorter initial construction duration	✓	✗
Long-term environmental impact	✗	✓
Long-term abutter impact	✗	✓
Preferred Solution	✗	✓

As described above, Alternative 2 would have lower initial construction costs, but higher anticipated costs over time as additional structures deteriorate on the line, relative to remobilization and increased labor and material costs. This alternative would also have higher environmental and community impact over time due to repeated access to the ROW. And, finally, this alternative would preclude the installation of new conductor and high-speed communication for many years.

A full line rebuild (Alternative 3) would have higher initial costs but lower anticipated costs over time. It would avoid future disruptions to the environment and local communities and provide near-term improvements to telecommunications capabilities for northern New Hampshire substations and avoid potential future projects to install OPGW or upgrade conductor. Based on these factors, Eversource continues to select the full line rebuild (Alternative 3) as the preferred solution for the X-178 line.

Evaluation of ISO-NE 2050 Study Results

The X-178 line was overloaded in some scenarios in the ISO-NE 2050 Study. Excluding the 2050 57 GW Winter peak scenario, the highest loading was 344 MVA under certain N-1-1 contingencies in the 2050 51 GW Winter peak scenario.

Achieving a winter Long-Term Emergency (LTE) rating of 344 MVA on the X-178 line would require upgrades to both the line conductor and substation equipment. The existing winter LTE rating of the line conductor is 278 MVA. Installation of 1272 ACSS 54/19 “Pheasant” conductor as part of Alternative 3 would increase the winter LTE rating of the conductor to 518 MVA, which exceeds the highest post-contingency flow observed during any scenario in the 2050 Study (including the 2050 57 GW winter peak scenario). The line itself would then be limited to 254 MVA due to substation equipment, which could be addressed as part of a future project.